What drives financial hedging?

A meta-regression analysis of corporate hedging determinants*

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Abstract

We examine the drivers of heterogeneity for the determinants of corporate hedging by applying meta-regression analysis on a sample of 175 primary studies. Taken all previous findings together, hedgers are large, profitable and geographically diversified firms with high capital expenditures and dividend payouts, large debt ratios, and low interest coverage. When breaking the effects down across different world regions, it becomes apparent that the importance of the hedging determinants varies and not all determinants have the same relevance in all geographical areas. Moreover, we find that the type of risk exposure, the source of the hedging data, the inclusion of relevant control variables, and the journal ranking of the publication outlet explain the variation in previous results. There is also evidence that accounting for endogeneity and operational hedging methods are responsible for differences in the reported findings. Researchers should be aware of these drivers of heterogeneity when comparing and interpreting empirical estimates for the hedging determinants obtained from different data and method selections.

1 Introduction

The question why non-financial firms engage in corporate hedging ranks among the most intensively discussed topics in corporate finance.[1] Classical finance theory claims that within a perfect capital market, financial hedging is irrelevant to firm value (Modigliani and Miller, 1958). However, more recent theories identify situations, in which hedging at the firm-level might be a value-enhancing strategy by reducing the costs of cash flow volatility arising from financial distress and bankruptcy, taxes, costly external financing, asymmetric information and agency conflicts (Bessembinder, 1991; DeMarzo and Duffie, 1991; Froot et al., 1993; Smith and Stulz, 1985). When it comes to the empirical investigation of the hedging theories, findings are rather mixed and do not allow any final conclusions, as emphasized in previous literature:

> *"As a whole, the findings of empirical studies [on corporate hedging] remain controversial because conclusions are largely sample specific." (Bartram et al., 2009, p. 185)*

> *"While the empirical studies are informative, they provide conflicting evidence as to which class of determinant is driving corporate derivatives usage." (Howton and Perfect, 1998, p. 53)*

> *"There is inconsistency in the risk management literature regarding the extent to which firms use financial derivatives." (Treanor et al., 2013, p. 64)*

In summary, previous authors suggest that the lack of robust results in the empirical hedging literature might be explained by the fact that existing studies widely differ in terms of their data sources (e.g., time period or type of risk exposure under examination), estimation techniques (e.g., inclusion of industry fixed effects or accounting for endogeneity), model specifications (e.g., inclusion of certain control variables), and study quality (some studies are published in prestigious peer-reviewed journals, others are unpublished working papers or doctoral theses). In addition, a recent strand of the literature puts forward that country-specific conditions and regional differences, such as the cultural environment, are important factors when searching for differences in the hedging behavior of non-financial firms (Bartram et al., 2009; Lel, 2012; Lievenbrück and Schmid, 2014). In summary, each of these factors might affect the reported results ending in a great diversity of possible explanations for the ambiguous empirical evidence.

In this study, we apply meta-regression analysis (MRA) to explain the heterogeneity in existing

[1] Early studies on the determinants of corporate hedging policy are Francis and Stephan (1990), Nance et al. (1993), or Smith and Stulz (1985).

empirical results. MRA is a statistical tool to model the effect of any aspect of study design for which information is available, to identify its impact on the reported results, and to correct for distorting effects through publication selection bias and model misspecification (Stanley, 2001). To apply MRA, we build on a sample of 7,024 manually collected estimates from 175 empirical primary studies[2] and analyze the impact of the fourteen most frequently examined hedging determinants, while accounting for geographical heterogeneity and differences in the data and methodological set up of the studies. Thereby, we contribute to the literature in several ways: (i) We present a quantitative summary of the complete body of empirical estimates on the determinants for both the decision to hedge and the extent of hedging, (ii) we analyze whether previous literature suffers from selective reporting of statistically significant results (publication selection bias) and report mean effects of the hedging determinants corrected for this bias, and (iii) we quantify the impact of a broad set of observable differences in study design on the reported empirical estimates. Through this analysis, we empirically address some intensively discussed issues in the literature, such as the impact of the type of risk exposure on the hedging behavior, differences between the decision to engage in corporate hedging and the extent of hedging, the effect of econometric challenges (such as the endogeneity of corporate financial decisions), as well as the influence of country-level factors.

The remainder of this study is outlined as follows. Section 2 contains the theoretical foundations and a review of the related literature. Section 3 describes the MRA methodology. Section 4 presents the construction of the sample of primary studies and the data preparation. Section 5 includes the selection of explanatory variables, which are assumed to affect the variation in previous research results. Section 6 presents the meta-analytical results, which are discussed in Section 7. Section 8 concludes. An online supplement provides additional materials and robustness tests.[3]

2 Hedging theories and related literature

According to Modigliani and Miller (1958), risk management activities do not contribute to firm value, as shareholders can effectively hedge risk on a private level.[4] Indeed, this proposition relies on the assumption of a perfect capital market. By incorporating market imperfections, scholars developed two

[2] Within this paper, we use the term *primary studies* to refer to the original empirical studies collected for synthesis in the meta-analysis.
[3] The supplement can be downloaded from the IRFA journal website or from https://doi.org/10.13140/RG.2.2.17071.79527/1.
[4] MacMinn (1987) shows that the irrelevance theorem by Modigliani and Miller (1958) is also valid for corporate risk management policy.

lines of theories serving as explanation why non-financial firms engage in corporate hedging. The shareholder value maximization hypothesis proposes that firms hedge to increase firm value by lowering costs associated with cash flow volatility. These costs could result from financial distress, expensive external financing and underinvestment, greater tax payments, or expenses to mitigate information asymmetries between shareholders and managers (DeMarzo and Duffie, 1991; Froot et al., 1993; Smith and Stulz, 1985). In contrast, the managerial utility maximization hypothesis sees hedging to be motivated by managers' personal interests arising from the willingness to reduce their private risk exposure or to signal managerial abilities to the labor market (DeMarzo and Duffie, 1995; Smith and Stulz, 1985). Apart from the two main hedging hypotheses, empirical research has identified a number of other firm characteristics which are supposed to impact costs and benefits of corporate hedging, for example, the existence of hedging substitutes, the level of a firm's risk exposure, economies of scale in the hedging costs, or country-level differences (Allayannis et al., 2001; Géczy et al., 1997; Nance et al., 1993).[5] A detailed description of the various hedging theories is available in the online supplement S1.

To model the theoretical hedging arguments, empirical studies define various proxy variables representing the hedging determinants. For example, the corporate debt ratio can be seen as a proxy for the level of financial distress. The general econometric model to test the impact of the determinants on a firm's hedging behavior can be formularized as follows:

$$H_{it} = \alpha + \beta X_{it} + \gamma Z_{it} + \eta_i + \delta_t + \varepsilon_{it}, \tag{1}$$

where i and t are firm and time subscripts; H is a measure of corporate hedging activities; X is a vector of the study-specific hedging determinants; Z represents a vector of control variables where previous studies have shown that they are important determinants of corporate hedging (e.g., firm size); η_i and δ_t capture firm-specific and time-specific effects. The vector of regression coefficients β measures the strength and direction of the relation between the proxies and the hedging variable. In the subsequent MRA, this effect will be aggregated across primary studies.

Regarding the dependent variable H, studies examine two dimensions of corporate hedging: the initial decision to set up a hedging program and the extent to which a company hedges its exposure (Dolde and

[5] Further incentives for corporate hedging are, among others, behavioral biases like managerial overconfidence (Adam et al., 2015), accruals management (Pincus and Rajgopal, 2002), or the existence of bond covenants (Beatty et al., 2012). However, these aspects are only discussed by a small number of studies and, so far, cannot be appropriately examined by MRA.

Mishra, 2007). We refer to these two levels as the *decision to hedge* and the *extent of hedging*. Studies investigating the decision to hedge typically use a Logit or Probit estimation with a binary variable to assign firms either to a group of hedgers or a group of non-hedgers (e.g., Nance et al., 1993). In contrast, the extent of hedging can be modeled by a continuous variable like the net notional amount of outstanding derivatives contracts (e.g., Graham and Rogers, 2002) or the percentage of the underlying exposure that is hedged (e.g., Carter et al., 2006).

Given the large body of literature and the inconclusive results of empirical primary studies on the determinants of corporate hedging, it is not surprising that the literature already provides consolidations of the empirical evidence.[6] Aretz and Bartram (2010) use a vote counting method and compare the number of statistically significant results for and against each hedging determinant with each other. However, their approach does not consider differences in study design. Hence, they implicitly assume that the studies included in their sample are homogenous and as such are directly comparable. Arnold et al. (2014) apply meta-analysis methods from medical research to calculate weighted averages of the standardized mean differences between the groups of hedging and non-hedging firms for 15 different hedging determinants. Geyer-Klingeberg et al. (2018b) extend this approach and additionally consider the multidimensional nature of the motives behind corporate derivatives usage by aggregating the Pearson correlation coefficients reported in the primary studies and incorporating the dependency structure among the hedging determinants using multivariate meta-analysis. For both studies, the overall conclusions about the importance of the hedging theories are fairly similar (see online supplement S2). Nevertheless, there are several weaknesses observable from the existing meta-analyses: (i) Both reviews primarily focus on the estimation of aggregated proxy variables. Thus, they give an answer to the question *what* is the average effect between a set of proxy variables and the corporate hedging decision. In contrast, the MRA approach applied in this study explicitly models the heterogeneity among previous publications, thereby providing evidence *why* individual studies reach different conclusions. (ii) Another issue is that both meta-analyses use effect sizes[7] estimated from the univariate results reported in the primary studies. However, relations might be driven by the interrelations among the hedging

[6] A summary of the findings presented in the previous reviews is presented in the online supplement S2.
[7] We refer to the term 'effect size' as any statistical measure defining the magnitude and direction of the relationship between two variables (Borenstein et al., 2009). These are the measures to be aggregated in a meta-analysis.

determinants and other control variables as indicated by the vectors X and Z in Eq. (1).[8] In this study, we directly collect estimates from the regression analysis sections of the primary studies. Thus, the derived effect sizes measure the partial relationship between the hedging variable and the hedging determinant, while holding the other variables constant. (iii) Previous reviews focus on results for the decision to hedge. However, literature shows that beyond the decision to engage in hedging, also the extent of hedging is an important aspect of the corporate risk management policy (Allayannis and Ofek, 2001; Haushalter, 2000). We extend this by analyzing both the decision to hedge and the hedging extent.

3 The meta-analysis data set

3.1 Search strategy

Before collecting the sample of primary studies, certain criteria must be defined to decide which of the identified papers should be included in the final database. This step is necessary to ensure that the collected estimates are comparable within and between studies, in such a way that differences can be coded by the inclusion of the meta-regression variables.

Firm type. Only studies investigating non-financial companies are included because risk management incentives of firms from the financial sector are usually quite different compared to other industrial companies (Gay and Nam, 1998; Knopf et al., 2002; Purnanandam, 2008).

Design of empirical analysis. Studies must report results from regression analysis as formularized in Eq. (1). The dependent variable should measure corporate hedging by a dummy or continuous variable that captures financial derivatives usage or a mix of derivatives and other hedging methods (like foreign debt or operational hedging). To ensure comparability of the results, samples excluding derivatives users from the hedging variable will not be considered. Moreover, we exclude estimates where the dependent variable measures selective hedging[9], because the results cannot be pooled in a sample with other studies examining risk reduction as the primary goal of corporate hedging.

Reported results. Studies must provide the statistical information required for MRA. This includes regression coefficients, sample sizes, and a precision measure of the regression estimates (such as

[8] Geyer-Klingeberg et al. (2018b) partly address this issue by modelling the dependency structure among the hedging determinants in their meta-analysis model.
[9] Managers may have incentives to actively time derivatives transactions based on their market view, a practice called *market timing* or *selective hedging* (Adam et al., 2017; Brown et al., 2006). Indeed, the sample of studies on selective hedging is too small to conduct a second MRA.

standard errors, *t*-statistics, or *p*-values).

Non-identical samples. Estimates from two or more studies using the same or largely overlapping data sets (regarding country and time span) are only included if the authors or analyses vary.

Publication outlet. Studies can either be articles published in referred journals or unpublished manuscripts and conference papers. The latter group of studies is also referred to as 'grey literature'. Including unpublished work is preferable as it captures recent studies that are not published yet and, moreover, increases the number of observations. In addition, our sample includes estimates from studies published in journals of different quality. Focusing only on top journals would lead to a significantly smaller data set and a reduction of variation of the MRA variables. As even biased and misspecified results bear useful information that should be incorporated in a meta-analysis (Stanley and Doucouliagos, 2012), we include all papers and explicitly control for study quality and other study characteristics in the meta-regression model.

For the literature search, we started with the sample of primary studies cited in the review by Aretz and Bartram (2010). Based on this initial selection, a search command was designed by linking terms that are often used in the titles, keywords, and abstracts of these studies.[10] Using this search query, the following major electronic databases were screened: ABI/Inform Complete, Business Source Premier, EconLit, Google Scholar, Scopus, and Social Science Research Network. To find studies not containing the required keywords, a 'snowballing' technique was conducted after the database search. This strategy involves a backward-tracking of the reference sections in the papers and a forward-tracking of each study's citations in Google Scholar. In the next step, we read the selected studies in detail and filtered the sample against the selection criteria. The final sample contains 175 primary studies. The full reference list is reported in the online supplement S3 (with more details of each study described in S4).

3.2 Hedging determinants

Literature investigates a wide range of hedging determinants captured by the vectors X and Z in Eq. (1). For instance, Aretz and Bartram (2010) identify 54 different variables in their review of the hedging literature. As a minimum number of observations is necessary to appropriately conduct MRA, only the

[10] The search command consists of keywords linked by Boolean operators with the following logic: (i) terms relating to corporate hedging (hedg* or derivative*), (ii) terms relating to non-financial companies (firm* or corporat*, non-financial, company), and (iii) terms relating to methodology (empiric*, data, sample, analy*, evidence, investigat*, relation*, impact).

most commonly examined hedging determinants are selected for synthesis. In their review of 140 meta-analyses, Nelson and Kennedy (2009) report that the median number of observations is 92. We use this number as a threshold that each hedging determinant must exceed to be included in the sample. After scanning the sample of 175 primary studies and counting the number of observations for each variable, a set of fourteen proxies is left.[11] Unfortunately, this procedure left no proxy for the asymmetric information and agency conflicts of equity and bondholders hypotheses.

Tab. 3 describes the set of selected hedging determinants that will be analyzed in the meta-regression analysis. The variable definitions are derived from the primary studies and are not unique since authors use a wide range of operationalizations (indicated by the optional elements or alternative definitions shown in parentheses). Furthermore, Tab. 1 assigns each determinant to the corresponding hedging theory. It also shows the hypothesized sign of the impact of the respective determinant on the hedging variable H from Eq. (1). A detailed description of each determinant and its impact on corporate hedging behavior is outlined in the online supplement S5.

<<< INSERT TABLE 1 ABOUT HERE >>>

4 Methodology

Meta-regression analysis is 'the regression analysis of regression analyses' (Stanley and Jarrell, 1989). Accordingly, the effect sizes to be aggregated are observational estimates from regression models. The general objective of MRA is two-fold: (i) Synthesize effect sizes from a set of primary studies within a single summary effect, and (ii) explain the heterogeneity among these effect sizes by identifying study characteristics that are associated with this variation. By pooling estimates across many studies, meta-analysis minimizes estimation error and allows inferences without depending on specific sample characteristics. Whereas results of any primary study are subject to its specific research design, MRA can objectively control for any study-specific aspect, such as the estimation technique, model specification, variable definitions, and other author-specific dimensions that might have an impact on the heterogeneous findings. Moreover, MRA adds value as it explicitly models the impact of 'study-invariant' factors, i.e. aspects that are constant within a study but vary across studies, such as publication status, number of citations, or the country under examination (Stanley and Doucouliagos, 2012).

[11] In total, the number of observations for 96 different proxy variables was collected in this step.

Due to its distinctive features, MRA has become a common method for research synthesis in economics research (see, e.g., Bellavance et al., 2009; Card et al., 2010; Havranek and Irsova, 2011). Existing applications in financial economics include the explanation of the heterogeneous results of the marginal tax effect on the corporate debt ratio (Feld et al., 2013), the market equity premium (van Ewijk et al., 2012), the efficient market hypothesis (Geyer-Klingeberg et al., 2018c; Kim et al., 2014), the determinants of corporate cash holdings (Weidemann, 2016), dividend smoothing (Fernau and Hirsch, 2017), the firm value effects of hedging (Geyer-Klingeberg et al., 2018a), and the determinants of corporate capital structure (Hang et al., 2018a, b).

4.1 Choice of effect size

The main criterion for the selection of the effect size is that the estimates must be comparable within and across studies (Stanley and Jarrell, 1989). In this paper, the measure to be aggregated is the regression coefficient β from Eq. (1). It captures the strength and direction of the effect of each hedging determinant on either the hedging decision or the extent of hedging. As obervable from Tab. 1, studies differ in the way they operationalize the proxy variables. Accordingly, the interpretation of the raw regression coefficient β heavily depends on the definition of the variables and the other controls being included. Thus, they are not directly comparable across studies. To account for measurement differences, we follow a common procedure in meta-analysis research and transform the reported effects into partial correlation cofficients (among many others, Doucouliagos et al., 2012; Valickova et al., 2015; Zigraiova and Havranek, 2016). The partial correlation r is a unitless measure for the strength and direction of the effect between two variables, while holding other factors constant (Stanley and Doucouliagos, 2012). The partial correlation coefficient and the corresponding standard errors can be derived from the reported t-statistics and the degrees of freedom used for estimation (Greene, 2011):

$$r_{ij} = \frac{t_{ij}}{\sqrt{t_{ij}^2 + df_{ij}}}, \text{ and } SE(r_{ij}) = \sqrt{\frac{(1 - r_{ij}^2)}{df_{ij}}}, \quad (2)$$

where i is the subscript for the estimate ($i = 1, \ldots, m$); j is the subscript for the study ($j = 1, \ldots, 175$); t is the t-statistic of the regression coefficient reported in the primary study; and df denotes the corresponding degrees of freedom. The effect sizes are calculated separately for each hedging determinant ($k = 1, \ldots, 14$).

The data required for the calculation of the partial correlations is not directly reported in each study. For example, the degrees of freedom are rarely found in the primary studies. Thus, we inferred them from the number of observations and the number of independent variables included.[12] If *t*-ratios are not available, we derived them from the reported *p*-values and the degrees of freedom.

4.2 The basic MRA model

An important challenge for every meta-analysis arises from *publication selection bias*, which appears when researchers and journals neglect results that are either statistically insignificant or inconsistent with theoretical predictions (Begg and Berlin, 1988; Card and Krueger, 1995; Rosenthal, 1979). Without such a preference for certain outcomes, the partial correlation coefficients should be randomly distributed around the true effect of the hedging determinants. However, discarding insignificant findings or estimates with unexpected signs leads to correlation between the reported estimates and their standard errors (Havranek and Irsova, 2011).[13] Such a correlation occurs if, for example, authors of studies with small sample sizes change their model specification until they find estimates to be large enough to offset high standard errors (Stanley et al., 2008). The statistical test for the presence and correction of publication selection bias is given by (Stanley, 2005):

$$r_{ij} = \beta_0 + \beta_1 SE(r_{ij}) + \varepsilon_{ij}, \quad \varepsilon_{ij} \sim N(0; SE(r_{ij})^2), \tag{3}$$

where i and j are estimate and study subscripts; r is the partial correlation coefficient between the respective hedging determinant and the dependent hedging variable; $SE(r)$ is the standard error of the partial correlation; ε is the error term. This model is estimated separately for each hedging determinant ($k = 1, \dots, 14$). According to Egger et al. (1997), the rejection of the null hypothesis, H_0: $\beta_1 = 0$, tests the presence of publication selection bias. The corresponding regression parameter $\hat{\beta}_1$ measures the direction and magnitude of the bias. The estimate for the intercept, $\hat{\beta}_0$, is the mean partial correlation assuming that $SE(r)$ is close to zero ($SE(r) \to 0, E(r) \to \hat{\beta}_0$). Thus, rejecting the null hypothesis, H_0: $\beta_0 = 0$, is a test for the existence of a genuine effect beyond publication selection bias (Stanley, 2008). Here, it should be noted that simulation studies have shown that using a non-linear term by replacing

[12] For fixed effects models, the number of year/time/country dummies is considered as well.

[13] Begg and Berlin (1988) show that when researchers favor statistically significant results, publication selection bias is proportional to the inverse of the square root of the sample size, which itself is proportional to the standard error.

$SE(r)$ with $SE(r)^2$ yields a better correction for publication selection (Stanley and Doucouliagos, 2014). Hence, we will use $\hat{\beta}_1$ to detect publication selection bias and calculate the corrected mean effect $\hat{\beta}_0$ from a model with squared standard error.

4.3 The augmented MRA model

The basic MRA model (Eq. 3) assumes that all studies estimate the same population effect and thus the variation of the partial correlations occurs from sampling error. However, the reported estimates probably depend on various aspects of study design causing excess heterogeneity beyond sampling error. As in any other regression model, omitting important factors that are supposed to have an impact on the dependent variable may end up in biased estimates for the MRA coefficients (Efendic et al., 2011). To accommodate omitted-variable bias, the augmented MRA explicitly models the impact of heterogeneity by including a set of explanatory variables that are suspected to be in charge of the large variation in the reported results (Stanley et al., 2008):

$$r_{ij} = \beta_0 + \beta_1 SE(r_{ij}) + \sum_{l=1}^{L} \gamma Y_{ijl} + \varepsilon_{ij}, \quad \varepsilon_{ij} \sim N(0; SE(r_{ij})^2), \tag{4}$$

where Y denotes a set of variables capturing heterogeneity in the partial correlations; other variables and subscripts are the same as in Eq. (3). $\hat{\beta}_1$ is still a measure for publication selection bias. The intercept $\hat{\beta}_0$ again represents the mean partial correlation corrected for publication selection, but now must be interpreted conditional on $\boldsymbol{Y} = 0$. The MRA coefficients γ reflect the effect of the particular study characteristic on the effect sizes. Accordingly, the explanatory variables can be interpreted as *moderators* for the relationship between the hedging determinants and the dependent hedging variable measured by the partial correlation coefficient (Borenstein et al., 2009).

<<< INSERT FIGURE 1 ABOUT HERE >>>

4.4 MRA model specification

Due to several econometric issues, the MRA models described in Eqs. (3) and (4) are rarely estimated in the form presented above.

Heteroscedasticity. The variance of the effect sizes depends on the sample size of the primary studies. As they are largely different, this leads to a non-constant variance of the error terms (heteroscedasticity). To address heteroscedasticity problems, all estimations are carried out by weighted least squares (WLS) using the inverse of the squared standard errors as weights (Stanley, 2005, 2008). The WLS approach also accounts for quality issues as studies reporting low standard errors and thus more precise results receive larger weights in the estimation.

Within-study dependencies. The studies in our sample regularly report multiple estimates for different model specifications, robustness tests, or subsamples. Sampling just one estimate (e.g., the most preferable) from each study would end in a great reduction of observations, as well as a loss of information, that is indeed necessary to explore the various sources of heterogeneity (Stanley and Doucouliagos, 2012). Moreover, choosing one specific estimate requires objective selection criteria which are hard to justify and thus may introduce subjective selection bias. Hence, we follow a best practice in meta-analysis research and sample all available estimates (among others, Feld et al., 2013; Kysucky and Norden, 2016; Rusnak et al., 2013). However, this approach bears the risk of within-study dependencies, which entails a violation of the assumption that the error terms in the Eqs. (3) and (4) are independently and identically distributed (Greene, 2011). To accommodate the issue of correlated effect sizes, the models are estimated with robust errors clustered at the study-level. This is a commonly applied remedy for within-study dependency in MRA research (Stanley and Doucouliagos, 2012).

Between-study dependencies. Besides correlation within studies, effect sizes could also be related across studies when different authors use similar data sets (e.g., US studies commonly examine S&P 500 firms). To consider such dependencies, standard errors in the MRA model are additionally clustered at the country-level using two-way clustering (Havranek and Irsova, 2017).

5 Description of meta-regression variables

There are two groups of heterogeneity (Havranek and Irsova, 2011; Rusnak et al., 2013). The first group covers real differences among the estimates reported in the primary studies (*structural heterogeneity*). Moreover, estimates might vary due to the employed methodology and specific study design (*methodological heterogeneity*). We collect several variables (denoted as Y vector in Eq. (4)) to quantify the impact of both types of heterogeneity. The selection of the variables is driven by data availability from the primary studies and discussions in the literature.[14] All variables are manually coded by reading the articles. See Tab. 2 and 3 for an overview of the selected variables and their definitions.

[14] Originally, we collected > 50 variables, but had to exclude several variables due to insufficient variation in the data or collinearity problems.

5.1 Structural heterogeneity

We cluster the countries examined in the primary studies into four geographical areas (*East Asia & Pacific, Europe, North America, and the Rest of the World*).[15] A further group named *Global* includes studies examining data from more than one region. Regarding the coverage of different industries, two groups of studies can be identified. The first category's focus is exclusively on one specific industry and the examined firms are often homogenous as they operate in a similar business environment. The second group examines firms from multiple industries, usually with strong differences in the underlying risk exposures (Davies et al., 2006). The inclusion of multiple industries increases the cross-sectional variation in the data, which could support the identification of differences in corporate hedging practices. To capture dissimilarities between single and multi-industry samples, a dummy (*Single industry*) is introduced that is equal to one for single-industry studies.

<<< INSERT TABLE 2 ABOUT HERE >>>

5.2 Methodological heterogeneity

Variables explaining methodological heterogeneity can be divided into four groups: differences in the dependent (hedging) variable, data characteristics to control for differences in the underlying data sets, estimation characteristics to incorporate differences in the applied econometric techniques, specification characteristics to account for differences in the model setup, and publication characteristics to consider differences in study quality not captured by the other variables.

<<< INSERT TABLE 3 ABOUT HERE >>>

Differences in the hedging measure. Risk reduction can be obtained by different financial and operational strategies. Thus, equating hedgers with derivatives users bears the risk of incorrectly defining firms without derivative holdings as non-hedging firms, although they just employ alternative strategies for risk reduction (Guay and Kothari, 2003). We code a dummy variable *Operational hedging included* that is equal to one for studies considering operational strategies in their hedging definition.[16] The question whether firms engage in derivatives usage for risk reduction or to benefit from market timing poses a further issue (Adam et al., 2017; Brown et al., 2006). The dummy variable *Risk reduction*

[15] The geographical regions are classified by the World Bank's Country and Lending Groups scheme (World Bank, 2016).

[16] Due to the low number of studies with a hedging definition beyond derivatives usage, this variable can only be included in the analysis of the decision to hedge.

only is added to control for studies that exclude firms with derivatives holdings for selective or trading purposes. However, this might be a 'noisy' proxy as many studies are assigned to the base category (no correction for selective hedging), whereas this does not necessarily mean that their samples contain selective hedgers. Although unreported, the firms included in their samples might use derivatives only for risk reduction. As firm-level data is required to construct a better measure for the presence of selective hedgers in the primary studies, we use the proxy as described while taking into account its noisy character when interpreting the results. Moreover, we include three variables capturing whether a reported result explicitly refers to hedging of foreign exchange risk, interest rate risk, or commodity price risk. A further variable forms the base category and covers studies examining a mix of several exposures. Among the continuous hedging variables, the gross notional amount defined as the sum of all outstanding derivatives contracts independent of the exact position (long or short) is the most commonly used hedging variable. As notional amounts might overestimate the hedging levels, they are often seen as a biased measure for hedging (Judge, 2007). As alternative, some studies use net notional amounts or the actual hedge ratio, which indicates the percentage of the underlying risk exposure that is being hedged. Indeed, both measures require additional data that is often unvailable. The dummy *Alternative hedging measure* is constructed for estimates where the dependent hedging variable is not the total notional amount.

Data characteristics. If a firm is a non-hedger, this might either be driven by its explicit decision against hedging or the absence of a risk exposure. To avoid biased inferences, various authors suggest that the group of firms without ex ante exposure should be excluded from the data (Davies et al., 2006; Géczy et al., 1997; Graham and Rogers, 2002). We add the dummy variable *Ex ante exposure* indicating studies which follow this recommendation. Moreover, the average year of the time period covered by a primary study's data set is included to measure structural changes in the effects of the hedging determinants. Another dummy (*Panel data*) distinguishes between studies using panel data as opposed to cross-sectional data. Due to the lack of hedging data available from annual reports, early studies make use of survey data, often with a low number of questionnaires sent back to the authors, which may cause a non-response bias in the data.[17] To account for differences between data from surveys compared to

[17] For example, the response rate is 27.9 % in Aabo et al. (2010), 10.3 % in Kim and Sung (2005), or 31.6 % in Nance et al. (1993).

data collected from annual reports or databases, the dummy variable *Survey data* is considered for studies observing hedging data from surveys.

Estimation characteristics. In addition to the standard control variables used in the hedging models (*Z* vector in Eq. 1), corporate hedging behavior might also be correlated with unobservable firm-, time-, and country-specific factors. A dummy variable (*Fixed effects*) is included that identifies studies considering fixed effects in their estimation. Furthermore, a major threat for the validity of empirical studies linking certain firm characteristics to corporate hedging arises from endogenous relations among the included hedging determinants and the error term. Endogeneity can be the result of the omission of relevant but unobservable variables (covered by the *Fixed effects* dummy above). Another source of endogeneity originates from the fact that financial decisions are often made simultaneously. More recent studies apply instrumental variable estimation to explicitly model the endogenous relations between a firm's hedging policy and its capital structure (among others, Bartram et al., 2009; Gay et al., 2011; Graham and Rogers, 2002), hedging and growth opportunities (Choi et al., 2013), hedging and liquidity choices (Disatnik et al., 2014), hedging and management compensation (Bakke et al., 2016), or hedging and payout flexibility (Bonaime et al., 2014). We include a dummy variable (*Endogeneity*) for studies that explicitly address endogeneity by instrumental variable models or lagged values of the hedging determinants. Moreover, studies analyzing the impact of the hedging determinants on the decision to hedge commonly apply Logit or Probit models. To find out whether the model choice affects the reported results, a dummy (*Logit*) denotes if an estimate comes from a Logit model. When examining the extent of hedging, the dependent variable usually has positive values for hedgers and zero values for non-hedgers (censored data). In this case, the standard OLS estimator is inconsistent. Thus, primary studies usually apply a Tobit or censored regression (Tobin, 1958). A weakness of this procedure lies in its assumption that the decision to hedge and the extent of hedging are both affected by the same variables (Goldberg et al., 1998). However, previous literature has shown that the determinants for the two levels of hedging decisions are not necessarily identical (Adam, 2002; Gay et al., 2011; Haushalter, 2001). A statistical solution for this problem is given by the Cragg model (Cragg, 1971) and the two-step Heckman regression (Heckman, 1979).[18] A dummy variable (*Cragg*) is coded that is equal to one if an estimate is observed from a model that accounts for censored data.

Specification characteristics. Most of the studies in our sample include standard controls for firm size (98 %), hedging substitutes (97 %), capital structure (91 %), or growth opportunities (90 %). In contrast, variables for other hedging theories are less frequently considered. To measure potential misspecification bias through the omission of these variables, three dummies are coded indicating whether a model contains proxies for a firm's risk exposure (*Control EXP*), the asymmetric information hypothesis (*Control ASI*), or the managerial risk aversion hypothesis (*Control MAV*). Furthermore, two other dummies indicate the presence of variables representing hedging methods different from derivatives usage, namely other financial hedging instruments (*Control OFH*) and geographical diversification (*Control GDF*).

Publication characteristics. To account for quality differences in the studies not captured by the other variables, a dummy (*Top journal*) marks if estimates are observed from one of the most influential journals in the area of financial economics, accounting, or business research. A journal is assigned to this group if its impact factor reported by the Scimago Journal Ranking[19] exceeds 1.

6 Empirical results

6.1 Descriptive statistics

Tab. 4 provides summary statistics for the MRA variables.[20]

<<< INSERT TABLE 4 ABOUT HERE >>>

The regional distribution of the collected estimates reveals a dominance of North American studies in the corporate hedging literature. Nevertheless, more than half of the observations in the full sample is based on data from other geographical regions. Regarding the distribution of the risk exposures, most studies focus on multiple sources of financial risk (38.1 % in Panel C). About one third of the estimates in the full sample refers to hedgers of FX exposures, which is regularly documented to be the most important source of risk in multi-industry studies (Bartram et al., 2009). The total number of articles

[18] Both approaches start with a model for the decision to hedge and in the second stage estimate the extent of hedging conditional on the results from the first-stage model.
[19] https://www.scimagojr.com/
[20] In addition, the online supplement presents descriptive statistics of the partial correlations (online supplement S6 and S7).

correcting for endogeneity bias in the determinants of hedging is still low, representing just 4.2% of the full sample size. Aretz and Bartram (2010) explain this observation by the difficulties occurring in the application of statistical methods that account for endogenous relations (e.g. the identification of appropriate instruments).

6.2 Analysis of publication selection bias and true effect beyond

Tab. 5 reports the results for the basic MRA model (Eq. (3)). The slope coefficient $\hat{\beta}_1$ measures the presence and magnitude of publication selection bias. The intercept $\hat{\beta}_0$ is an estimate for the mean effect beyond publication selection bias. For its calculation, $SE(r_{ij})$ is replaced by $SE(r_{ij})^2$ in Eq. (3), which has been shown to yield better correction for publication selection (Stanley and Doucouliagos, 2014). The reported *t*-statistics are based on robust errors, clustered at the study-level and country-level to account for dependencies among estimates taken from the same study or similar data sets.

<<< INSERT TABLE 5 ABOUT HERE >>>

Overall, the results for *Panel A* reveal that, compared to non-hedging firms, hedgers are large, profitable and geographically diversified firms with high capital expenditures and dividend payouts, large debt ratios and low interest coverage. The mean effects for these variables are all statistically significant (at least at the 1 % level). Despite of profitability (PRO), all significant variables have the sign predicted by theory. The positive relation between PRO and the decision to hedge might be explained by the cost argument. Accordingly, more profitable firms have more financial resources available to set up a fixed costs-intensive hedging program. Regarding the two determinants with theoretical predictions in both directions (FSZ and GDF), the positive sign for firm size provides evidence that economies of scale are highly relevant for hedging firms. The positive impact of the degree of geographical diversification is in line with the exposure argument and contradicts the prediction that operational hedging is a substitute for financial hedging.

Regarding the size of the mean effects, the most important hedging determinants for the decision to hedge are the degree of geographical diversification, firm size, and the amount of foreign sales. All three variables show mean partial correlations between 0.10 and 0.14, which is multiple times above the values of the other proxies. Additionally, the estimates for DRA and ICR support the theory that hedging is employed to reduce financial distress costs. Moreover, DRA and DIY indicate that interactions with other financial decisions are important for a firm's hedging policy. However, these results are difficult to interpret as they might be contaminated by endogeneity problems.

The results for the bias coefficients $\hat{\beta}_1$ detect publication selection bias for five of the fourteen variables. For the interpretation of the magnitude of the bias, we follow the guidance by Doucouliagos and Stanley (2013).[21] Using this classification, substantial bias can be confirmed for FSA, FSZ, RAD, and SOS. In the case of GDF, the bias is even severe.

The results for *Panel B* uncover that five of the variables that are determinants of the decision to hedge also play a relevant role when deciding about the extent of hedging (CPX, DRA, FSZ, ICR, and PRO). However, the size of the coefficients is somewhat smaller compared to Panel A, except for ICR, where the effect is about four times larger. Furthermore, the sign of PRO coincides with the theoretical prediction that more profitable firms have lower hedge volumes as they are less likely to face financial distress. Moreover, the mean partial correlations for MTB and OOS turn out to be statistically significant, even though both have reverse signs as compared to theory. One explanation for this finding might be that both variables are no ideal measures for the underlying theories. For MTB, theory proposes that underinvestment is a threat for firms with growth options and high leverage. Although MTB is a proxy for growth opportunities, it does not say much about the corporate debt level. An explanation for the direction of the OOS variable is given by Gay and Nam (1998), who argue that firms often replace out-of-the-money options by new options with strike prices equal to the current stock price. In this case, option payoff provides incentives similar to common shares. Regarding the size of the mean effects, three determinants turn out to be the key factors for the extent of hedging: FSZ, ICR, and OOS.

Tab. 6 presents the results from the same model featured in Tab. 5, but now separately for the geographical regions. The number of estimates for some of the clusters is rather low or even zero. To avoid biased inferences from small samples, only those estimates are reported where the number of observations is at least 15.[22] Standard errors are only clustered at study-level.

<<< INSERT TABLE 6 ABOUT HERE >>>

[21] The strength of publication selection bias is classified as 'little to modest' if the bias coefficient is stat. insignificant or $|\hat{\beta}_1| < 1$; 'substantial' if the coefficient is stat. significant and $1 \leq |\hat{\beta}_1| \leq 2$; and 'severe' if the coefficient is stat. significant and $|\hat{\beta}_1| > 2$.

[22] This threshold might be arbitrary, but most of the results from estimations with less than 15 observations show extremely inflated *t*-statistics.

There are three groups of findings: (i) Determinants with the same sign and strong statistical significance across all regions, (ii) determinants with mixed signs and/or mixed statistical significance across the regions, and (iii) determinants with overall weak support across all regions.

FSA, FSZ, and GDF show positive and highly significant effects for all regional subsamples, independent of whether they measure the impact on the decision to hedge (Panel A) or the extent of hedging (Panel B). Nevertheless, there are some meaningful differences in the size of the effects. For example, the corrected mean partial correlation for FSA in the East Asia & Pacific region is 0.248 (Panel B), which is more than twice as high compared to the effect of 0.094 identified for North American firms. This finding might be explained by the high proportion of companies from Australia and New Zealand in the East Asia & Pacific group. The examined firms from these countries (mostly companies from the natural resources sector) are usually characterized by high export ratios and thus might be more sensitive to exchange rate swings. In a similar vein, firm size seems to be a less important factor for North American firms when determining their hedge volume (0.119 in Panel A and 0.043 in Panel B). This observation might arise from the high liquidity of the US derivatives market and the access to a broad range of financial hedging instruments even for smaller firms. Another finding to be emphasized is that the effect for GDF indicates that operational strategies quantified by the degree of geographical diversification act as a complement rather than a substitute for hedging. One reason for this could be that firms employ operational hedging to protect themselves against long-term risks, while financial hedges commonly refer to shorter time horizons (Triantis, 2000).

The second group of results covers CPX, DIY, DRA, ICR, LIQ, MTB, OOS, and PRO. One implication from the estimates for these variables might be that the interplay between corporate hedging policy and other financial decisions measured by DIY and DRA is an important factor for the decision to hedge, but less important for the actual hedging volume. This conclusion stems from the fact that the coefficients for the two variables are statistically significant across most of the regions in Panel A, whereas the results in Panel B are weaker. A similar finding can be observed for the availability of hedging substitutes represented by DIY and LIQ. Furthermore, the signs and the levels of statistical significance of the coefficients for CPX and MTB differ between the world regions. This might either be reasoned by real differences in the relevance of the underinvestment hypothesis across countries, or again by the fact that growth options itself are not the best proxy because underinvestment theory predicts an interaction between debt ratio and growth options. Finally, ICR and OOS both show significant results with expected signs in Panel A, whereas the evidence in Panel B is either weak (for ICR) or shows a reverse sign (for OOS).

Weak support across multiple regions, independent of whether looking at Panel A or Panel B, can be confirmed for RAD, SOS and TLC. One exception is the strong effect of R&D expenses on the hedging decision of European firms.

In summary, the regional subgroup analysis reveals some crucial geographical differences in the relevance of the hedging determinants. A comparison between the results for the pooled sample (Tab. 5) and the subgroups (Tab. 6) underlines this conclusion, as, for example, the coefficients for LIQ do not show significant results in the full sample, but when dividing the sample into regional clusters, liquidity seems to be an important substitute for hedging in three out of five regions (Panel A). Thus, making inferences about the hedging determinants without accounting for regional differences might end up in incorrect conclusions.

6.3 Analysis of heterogeneity

So far, the basic MRA explicitly considered the biasing effect of publication selection as well as heterogeneity arising from geographical differences. A shortcoming of this approach is the omission of other potentially important variables measuring methodological heterogeneity across studies. Moreover, the impact of the world regions is only analyzed by creating subgroups, which neglects possible interdependencies between the country clusters. The multivariate MRA model accounts for this issue by simultaneously testing the impact of a broad set of structural and methodological differences.

Tab. 7 and 8 show the results for the augmented MRA from Eq. (4). Again, $SE(r)$ is added to all models to ensure that the results are robust to publication selection. For the regional dummies, coefficients are not reported for less than 15 observations. The exclusion of variables for methodological differences from some models is reasoned by one of the following aspects: (i) There are no estimates reported in the primary studies. For example, no observation is available for the impact of CPX on the extent of hedging in single-industry studies. (ii) The control variable is obsolete. For example, it would be meaningless to add a dummy indicating the inclusion of a geographical diversification variable

(*Control GDF*) in the model for GDF. For the same reason, the control variable for managerial risk aversion (*Control MAV*) is not considered in the models for OOS and SOS. (iii) Variables are subject to multicollinearity. In this case, the most insignificant among the correlated variables was dropped until the mean variance inflation factor has a value below 10. For example, the average year of the primary study data is left out due to the high collinearity with the panel data dummy in the model for RAD (Panel A).

<<< INSERT TABLE 7 ABOUT HERE >>>

<<< INSERT TABLE 8 ABOUT HERE >>>

For the interpretation of the estimated coefficients, it should be noted that North America is left out as base category. Hence, the regression parameters for the other country clusters indicate if the relation between the respective hedging determinant and the hedging variable is systematically different compared to North America. This means that, in contrast to the basic MRA, the augmented model analyzes whether differences in the effects across the country groups are large enough to be statistically significant. Moreover, the methodological variables show if the presence of a specific method choice affects the size of the partial correlations. Due to the large amount of results, we will not interpret all coefficients but rather focus on key findings. The first section refers to the geographical differences.

Overall findings. The total number of statistically significant coefficients[23] uncovers that the importance of the hedging determinants is not equal in all countries. Differences are apparent in each cluster. The strongest and statistically significant deviations from the base category (North America) could be found for GDF, LIQ, OOS, and RAD (Panel A) as well as DIY, FSZ, and PRO (Panel B). Hence, researchers combining observations from different regions without controlling for these differences should be careful with the interpretation of the results. Furthermore, there are only a few coefficients with similar estimates in both subsamples (Panel A and B), which supports the view that the decision to hedge and the extent of hedging are driven by different dimensions.

DIY (Panel A and B). The coefficient for European countries is significant and positive for both the decision to hedge (0.024) and the extent of hedging (0.092). For the group of East Asian & Pacific

[23] Results are classified as statistically significant if they have *p*-values equal to or less than 0.05.

countries, the same effect can be found in Panel B. Compared to North America, dividend payout seems to be a more important determinant for corporate hedging policy in these two regions. Following La Porta et al. (2000), an explanation for this finding could be that dividend payouts are often higher in European countries (e.g., Germany or Spain) and the East Asia & Pacific region (e.g., Australia or Hong Kong). As a consequence, firms located in one of these countries might have greater incentives for hedging to reduce financial distress and agency conflicts of debt arising from higher dividend payments.

DRA and FSA (Panel A). Looking at highly developed country groups (North America, Europe, and East Asia & Pacific), the debt ratio and foreign sales variables do not exhibit meaningful differences regarding the magnitude of the partial correlations. This underlines the similar importance of the two variables for the decision to hedge in the three regions, a result already documented in the basic MRA.

FSZ (Panel A and B). Except of the global studies, the insignificant MRA coefficients in Panel A indicate that firm size is an equally important factor for the corporate hedging decision. In contrast, firm size is (on average) more relevant for the hedging extent in Europe, East Asia & Pacific, and global studies. This might again be reasoned by the fact that the high liquidity of the financial markets in North America improves the availability of financial hedging instruments, also for small firms.

GDF (Panel A). For the decision to hedge, it can be observed that the degree of geographical diversification is, on average, a less important determinant in European countries and the East Asia & Pacific region. An interpretation for this finding could be that an increased risk exposure from geographical diversification induces North American firms to hedge, while firms in the other regions more often use diversification as operational hedging strategy, which results in lower or even negative effects of GDF on hedging.

LIQ (Panel A and B). The coefficient of the *Rest of the World* dummy (-0.101) is negative and highly significant, whereas the same result with a reverse sign (0.102) can be found for the decision to hedge. It might be concluded that firms in countries with less liquid derivatives markets face higher costs for financial hedging and thus cash management serves as an appropriate substitute. However, when initially deciding whether or not to engage in hedging other factors, such as firm size, are predominant.

The second group of the variables covers methodological differences. The main findings can be described as follows.

Differences in the hedging variable. From the estimates in Panel A it becomes apparent that studies considering operational strategies as part of their hedging definition report, on average, lower effects for CPX, DIY, and FSZ. The results also suggest that the impact of the hedging determinants depends on the type of risk exposure. For example, the coefficients for the foreign exchange exposure dummy (*FX only*) in the DRA models are negative and statistically significant (Panel A and B). As the omitted category refers to samples with mixed exposures, this finding shows that for FX hedgers, the effect of the debt ratio is less important because this proxy especially reflects aspects related to interest rate exposure. In the same way, the dummy for studies focusing on IR hedgers (*IR only*) is negative and significant for the FX-related proxies such as GDF in Panel A or FSA in Panel B.

Data characteristics. The variable for the exclusion of firms without ex ante exposure shows that if studies focus on firms that are exposed to market prices risks, they often find a stronger link between FSA and the extent of hedging (Panel B). The results also suggest that the effects of some determinants will be reduced when using panel data sets for the analysis instead of cross-sections. For example, the panel data dummy has a negative coefficient on the impact of FSA and FSZ in Panel B. In addition, the average year of the primary study's data set has a systematic impact on the effect of several hedging determinants. For instance, the coefficients in the models for CPX, DIY, and DRA are all significant with values around 0.002 in Panel A. In other words, using more recent data seems to increase the partial correlation coefficients for these determinants by a factor of 0.002 each year, assuming other things equal. It can also be derived that studies focusing on one specific industry often find a stronger relation between the proxies and the hedging measure (especially for LIQ and SOS in Panel A, or FSA, FSZ, LIQ, and PRO in Panel B). Therefore, researchers using more homogenous firm samples tend to obtain larger estimates for some of the hedging determinants.

Estimation characteristics. Controlling for endogeneity is important in some cases. For instance, the control variable is negative and statistically significant for LIQ in Panel A and B meaning that studies accounting for endogeneity yield, on average, a stronger substitution effect for liquidity. It is remarkable that the significant coefficients for the endogeneity variable show high levels of significance. Thus, if studies accounting for endogenous relations in their models yield different estimates, these differences are vital. Nevertheless, it must be noted that the number of observations for studies controlling for endogeneity is typically low. This weakens the explanatory power of the control variable.

Specification characteristics. The estimates for the variables reflecting specification differences reveal that the inclusion of important control variables in the primary studies systematically influences the partial correlation coefficients between the hedging determinants and the dependent hedging measure. For example, most of the coefficients for *Control MAV* have negative signs in Panel A. Therefore, adding a control for the managerial risk aversion hypothesis often decreases the reported estimates.

Publication characteristics. There is evidence that the quality of the publication outlet has an impact on the reported results. However, the direction of this effect is not obvious. For some of the hedging determinants, the coefficients indicate that estimates collected from top journals reduce the outcome predicted by theory. For example, in Panel B, the coefficient of the *Top journal* dummy is negative in the models for FSA and FSZ as well as positive for ICR and OOS. In contrast, the variable implies higher values than the average partial correlations for PRO or SOS in Panel A.

7 Discussion

7.1 Summary of results from multivariate analysis

To see the overall picture of the diverse results for the fourteen hedging determinants, we aggregate the findings reported in Tab. 7 and 8. Tab. 9 summarizes the results for the regional differences. The coefficients of the single determinants are aggregated for each hedging hypothesis as defined in Tab. 1. The first digit in brackets represents the number of significant effects (at least at the 5% level). The second digit in brackets is the total number of hedging determinants with results reported in the multivariate MRA. The sign shown before brackets refers to the dominating sign of the effect on the decision to hedge (Panel A) and the extent of hedging (Panel B). Signs of the MRA results from Tab. 7 and 8 are counted as positive (negative) if the coefficient is identical (the opposite) to the predicted sign of the hedging determinant. A positive (negative) sign reported in Tab. 9 means that this effect is stronger (weaker) in a certain world region as compared to the North America.

<<< INSERT TABLE 9 ABOUT HERE >>>

From Tab. 9, we can see that geographical differences are especially present for the hypotheses that financial distress, managerial risk aversion, and the availability of hedging substitutes foster corporate hedging activities. The negative signs of the Non-US world regions indicate that financial distress costs are a less important driver for hedging outside the US. Even stronger is the result for the managerial risk aversion hypothesis on the decision to hedge (Panel A). Accordingly, managerial stock and option ownership are more important factors for hedging in countries outside the US. Finally, the availability of substitutes for derivatives hedging like geographical diversification and liquidity is more pronounced in other countries than the US. This result is not surprising, as the US has the maturest derivatives markets and thus alternative hedging strategies are more important in countries with more restricted access to derivatives instruments. A finding, which is also in line with previous studies on the country-level drivers of hedging (Bartram et al., 2009).

<<< INSERT TABLE 10 ABOUT HERE >>>

Similar as in Tab. 9, we summarize the findings for the methodological heterogeneity analysis. In Tab. 10, a positive (negative) dominating sign indicates that this moderator has a positive (negative) overall impact on the decision to hedge (Panel A) and the extend of hedging (Panel B). Although many variables reveal substantial explanatory power for the differences in empirical findings, four main moderators can be identified for the decision to hedge: *Average year, Data from survey*, *Control MAV*, and *Top journal*. The coefficients for these variables are statistically significant in at least 50% of the models shown in Tab. 7 and 8. Regarding the sign of these variables, we find that the influence of the hedging determinants on the decision to hedge is stronger for more recent sample years, lower for survey data compared to hedging data coded from annual reports, and lower for studies including control variables for managerial risk aversion, as well as stronger for publications in highly ranked journals. Seven variables are classified as the main moderators for the extent of hedging: *Single industry, Foreign exchange risk, Interest rate risk, Commodity risk, Control MAV, Control GDF*, and *Top Journal*. Regarding the sign of the variables, we can conclude that the impact of the hedging determinants on the extent of hedging is stronger in studies focusing on firms from a specific industry, stronger (weaker) for explicit interest rate and commodity price (foreign exchange) hedgers compared to findings for mixed exposures, stronger (weaker) for studies including control variables for managerial risk aversion (geographical diversification), and stronger for publications in highly ranked journals. Interestingly, there is also evidence that accounting for operational hedging methods (Panel A) and endogeneity (Panel B) are responsible for differences in the findings across studies. While considering operational activities in the hedging measure reduces the impact of the hedging determinants, there is no clear sign for the impact of endogeneity correction.

7.2 Robustness

To evaluate the robustness of the heterogeneity analysis, a variety of sensitivity analyses has been conducted. The results are reported in the online supplements S8-S13. First, we use Fisher's z-transformation of the partial correlation coefficients to account for the skewness in the distribution of the partial correlation (Stanley and Doucouliagos, 2012). A comparison with the MRA coefficients from the main results reveals that the findings are quite robust against the transformation of the effect size.

Second, we also cluster standard errors of the MRA model at the level of study authors. This approach accounts for the fact that some authors are presented in multiple studies. For example, Knopf et al. (2002) investigate the hedging behavior of US firms and Hagelin et al. (2007) look at Swedish firms. In both studies, John D. Knopf is a co-author. In this case, it could be argued that estimates taken from different studies having the same author(s) are likely to show some kind of dependency due to idiosyncratic author characteristics. The corresponding results are fairly close to the main findings discussed in the previous section, just the *t*-statistics slightly change for some coefficients due to the adjusted standard errors.

Third, beyond the endogeneity concerns in the primary studies, there may also exists a potential endogeneity in the MRA model. After the coding of the studies, we had to drop many aspects of study design due to collinearity problems. If the omitted variables affect the reported estimates and their standard errors in the same direction, the correlation between the error term ε and the standard error $SE(r)$ might result in biased estimates of the coefficient measuring publication selection bias (Havranek, 2015). A potential solution for this issue is to use an appropriate instrument for the standard error. Havranek et al. (2017) suggests the inverted squared root of the degrees of freedom $(1/\sqrt{df})$ as they are directly proportional to the standard error (larger studies are usually more precise), but less likely to be influenced by method choices. Whereas the coefficients for the regional dummies remain stable, the bias coefficients in the model for GDF indicates no more evidence for publication selection in Panel A. Similar conclusions can be drawn for the FSA and FSZ models in Panel B. Nevertheless, there still remains strong evidence for publication selection bias in the models for FSZ, FSA, and RAD (Panel A) as well as DRA, ICR, RAD, and TLC (Panel B). This underpins the importance of controlling for selective reporting in the MRA models.

7.3 Limitations

Every meta-analysis is limited by constraints from the primary studies being synthesized. Two of the most important challenges in the empirical examination of the hedging determinants are the endogeneity concerns arising from the reverse causality among the various aspects of corporate financial policy, and the fact that most studies focus on derivatives use although theory refers to a broader definition of hedging (Aretz and Bartram, 2010). To mitigate biasing effects from these issues, we include control variables in the MRA in order to identify whether studies addressing endogeneity or using a broader definition of hedging yield systematically different results. A drawback of this procedure is that the problem of endogeneity is only addressed in a handful of studies. Similarly, a small proportion of studies considers other hedging strategies beyond derivatives use in their hedging variable. Therefore, final conclusions about the real impact of the two issues can hardly be drawn.

Another limitation concerns the interpretation of the hedging determinants. Taking into account selective hedging considerations, it remains unclear whether a certain finding should be interpreted as a test for risk reduction or market timing (Adam and Fernando, 2006; Géczy et al., 1997). A significant number of primary studies in our sample tackles this issue either by highlighting that all firms in their sample use financial derivatives to achieve risk reduction, or by excluding firms with derivatives held for speculation or trading purposes (Choi et al., 2013; Goldberg et al., 1998; Huang et al., 2007). If derivatives would be used for speculation as opposed to risk reduction, firms should hedge independent of their risk exposure. However, the MRA results strongly suggest that the exposure variables (debt ratio, foreign sales, geographical diversification) are positively related to hedging.

8 Conclusion

This paper presents a meta-regression analysis of 7,024 empirical estimates on the influence of the fourteen most commonly examined rationales for hedging activities of non-financial firms. The aggregation of the existing research record within the basic meta-regression reveals that firm size, capital structure, and risk exposure are key determinants for the decision to hedge. Moreover, firm size, interest coverage, and option ownership are key determinants for the extent of hedging. The actual strength of the effects depends on the examined country. Relating the findings to the classical hedging theories underpins the relevance of the economies of scale and the risk exposure hypothesis. Some support can be confirmed for the theory that the availability of hedging substitutes or the reduction of expected costs of financial distress motivate a firm's hedging policy. Finally, there is weak or even no robust evidence that firms hedge to avoid underinvestment, to realize tax benefits, or that undiversifiable risk positions induce managers to hedge for the sake of their own interests.

The multivariate MRA incorporates a broad set of variables to measure differences across world regions and methodological characteristics of the primary studies. The analysis underpins that the importance of several hedging determinants significantly varies across countries. Especially the impact of variables measuring managerial risk aversion and hedging substitutes is more pronounced in countries outside the US. Moreover, we find several methodological and data-related aspects to explain the large heterogeneity. Especially the inclusion of relevant control variables for managerial risk aversion in the primary study models and the journal ranking of the publication outlet matter. Moreover, for the decision to hedge it is also relevant whether hedging data is obtained from surveys as compared to annual reports and which sample years are examined. For the extent of hedging, the type of risk exposure being hedged, and the specific industry drive the reported results. Moreover, also accounting for endogeneity is a relevant factor.

The theoretical explanations of corporate hedging abstract from country-specific features, thereby supposing that the theories are equally important for firms independent of their legal, economic, and financial environment. However, the outcomes of the MRA challenge this assumption and give rise to the proposition that the classical theories should be extended by a further dimension covering the country-specific firm surroundings. Compared to regional differences, methodological aspects of the study-design explain even a larger proportion of the heterogeneity in the collected effect sizes. These results should be considered when comparing and interpreting empirical estimates for the hedging determinants from studies looking at different countries or applying different econometric models.

References[24]

Aabo, T., Høg, E., Kuhn, J., 2010. Integrated foreign exchange risk management: The role of import in medium-sized manufacturing firms. Journal of Multinational Financial Management 20, 235-250. doi: 10.1016/j.mulfin.2010.08.002.

Adam, T.R., 2002. Do Firms Use Derivatives to Reduce Their Dependence on External Capital Markets? Review of Finance (former European Finance Review) 6, 163-187. doi: 10.1023/A:1020121007127.

Adam, T.R., Fernando, C.S., 2006. Hedging, speculation, and shareholder value. Journal of Financial Economics 81, 283-309. doi: 10.1016/j.jfineco.2005.03.014.

Adam, T.R., Fernando, C.S., Golubeva, E., 2015. Managerial overconfidence and corporate risk management. Journal of Banking and Finance 60, 195-208. doi: 10.1016/j.jbankfin.2015.07.013.

Adam, T.R., Fernando, C.S., Salas, J.M., 2017. Why do firms engage in selective hedging? Evidence from the gold mining industry. Journal of Banking and Finance 77, 269-282. doi: 10.1016/j.jbankfin.2015.05.006.

Allayannis, G., Ihrig, J., Weston, J.P., 2001. Exchange-Rate Hedging: Financial versus Operational Strategies. American Economic Review 91, 391-395.

Allayannis, G., Ofek, E., 2001. Exchange rate exposure, hedging, and the use of foreign currency derivatives. Journal of International Money and Finance 20, 273-296. doi: 10.1016/S0261-5606(00)00050-4.

Aretz, K., Bartram, S.M., 2010. Corporate Hedging and Shareholder Value. The Journal of Financial Research 33, 317-371.

Arnold, M.M., Rathgeber, A.W., Stöckl, S., 2014. Determinants of Corporate Hedging: A (statistical) meta-analysis. The Quarterly Review of Economics and Finance 54, 443-458. doi: 10.1016/j.qref.2014.05.002.

Bakke, T.-E., Mahmudi, H., Fernando, C.S., Salas, J.M., 2016. The causal effect of option pay on corporate risk management. Journal of Financial Economics (Forthcoming). doi: 10.2139/ssrn.2614212.

Bartram, S.M., Brown, G.W., Fehle, F.R., 2009. International Evidence on Financial Derivatives Usage. Financial Management 28, 185-206. doi: 10.1111/j.1755-053X.2009.01033.x.

Beatty, A., Petacchi, R., Zhang, H., 2012. Hedge commitments and agency costs of debt: evidence from interest rate protection covenants and accounting conservatism. Review of Accounting Studies 17, 700-738. doi: 10.1007/s11142-012-9189-4.

Begg, C.B., Berlin, J.A., 1988. Publication Bias: A Problem in Interpreting Medical Data. Journal of the Royal Statistical Society. Series A (Statistics in Society) 151, 419-463. doi: 10.2307/2982993

Bellavance, F., Dionne, G., Lebau, M., 2009. The value of a statistical life: A meta-analysis with a mixed effects regression model. Journal of Health Economics 28, 444-464. doi: 10.1016/j.jhealeco.2008.10.013.

Bessembinder, H., 1991. Forward Contracts and Firm Value: Investment Incentive and Contracting Effects. Journal of Financial and Quantitative Analysis 26, 519-532. doi: 10.2307/2331409.

Bonaime, A.A., Hankins, K.W., Harford, J., 2014. Financial Flexibility, Risk Management, and Payout Choice. The Review of Financial Studies 27, 1074-1101.

Borenstein, M., Hedges, L.V., Higgins, J.P.T., Rothstein, H.R., 2009. Introduction to Meta-Analysis. John Wiley & Sons, Chichester, UK.

Brown, G.W., Crabb, P.R., Haushalter, D., 2006. Are Firms Successful at Selective Hedging? The Journal of Business 79, 2925-2949.

[24] Online supplement S4 presents the full list of studies included in the meta-analysis.

Card, D., Kluve, J., Weber, A., 2010. Active Labour Market Policy Evaluations: A Meta-Analysis. The Economic Journal 120, 452-477. doi: 10.1111/j.1468-0297.2010.02387.x.

Card, D., Krueger, A.B., 1995. Time-Series Minimum-Wage Studies: A Meta-Analysis. The American Economic Review 85, 238-243.

Carter, D.A., Rogers, D.A., Simkins, B.J., 2006. Does Hedging Affect Firm Value? Evidence from the US Airline Industry. Financial Management 35, 53-86. doi: 10.1111/j.1755-053X.2006.tb00131.x.

Choi, J.J., Mao, C.X., Upadhyay, A.D., 2013. Corporate Risk Management under Information Asymmetry. Journal of Business Finance and Accounting 40, 239-271. doi: 10.1111/jbfa.12008.

Cragg, J.G., 1971. Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods. Econometrica 39, 829-844. doi: 10.2307/1909582.

Davies, D., Eckberg, C., Marshall, A.P., 2006. The Determinants of Norwegian Exporters' Forgein Exchange Risk Management. The European Journal of Finance 12, 217-240. doi: 10.1080/13518470500249274.

DeMarzo, P.M., Duffie, D., 1991. Corporate Financial Hedging with Proprietary Information. Journal of Economic Theory 53, 261-286. doi: 10.1016/0022-0531(91)90156-X.

DeMarzo, P.M., Duffie, D., 1995. Corporate Incentives for Hedging and Hedge Accounting. The Review of Financial Studies 8, 743-771. doi: 10.1093/rfs/8.3.743.

Disatnik, D., Duchin, R., Schmidt, B., 2014. Cash Flow Hedging and Liquidity Choices. Review of Finance 18, 715-748. doi: 10.1093/rof/rft006.

Dolde, W., Mishra, D.R., 2007. Firm Complexity and FX Derivatives Use. Quarterly Journal of Business and Economics 46, 3-22.

Doucouliagos, C., Stanley, T.D., 2013. Are All Economic Facts Greatly Exaggerated? Theory Competition and Selectivity. Journal of Economic Surveys 27, 316-339. doi: 10.1111/j.1467-6419.2011.00706.x.

Doucouliagos, H., Haman, J., Stanley, T.D., 2012. Pay for Performance and Corporate Governance Reform. Industrial Relations: A Journal of Economy and Society 51, 670-703. doi: 10.1111/j.1468-232X.2012.00695.x.

Efendic, A., Pugh, G., Adnett, N., 2011. Institutions and economic performance: A meta-regression analysis. European Journal of Political Economy 27, 586-599. doi: 10.1016/j.ejpoleco.2010.12.003.

Egger, M., Smith, G.D., Schneider, M., Minder, C., 1997. Bias in Meta-Analysis Detected by a Simple, Graphical Test. British Medical Journal 315, 629-634. doi: 10.1136/bmj.315.7109.629.

Feld, L.P., Heckemeyer, J.H., Overesch, M., 2013. Capital Structure Choice and Company Taxation: A Meta-Study. Journal of Banking and Finance 37, 2850-2866. doi: 10.1016/j.jbankfin.2013.03.017.

Fernau, E., Hirsch, S., 2017. What drives dividend smoothing? A meta regression analysis of the Lintner model. Paper presented at the 2017 Meeting of the European Financial Management Association (EFMA), Athens, Greece.

Francis, J., Stephan, J., 1990. Characteristics of hedging firms: an empirical examination, in: Schwartz, R.J., Smith, C.W. (Eds.), Advanced Strategies in Financial Risk Management. New York Institute of Finance, New York, pp. 615-635.

Froot, K.A., Scharfstein, D.S., Stein, J.C., 1993. Risk Management: Coordinating Corporate Investment and Financing Policies. The Journal of Finance 48, 1629-1658. doi: 10.1111/j.1540-6261.1993.tb05123.x.

Gay, G.D., Lin, C.-M., Smith, S.D., 2011. Corporate Derivatives Use and the Cost of Equity. Journal of Banking and Finance 35, 1491-1506. doi: 10.1016/j.jbankfin.2010.10.033.

Gay, G.D., Nam, J., 1998. The Underinvestment Problem and Corporate Derivatives Use. Financial Management 27, 53-69. doi: 10.2307/3666413.

Géczy, C.C., Minton, B.A., Schrand, C., 1997. Why Firms Use Currency Derivatives. The Journal of Finance 52, 1323-1354. doi: 10.1111/j.1540-6261.1997.tb01112.x.

Geyer-Klingeberg, J., Hang, M., Rathgeber, A., 2018a. Corporate financial hedging and firm value: A meta-analysis. Paper presented at 9th CEQURA Conference on Advances in Financial and Insurance Risk Management (Munich, Germany).

Geyer-Klingeberg, J., Hang, M., Rathgeber, A.W., Stöckl, S., 2018b. What Do We Really Know About Corporate Hedging? A Meta-Analytical Study. Business Research 11, 1-31. doi: 10.1007/s40685-017-0052-0.

Geyer-Klingeberg, J., Walter, M., Hang, M., Rathgeber, A., 2018c. Do Stock Markets react to Soccer Games? A Meta-Regression Analysis. Applied Economics 50, 2171-2189. doi: 10.1080/00036846.2017.1392002.

Goldberg, S.R., Godwin, J.H., Kim, M.-S., Tritschler, C.A., 1998. On the Determinants of Corporate Usage of Financial Derivatives. Journal of International Financial Management and Accounting 9, 132-166. doi: 10.1111/1467-646X.00034.

Graham, J., Rogers, D.A., 2002. Do Firms Hedge in Response to Tax Incentives. The Journal of Finance 57, 815-839. doi: 10.1111/1540-6261.00443.

Greene, W.H., 2011. Econometric Analysis, 7th ed. Prentice Hall, New York.

Guay, W.R., Kothari, S.P., 2003. How Much Do Firms Hedge With Derivatives? Journal of Financial Economics 70, 423-461. doi: 10.1016/S0304-405X(03)00179-X.

Hagelin, N., Holmén, M., Knopf, J.D., Pramborg, B., 2007. Managerial Stock Options and the Hedging Premium. European Financial Management 13, 721-741. doi: 10.1111/j.1468-036X.2007.00380.x.

Hang, M., Geyer-Klingeberg, J., Rathgeber, A., Stöckl, S., 2018a. If, When, and How Financial Decisions Affect Firm Value: A Meta-Analysis. Academy of Management Proceedings 2018. doi: 10.5465/AMBPP.2018.14232abstract.

Hang, M., Geyer-Klingeberg, J., Rathgeber, A., Stöckl, S., 2018b. Measurement matters – A meta-study of the determinants of corporate capital structure. Quarterly Review of Economics and Finance 68, 211-225. doi: 10.1016/j.qref.2017.11.011.

Haushalter, D., 2001. Why Hedge? Some Evidence from Oil and Gas Producers. Journal of Applied Corporate Finance 13, 87-92. doi: 10.1111/j.1745-6622.2001.tb00428.x.

Haushalter, D.G., 2000. Financing Policy, Basis Risk, and Corporate Hedging: Evidence from Oil and Gas Producers. The Journal of Finance 55, 107-152. doi: 10.1111/0022-1082.00202.

Havranek, T., 2015. Measuring intertemporal substitution: The importance of method choices and selective reporting. Journal of the European Economic Association 13, 1180-1204. doi: 10.1111/jeea.12133.

Havranek, T., Irsova, Z., 2011. Estimating Vertical Spillovers from FDI: Why Results Vary and What the True Effect is. Journal of International Economics 85, 234-2444. doi: 10.1016/j.jinteco.2011.07.004.

Havranek, T., Irsova, Z., 2017. Do Borders Really Slash Trade? A Meta-Analysis. IMF Economic Review 65, 365-396. doi: 10.1057/s41308-016-0001-5.

Havranek, T., Rusnak, M., Sokolova, A., 2017. Habit Formation in Consumption: A Meta-Analysis. European Economic Review 95, 142-167. doi: 10.1016/j.euroecorev.2017.03.009.

Heckman, J.J., 1979. Sample Selection Bias as a Specification Error. Econometrica 47, 153-161. doi: 10.2307/1912352.

Howton, S.D., Perfect, S.B., 1998. Managerial Compensation and Firm Derivative Usage: An Empirical Analysis. The Journal of Derivatives 6, 53-64. doi: 10.3905/jod.6.2.53.

Huang, P., Ryan, H.E., Wiggins III, R.A., 2007. The Influence of Firm- and CEO-Specific Characteristics on the Use of Nonlinear Derivative Instruments. The Journal of Financial Research 30, 415-436. doi: 10.1111/j.1475-6803.2007.00221.x.

Judge, A., 2006. Why and How UK Firms Hedge. European Financial Management 12, 407-441. doi: 10.1111/j.1354-7798.2006.00326.x.

Judge, A., 2007. Why Do Firms Hedge? A Review of the Evidence, in: McCombie, J., González, C.R. (Eds.), Issues in Finance and Monetary Policy. Palgrave Macmillan, Basingstoke, pp. 128-152.

Kim, J.H., Doucouliagos, H., Stanley, T.D., 2014. Market Efficiency in Asian and Australasian Stock Markets: A Fresh Look at the Evidence, Working paper at La Trobe University, Bundoora (Australia).

Kim, W., Sung, T., 2005. What makes firms manage FX risk? Emerging Markets Review 6, 263-288. doi: 10.1016/j.ememar.2005.06.002.

Knopf, J.D., Nam, J., Thornton, J., 2002. The Volatility and Price Sensitivities of Managerial Stock Option Portfolios and Corporate Hedging. The Journal of Finance 57, 801-813. doi: 10.1111/1540-6261.00442.

Kysucky, V., Norden, L., 2016. The Benefits of Relationship Lending in a Cross-Country Context: A Meta-Analysis. Management Science 62, 90-110. doi: 10.1287/mnsc.2014.2088.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R.W., 2000. Agency Problems and Dividend Policies around the World. The Journal of Finance 55, 1-33. doi: 10.1111/0022-1082.00199.

Lel, U., 2012. Currency Hedging and Corporate Governance: A Cross-Country Analysis. Journal of Corporate Finance 18, 221-237. doi: 10.1016/j.jcorpfin.2011.12.002.

Lievenbrück, M., Schmid, T., 2014. Why do firms (not) hedge? Novel evidence on cultural influence. Journal of Corporate Finance 25, 92-106. doi: 10.1016/j.jcorpfin.2013.10.010.

MacMinn, R.D., 1987. Forward Markets, Stock Markets, and the Theory of the Firm. The Journal of Finance 42, 1167-1185.

Modigliani, F., Miller, M.H., 1958. The Cost of Capital, Corporation Finance and the Theory of Investment. The American Economic Review 48, 261-297.

Nance, D.R., Smith Jr, C.W., Smithson, C.W., 1993. On the Determinants of Corporate Hedging. The Journal of Finance 48, 267-284. doi: 10.1111/j.1540-6261.1993.tb04709.x.

Nelson, J.P., Kennedy, P.E., 2009. The Use and (Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment. Environmental and Resource Economics 42, 345-377. doi: 10.1007/s10640-008-9253-5.

Pincus, M., Rajgopal, S., 2002. The Interaction Between Accrual Management and Hedging: Evidence from Oil and Gas Firms. The Accounting Review 77, 127-160.

Purnanandam, A., 2008. Financial distress and corporate risk management: Theory and evidence. Journal of Financial Economics 87, 706-739. doi: 10.1016/j.jfineco.2007.04.003.

Rosenthal, R., 1979. The File Drawer Problem and Tolerance for Null Results. Psychological Bulletin 86, 638-641. doi: 10.1037/0033-2909.86.3.638.

Rusnak, M., Havranek, T., Horvath, R., 2013. How to Solve the Price Puzzle? A Meta-Analysis. Journal of Money, Credit and Banking 45, 37-70. doi: 10.1111/j.1538-4616.2012.00561.x.

Smith, C.W., Stulz, R.M., 1985. The Determinants of Firms' Hedging Policies. Journal of Financial and Quantitative Analysis 20, 391-405. doi: 10.2307/2330757.

Stanley, T.D., 2001. Wheat from Chaff: Meta-Analysis as Quantitative Literature Review. Journal of Economic Perspectives 15, 131-150. doi: 10.1257/jep.15.3.131.

Stanley, T.D., 2005. Beyond Publication Bias. Journal of Economic Surveys 19, 309-345. doi: 10.1111/j.0950-0804.2005.00250.x.

Stanley, T.D., 2008. Meta-regression methods for detecting and estimating empirical effect in the presence of publication bias. Oxford Bulletin of Economics and Statistics 70, 103-127. doi: 10.1111/j.1468-0084.2007.00487.x.

Stanley, T.D., Doucouliagos, C., Jarrell, S.B., 2008. Meta-Regression Analysis as the Socio-Economics of Economics Research. The Journal of Socio-Economics 37, 276-292.

Stanley, T.D., Doucouliagos, H., 2012. Meta-Regression Analysis in Economics and Business. Routledge, Abingdon.

Stanley, T.D., Doucouliagos, H., 2014. Meta-Regression Approximations to Reduce Publication Selection Bias. Research Synthesis Methods 5, 60-78. doi: 10.1002/jrsm.1095.

Stanley, T.D., Jarrell, S.B., 1989. Meta-Regression Analysis: A Quantitative Method of Literature Surveys. Journal of Economic Surveys 3, 161-170.

Tobin, J., 1958. Estimation of Relationships for Limited Dependent Variables. Econometrica 26, 24-36. doi: 10.2307/1907382.

Treanor, S.D., Carter, D.D., Rogers, D.A., Simkins, B.J., 2013. Operational and Financial Hedging: Friend or Foe? Evidence from the U.S. Airline Industry. Journal of Accounting and Finance 13, 64-91.

Triantis, A.J., 2000. Real options and corporate risk management. Journal of Applied Corporate Finance 13, 64-73. doi: 10.1111/j.1745-6622.2000.tb00054.x.

Valickova, P., Havranek, T., Horvath, R., 2015. Financial Development and Economic Growth: A Meta-Analysis. Journal of Economic Surveys 29, 506-526. doi: 10.1111/joes.12068.

van Ewijk, C., de Groot, H.L.F., Santing, A.J.C., 2012. A Meta-Analysis of the Equity Premium. Journal of Empirical Finance 19, 819-830. doi: 10.1016/j.jempfin.2012.07.002.

Weidemann, J.F., 2016. The Determinants of Cash Holdings: Evidence from Meta-Regression Analysis, European Financial Management Annual Meetings, Basel.

World Bank, 2016. World Bank Country and Lending Groups.

Zigraiova, D., Havranek, T., 2016. Bank Competition and Financial Stability: Much Ado about Nothing? Journal of Economic Surveys 30, 944-981. doi: 10.1111/joes.12131.

Table 1. Definition of hedging determinants examined in the MRA

Hedging determinant	Abb.	Definition	Hedging theories and predicted signs for relation between proxy and hedging variable						
			FIN	UND	TAX	MNG	SUB	EXP	EOS
Capex	CPX	[Capital expenditures] ÷ [measure of firm size]		+					
Dividend yield	DIY	[Cash dividends (per share)] ÷ [(earnings per share) or (closing share price) or (market value of common equity)]; [Dummy that indicates whether a firm pays dividends]					+		
Debt ratio	DRA	[(Total debt) or (long-term debt) or (short-term debt) or (industry-adjusted debt) (+ book value of preferred stock)] ÷ [measure of firm size]	+	+				+	
Foreign sales	FSA	[(Foreign sales) or (foreign income)] ÷ [measure of firm size]; [Dummy that indicates whether a firm has foreign sales]						+	
Firm size	FSZ	[Total assets] or [total sales] or [market value of common equity (+ book value of preferred stock) (+ book value of debt)]	–						+
Geographical diversification	GDF	[Number of (countries where a firm operates) or (currencies)], or [Herfindahl-Hirschman index over (countries) or (regions where a firm operates)]; [Dummy that indicates whether a firm operates in more than one country]					–	+	
Interest coverage ratio	ICR	[(Gross profit) or (EBIT)] ÷ [interest expenses]	–						
Liquidity	LIQ	[(Cash (and cash equivalents) or (current assets (– inventory))] ÷ [(current liabilities) or (a measure of firm size)]					–		
Market-to-book ratio	MTB	[Market value of (common equity) or (assets) (+ book value of debt)] ÷ [book value of (common equity) or (assets) or (replacement costs of assets)]		+					
Option ownership	OOS	[(Number) or (market value) of options held by (CEO) or (managers) or/and (directors)] ÷ [(number of managers) or (total compensation)]; [Dummy that indicates whether options are held by (CEO) or (managers) or/and (directors)]				–			
Profitability	PRO	[Return on assets] or [return on capital employed] or [(gross profit) or (operating profit) or (net profit)] ÷ [sales] or [operating profit ÷ number of outstanding shares]	–						
Research and development	RAD	[Expenses for research and development] ÷ [measure of firm size]; [Dummy that indicates whether a firm has expenses for research and development]		+					
Share ownership	SOS	[(Number) or (market value) of shares held by (CEO) or (managers) or/and (directors)] ÷ [(total assets) or (total number of outstanding shares)]; [Dummy that indicates whether managers held stocks]				+			
Tax-loss carry forwards	TLC	[Tax loss carry forwards (+ tax credits)] ÷ [a measure of firm size]; [Dummy that indicates the availability of tax loss carry forwards]	+		+				

Notes: This table shows the fourteen hedging determinants that are identified to be the most commonly examined variables in the literature. The predicted signs indicate whether theory assumes a positive or negative relation between the proxy and the hedging variable. The assignment of the hedging determinants to the theories and the predicted signs are based on Aretz and Bartram (2010), Haushalter (2000), and Judge (2006). Logarithmic transformations of the variables are left out to reduce complexity.

FIN = Financial distress costs; UND = Underinvestment; TAX = Tax benefits; MNG = Managerial risk aversion; SUB = Hedging substitutes; EXP = Risk exposure; EOS = Economies of scale.

Table 2. Definition of explanatory variables for structural heterogeneity

Variable	Definition
Geographical differences	
North America (Omitted base category)	= 1 if an estimate refers to firm data from North America, 0 otherwise.
Europe	= 1 if an estimate refers to firm data from Europe, 0 otherwise.
East Asia & Pacific	= 1 if an estimate refers to firm data from East Asia & Pacific, 0 otherwise.
Rest of the World	= 1 if an estimate refers to firm data from Latin America & Caribbean, Middle East & North Africa, South Asia, or Sub-Saharan Africa, 0 otherwise.
Global	= 1 if an estimate refers to pooled firm data from more than one region, 0 otherwise.
Industry differences	
Single industry	= 1 if a specific industry is examined, 0 for mixed industry samples.

Notes: This table defines the moderator variables for structural heterogeneity.

Table 3. Definition of explanatory variables for methodological heterogeneity

Variable	Definition
Differences in the hedging measure	
Operational hedging included[a]	= 1 if the hedging variable includes operational strategies and other financial instruments, 0 if hedging variables refers to derivatives users only.
Risk reduction only	= 1 if a study explicitly excludes firms with derivatives holdings for selective hedging, 0 otherwise.
FX only	= 1 if the hedging variable refers to FX hedgers only, 0 otherwise.
IR only	= 1 if the hedging variable refers to IR hedgers only, 0 otherwise.
CP only	= 1 if the hedging variable refers to CP hedgers only, 0 otherwise.
Mixed exposure (Base category)	= 1 if the hedging variable refers to hedgers of more than one exposure, 0 otherwise.
Alternative hedging measure[b]	= 1 if the net notional amount of outstanding derivatives, fair value of outstanding derivatives, or the delta percentage of the derivatives portfolio is used as continuous hedging variable, 0 if the total notional amount is used.
Data characteristics	
Ex ante exposure	= 1 if a sample excludes firms without ex ante risk exposure, 0 otherwise.
Avg. Year	Average year of the data under examination (1995 as base).
Panel data	= 1 if the study examines panel data, 0 for cross-sectional data.
Survey data	= 1 if hedging data is obtained from a survey, 0 otherwise.
Estimation characteristics	
Fixed effects	= 1 if industry, year, or country fixed effects are included, 0 if otherwise.
Endogeneity	= 1 if the model accounts for reverse causality, 0 otherwise.
Logit[a]	= 1 if a Logit model is used for estimation, 0 if a Probit model is used.
Cragg[b]	= 1 if estimation with a continuous hedging variable accounts for sample selection bias via two-stage modeling as proposed by Cragg (1971) or Heckman (1979), 0 otherwise.
Specification characteristics	
Control EXP	= 1 if the model includes a control variable for a firm's risk exposure, 0 otherwise.
Control ASI	= 1 if the model includes a control variable for asymmetric information, 0 otherwise.
Control MAV	= 1 if the model includes a control variable for managerial risk aversion, 0 otherwise.
Control OFH	= 1 if the model includes a control variable for other financial hedging instruments except of derivatives, 0 otherwise.
Control GDF	= 1 if the model includes a control variable for geographical diversification, 0 otherwise.
Publication characteristics	
Top journal	= 1 if an estimate comes from a published journal article with a SJR rank above 1.0, 0 otherwise.

Notes: This table provides an overview of the explanatory variables for methodological differences among the collected effect estimates.
[a] This variable is only analyzed for the relation between the hedging determinants and the decision to hedge.
[b] This variable is only analyzed for the relation between the hedging determinants and the extent of hedging.

Table 4. Descriptive statistics of meta-regression variables

	Panel A: Decision to hedge		*Panel B: Extent of hedging*		*Panel C: Full sample*	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Structural heterogeneity						
North America (Base category)	0.384	0.486	0.604	0.489	0.478	0.500
Europe	0.283	0.451	0.110	0.313	0.209	0.406
East Asia & Pacific	0.192	0.394	0.179	0.383	0.186	0.389
Rest of the World	0.044	0.205	0.036	0.188	0.041	0.198
Global	0.120	0.326	0.075	0.264	0.101	0.301
Single industry	0.208	0.406	0.261	0.439	0.231	0.422
Hedging variable						
Op. hedging included	0.154	0.361	-	-	0.104	0.305
Risk reduction only	0.043	0.203	0.073	0.261	0.056	0.230
Alt. hedging measure	-	-	0.470	0.499	0.202	0.401
Mixed exposure	0.410	0.492	0.342	0.474	0.381	0.486
Foreign exchange risk	0.360	0.480	0.300	0.458	0.334	0.472
Interest rate risk	0.108	0.311	0.132	0.338	0.118	0.323
Commodity risk	0.108	0.310	0.228	0.419	0.159	0.366
Data characteristics						
Ex ante exposure	0.206	0.405	0.361	0.480	0.272	0.445
Avg. year	5.897	5.045	3.521	5.039	4.877	5.177
Panel data	0.425	0.494	0.530	0.499	0.470	0.499
Data from survey	0.165	0.371	0.125	0.330	0.148	0.355
Estimation characteristics						
Fixed effects	0.534	0.499	0.437	0.496	0.492	0.500
Endogeneity	0.032	0.177	0.055	0.229	0.042	0.201
Logit	0.565	0.496	-	-	0.324	0.468
Cragg	-	-	0.186	0.389	0.088	0.283
Specification characteristics						
Control EXP	0.706	0.456	0.501	0.500	0.618	0.486
Control ASI	0.286	0.452	0.389	0.488	0.330	0.470
Control MAV	0.518	0.500	0.621	0.485	0.562	0.496
Control OFH	0.220	0.414	0.117	0.321	0.176	0.380
Control GDF	0.172	0.377	0.064	0.244	0.125	0.331
Publication characteristics						
Top journal	0.367	0.482	0.504	0.500	0.426	0.495
#Obs.	4,010		3,014		7,024	
#Studies	137		90		175	

Notes: This table presents the descriptive statistics for the variables measuring methodological heterogeneity. Variable definitions are reported in Tab. 3.

Table 5. Basic MRA results

Predicted sign	(1) CPX [+]	(2) DIY [+]	(3) DRA [+]	(4) FSA [+]	(5) FSZ [+/–]	(6) GDF [+/–]	(7) ICR [–]	(8) LIQ [–]	(9) MTB [+]	(10) OOS [–]	(11) PRO [–]	(12) RAD [+]	(13) SOS [+]	(14) TLC [+]
Panel A: Decision to hedge														
Mean effect ($\hat{\beta}_0$)	**0.022*****	**0.027*****	**0.039*****	**0.102*****	**0.122*****	**0.144*****	**-0.011*****	-0.022*	-0.008	-0.002	**0.012*****	0.005	0.003	0.004
	(9.25)	(2.84)	(10.09)	(16.25)	(21.71)	(3.73)	(-3.25)	(-1.91)	(-1.01)	(-1.05)	(3.88)	(1.39)	(0.52)	(1.15)
Bias ($\hat{\beta}_1$)	0.164	0.045	0.136	**1.013*****	**1.246*****	**-2.031*****	-0.712	-0.496*	-0.115	0.236	0.205	**1.858*****	**-1.078*****	0.259
	(-0.67)	(0.15)	(0.61)	(2.64)	(5.44)	(-2.60)	(-1.34)	(-1.75)	(-0.46)	(0.62)	(0.54)	(4.56)	(-6.94)	(1.57)
#Obs.	111	292	608	279	631	110	152	455	374	160	271	171	187	208
#Studies	30	58	115	63	128	18	25	93	73	26	42	35	45	48
Panel B: Extent of hedging														
Mean effect ($\hat{\beta}_0$)	**0.008*****	0.017	**0.016*****	0.062*	**0.087****	-0.018	**-0.046*****	-0.009	**-0.023*****	**0.029*****	**-0.007*****	0.003	0.020	-0.003
	(3.87)	(1.29)	(6.39)	(1.92)	(2.31)	(-0.56)	(-7.16)	(-1.61)	(-4.46)	(4.11)	(-8.20)	(0.87)	(1.00)	(-0.82)
Bias ($\hat{\beta}_1$)	0.087	-0.080	**1.535*****	1.525*	0.431	**1.324*****	-0.169	**-0.510*****	**0.735****	**-1.656*****	0.053	**1.440*****	0.312	-0.092
	(0.62)	(-0.27)	(4.65)	(1.73)	(0.90)	(2.95)	(-0.52)	(-3.70)	(2.21)	(-3.46)	(0.24)	(4.19)	(1.57)	(-0.22)
#Obs.	152	207	465	174	482	37	80	289	235	151	149	165	250	178
#Studies	24	37	79	35	85	13	14	65	50	25	27	27	39	29

Notes: This table reports the results of Eq. (3). The model is estimated by weighted least squares estimation using the inverse of the estimates' squared standard errors as weights. $\hat{\beta}_1$ measures the presence and magnitude of publication selection bias. $\hat{\beta}_0$ measures the mean effect corrected for publication selection. For the calculation of the mean effects, $SE(r_{ij})$ in Eq. (3) is replaced by $SE(r_{ij})^2$, which has been shown to yield a better correction for publication selection (Stanley and Doucouliagos, 2014). The *t*-statistics of the regression parameters reported in parentheses are based on robust errors, clustered at study-level and country-level. Columns represent the fourteen determinants that are most commonly examined in the hedging literature, with definitions reported in Tab. 1.

Asterisks indicate statistical significance: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 6. Basic MRA results split by geographical regions

Predicted sign	(1) CPX [+]	(2) DIY [+]	(3) DRA [+]	(4) FSA [+]	(5) FSZ [+/–]	(6) GDF [+/–]	(7) ICR [–]	(8) LIQ [–]	(9) MTB [+]	(10) OOS [–]	(11) PRO [–]	(12) RAD [+]	(13) SOS [+]	(14) TLC [+]
Panel A: Decision to hedge														
North America	**0.024*****	0.002	**0.042*****	**0.095****	**0.119*****	**0.200*****	0.016	**-0.040*****	0.0001	-0.004	0.006	0.001	0.004	0.004
Europe	0.013	**0.032*****	**0.050*****	**0.148*****	**0.141*****	**0.071****	**-0.069*****	**-0.052*****	0.004	0.012	**0.017****	**0.202*****	-0.020	-0.019*
East Asia & Pacific		**0.076*****	**0.040****	**0.174*****	**0.148*****		0.037	0.024	**-0.014****	**-0.033****	0.007	0.006	0.003	**0.041*****
Rest of the World			0.040	**0.054*****	**0.142*****	**0.049*****		0.013	**0.023****					
Global		**0.034*****	**0.030*****	**0.158*****	**0.093****		**-0.009*****	**-0.028*****	**-0.020****	**-0.005*****	0.015			
Panel B: Extent of hedging														
North America	**0.010****	0.003	0.015	**0.094*****	**0.043*****	**0.163*****	0.038	**-0.013*****	**-0.022*****	**0.031****	**-0.006*****	-0.001	0.001	-0.002
Europe	**-0.123*****	0.045	-0.173	**0.161*****	**0.457*****			-0.008	-0.021		-0.011		0.061	0.251*
East Asia & Pacific		**0.087*****	0.017	**0.248*****	**0.175*****			0.006	**-0.041*****			**0.025*****	**-0.052*****	0.021
Rest of the World			0.012		**0.080*****			-0.069	**0.034*****					
Global		**0.046*****	**0.043****		**0.161*****				**0.010*****		**0.014*****		**0.085*****	

Notes: This table reports the mean effects corrected for publication selection ($\hat{\beta}_0$) observed from the estimation of equation (3) with squared standard error. The model is estimated by weighted least squares estimation using the inverse of the estimates' squared standard errors as weights. The slope estimate $\hat{\beta}_1$ and the *t*-statistics (clustered at study-level) are both unreported. Moreover, estimates with less than fifteen observations are unreported to avoid small-sample bias. Columns represent the fourteen determinants that are most commonly examined in the hedging literature, with definitions reported in Tab. 1.

Asterisks indicate statistical significance: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 7. Analysis of heterogeneity: Decision to hedge

Predicted sign	(1) CPX [+]	(2) DIY [+]	(3) DRA [+]	(4) FSA [+]	(5) FSZ [+/–]	(6) GDF [+/–]	(7) ICR [–]	(8) LIQ [–]	(9) MTB [+]	(10) OOS [–]	(11) PRO [–]	(12) RAD [+]	(13) SOS [+]	(14) TLC [+]
Panel A: Decision to hedge														
Intercept	0.043*	0.009	0.079***	0.065***	0.157***	0.105***	0.008	-0.034*	-0.016	0.011	0.074**	0.034	-0.049	-0.006
	(1.80)	(0.85)	(4.76)	(5.25)	(5.64)	(8.32)	(0.46)	(-1.75)	(-0.89)	(0.52)	(2.37)	(0.75)	(-1.31)	(-0.35)
SE(r)	0.491	0.316	-0.041	1.030***	1.363***	-2.459**	-0.447	-0.422*	0.120	0.098	0.031	1.830**	0.025	0.295
	(1.13)	(0.87)	(-0.10)	(3.20)	(4.62)	(-2.57)	(-1.09)	(-1.92)	(0.47)	(0.20)	(0.07)	(2.33)	(0.10)	(1.27)
Europe	0.004	**0.024*****	0.023	0.009	0.025	**-0.115*****	-0.024	-0.025	-0.011	**-0.027****	0.002	**-0.105****	**-0.079****	-0.004
	(0.27)	(2.59)	(0.98)	(0.51)	(1.37)	(-6.56)	(-1.04)	(-1.35)	(-0.82)	(-2.02)	(0.10)	(-2.48)	(-2.28)	(-0.26)
East Asia & Pacif.		0.021	0.013	0.086*	0.015		**0.049****	**0.021****	-0.007	**-0.080*****	-0.0001	**-0.032****	-0.022	0.030*
		(1.39)	(0.84)	(1.67)	(0.56)		(2.74)	(2.09)	(-0.36)	(-3.07)	(-0.01)	(-2.49)	(-0.86)	(1.66)
Rest of the World			0.025	**-0.071*****	0.015	**-0.158*****		**0.102*****	0.068*					
			(0.95)	(-3.28)	(0.40)	(-5.91)		(5.34)	(1.96)					
Global		0.019	**-0.053****	0.011	**-0.073*****		-0.017*	0.004*	0.013	**-0.035*****	**0.033****			
		(1.62)	(-2.06)	(0.48)	(-3.19)		(-1.75)	(1.83)	(0.81)	(-5.52)	(2.34)			
Single industry	**-0.035*****	-0.016*	-0.012	0.003	0.020	-0.036	-0.027	**-0.024****	-0.028		-0.010	0.002	**0.023*****	-0.015
	(-3.83)	(-1.72)	(-0.38)	(0.15)	(0.77)	(-0.55)	(-0.63)	(-2.28)	(-1.03)		(-0.44)	(0.08)	(2.68)	(-0.91)
Op. hedging incl.	**-0.049*****	**-0.079*****	-0.022	-0.004	**-0.075*****		**-0.232*****	0.004	0.034*	-0.011	-0.005		**0.070*****	0.002
	(-2.62)	(-5.36)	(-1.12)	(-0.11)	(-2.62)		(-8.38)	(0.21)	(1.75)	(-0.25)	(-0.21)		(4.77)	(0.06)
Risk red. only		0.023*	**-0.061****	-0.075	0.006	**0.080*****	**-0.091****	-0.030*	0.022	0.152*	**0.135*****	0.052	0.018	-0.004
		(1.80)	(-2.38)	(-1.39)	(0.12)	(6.00)	(-2.59)	(-1.78)	(1.50)	(1.87)	(4.94)	(1.38)	(0.30)	(-0.50)
FX only	**-0.066*****	0.002	**-0.035*****	-0.012	0.006	**0.109****	**-0.022*****	0.009	-0.006	-0.003	-0.024	-0.0001	0.045*	**-0.028*****
	(-3.06)	(0.34)	(-2.68)	(-1.12)	(0.25)	(2.26)	(-4.88)	(0.77)	(-0.57)	(-0.71)	(-1.66)	(-0.01)	(1.71)	(-4.01)
IR only	**-0.076****	0.003	0.029	-0.095*	-0.010	**-0.102*****	**0.004****	-0.001	-0.013	-0.001	**-0.027*****	-0.003	0.059	-0.013
	(-2.43)	(0.34)	(1.53)	(-1.69)	(-0.25)	(-6.70)	(2.34)	(-0.06)	(-1.21)	(-0.10)	(-5.17)	(-0.06)	(0.82)	(-1.24)
CP only	0.025	-0.009	-0.007		0.002	-0.063	**-0.024*****	0.017	-0.021	-0.002	**-0.024*****	**-0.252*****	0.018	**0.019****
	(0.93)	(-1.54)	(-0.45)		(0.09)	(-1.30)	(-9.84)	(0.99)	(-0.94)	(-0.28)	(-4.69)	(-4.37)	(0.71)	(2.01)
Ex ante exposure	-0.0004	0.009	0.030	0.036	-0.0001	-0.023	**0.123*****	0.017	0.013	0.001	0.0001	-0.032	-0.0004	0.022
	(-0.02)	(0.70)	(1.47)	(1.46)	(-0.01)	(-0.34)	(3.24)	(1.36)	(0.42)	(0.02)	(0.01)	(-0.69)	(-0.02)	(0.74)
Avg. year	**0.002*****	**0.002*****	**0.002*****	**-0.004*****	0.006*		-0.000	**0.003*****	**0.005*****		**-0.005*****		0.003	0.001
	(2.63)	(5.83)	(3.26)	(-4.29)	(1.86)		(-0.04)	(2.59)	(4.51)		(-3.30)		(1.50)	(1.09)
Panel data	**-0.051*****	**-0.031*****	-0.014*	0.025	-0.046	0.003	0.026	**-0.038****	0.001	-0.018	0.003	**-0.063****	0.008	-0.003
	(-2.94)	(-4.58)	(-1.77)	(1.25)	(-1.31)	(0.11)	(0.84)	(-2.47)	(0.05)	(-0.41)	(0.19)	(-2.54)	(0.26)	(-0.12)
Survey data	-0.015	**0.051****	0.014	0.009	-0.029	**0.348*****	-0.050	**0.048****	**-0.071*****	0.026	-0.048	**-0.031*****	**-0.103*****	**0.055*****
	(-0.68)	(2.06)	(0.61)	(0.32)	(-0.88)	(2.65)	(-1.42)	(2.14)	(-3.54)	(0.33)	(-1.26)	(-2.85)	(-2.73)	(3.29)
Fixed effects	0.006	**-0.010****	0.002	0.011	**0.047*****	**0.090*****	**0.014*****	0.005	0.016		0.009	**0.041*****	**-0.051*****	-0.0001
	(0.51)	(-2.12)	(1.05)	(0.54)	(3.07)	(3.35)	(3.95)	(0.73)	(1.46)		(0.91)	(6.37)	(-3.56)	(-0.02)

	(1) CPX	(2) DIY	(3) DRA	(4) FSA	(5) FSZ	(6) GDF	(7) ICR	(8) LIQ	(9) MTB	(10) OOS	(11) PRO	(12) RAD	(13) SOS	(14) TLC
Predicted sign	[+]	[+]	[+]	[+]	[+/–]	[+/–]	[–]	[–]	[+]	[–]	[–]	[+]	[+]	[+]
Endogeneity	**0.074*****	0.006	-0.013	-0.095*	0.003		-0.001	**-0.037*****	0.033	0.030	0.032	0.000	-0.014	
	(11.07)	(0.63)	(-0.87)	(-1.86)	(0.06)		(-0.03)	(-3.98)	(1.55)	(0.75)	(0.65)	(0.02)	(-1.31)	
Logit	-0.009	**0.018*****	**-0.018****	0.036	**-0.036*****			-0.001	**-0.014****	**0.027*****	-0.005	-0.003	0.010	0.011
	(-1.40)	(3.22)	(-2.51)	(1.33)	(-3.01)			(-0.12)	(-2.09)	(2.62)	(-0.66)	(-0.94)	(0.62)	(1.39)
Control EXP	-0.005		**-0.031****		-0.025			-0.021*	**-0.019****			-0.011	-0.002	
	(-0.82)		(-2.29)		(-1.37)			(-1.82)	(-2.50)			(-0.66)	(-0.21)	
Control ASI	0.005*	0.021	**-0.035*****	**0.054*****	-0.021	0.030	**-0.094*****	0.025*	-0.007	0.002	-0.003	**0.028*****	**0.026*****	**-0.017*****
	(1.72)	(1.38)	(-3.22)	(2.74)	(-1.06)	(1.03)	(-3.45)	(1.73)	(-0.74)	(0.09)	(-0.21)	(4.45)	(2.64)	(-4.25)
Control MAV	**-0.007*****	**-0.027*****	**-0.025****	**-0.035*****	**-0.103*****	**0.019*****		0.011*	**-0.012****		0.009	-0.017		-0.007
	(-7.02)	(-4.24)	(-2.18)	(-3.49)	(-3.13)	(4.39)		(1.70)	(-2.26)		(0.83)	(-1.54)		(-1.59)
Control OFH	**0.164*****		0.029	**-0.060*****	0.018	0.008		**-0.029*****	-0.018			0.028	-0.035	0.007
	(7.27)		(1.57)	(-3.12)	(0.74)	(0.12)		(-3.84)	(-0.73)			(0.71)	(-1.19)	(0.30)
Control GDF		-0.002	-0.008	0.023	**-0.068*****			-0.013	-0.009	**0.048****	-0.004	-0.007	-0.019	0.003
		(-0.12)	(-0.38)	(1.32)	(-3.21)			(-1.33)	(-0.39)	(2.32)	(-0.37)	(-1.50)	(-1.04)	(0.35)
Top journal	0.019	0.011	**0.038****	**-0.019****	0.012			**0.025*****	-0.000		**-0.051*****	-0.009	**0.060*****	**0.028*****
	(1.01)	(1.16)	(2.01)	(-2.14)	(0.59)			(2.85)	(-0.02)		(-3.04)	(-0.65)	(3.24)	(5.03)
Adj. R^2	0.35	0.27	0.18	0.56	0.32	0.67	0.50	0.39	0.28	0.15	0.25	0.58	0.29	0.24
#Obs.	111	292	607	279	630	110	152	454	373	160	271	171	187	208
#Studies	30	58	115	63	128	18	25	93	73	26	42	35	45	48

Notes: This table reports the results of Eq. (4). Regional dummies with less than fifteen observations are not included to avoid estimates suffering from small-sample bias. The model is 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. For the variables ICR and PRO, standard errors are only clustered at study-level as the number of country clusters is insufficient for the calculation of a robust covariance matrix. Columns represent the fourteen determinants that are most commonly examined in the hedging literature, with definitions reported in Tab. 1. Definitions of the explanatory variable can be found in Tab. 2 and 3. Coefficients for structural and methodological heterogeneity that are statistically significant, at least at the 5 % level, are highlighted in bold face.

Asterisks indicate statistical significance: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 8. Analysis of heterogeneity: Extent of hedging

Predicted sign	(1) CPX [+]	(2) DIY [+]	(3) DRA [+]	(4) FSA [+]	(5) FSZ [+/–]	(6) GDF [+/–]	(7) ICR [–]	(8) LIQ [–]	(9) MTB [+]	(10) OOS [–]	(11) PRO [–]	(12) RAD [+]	(13) SOS [+]	(14) TLC [+]
Panel B: Extent of hedging														
Intercept	-0.037***	-0.001	0.069***	0.277***	0.227***	0.126	0.134***	-0.044***	0.005	-0.021	-0.005	0.017	-0.069**	-0.148***
	(-2.92)	(-0.05)	(2.59)	(8.16)	(4.49)	(0.77)	(6.64)	(-2.79)	(0.26)	(-0.68)	(-0.89)	(0.59)	(-2.57)	(-8.43)
SE(r)	0.057	-1.031**	0.985***	-1.380**	-2.106**	0.907	-4.047***	0.206	0.002	0.251	0.396	1.046**	0.318	1.958***
	(0.38)	(-2.42)	(2.68)	(-2.43)	(-2.37)	(1.29)	(-9.34)	(0.58)	(0.00)	(0.46)	(1.13)	(2.38)	(0.94)	(4.98)
Europe	**-0.062*****	**0.092*****	**-0.151*****	-0.055	**0.206*****			-0.013	-0.001		**-0.061*****		0.085	**0.095*****
	(-2.65)	(6.89)	(-4.08)	(-1.02)	(7.15)			(-0.35)	(-0.01)		(-3.43)		(1.48)	(2.85)
East Asia & Pacif.		**0.038*****	-0.015	-0.017	**0.107*****			0.016	-0.019			-0.034*	**-0.095*****	0.039
		(3.42)	(-0.72)	(-0.30)	(2.59)			(0.71)	(-0.77)			(-1.66)	(-2.63)	(1.15)
Rest of the World			0.046		-0.004			**-0.101*****	0.020					
			(0.66)		(-0.08)			(-2.90)	(0.56)					
Global		**0.044*****	-0.009		**0.112*****				0.002		**0.033*****		-0.035*	
		(3.88)	(-0.35)		(6.12)				(0.09)		(4.48)		(-1.70)	
Single industry		-0.016	-0.014	**0.115*****	**0.090****	0.027		**-0.055*****	-0.010		**-0.038****		0.023	**-0.058*****
		(-0.77)	(-1.46)	(3.61)	(2.11)	(0.34)		(-3.39)	(-0.61)		(-2.27)		(0.61)	(-2.67)
Risk red. only	0.010	0.003	-0.014	-0.002	0.003			**-0.038*****	0.022	**0.072****	0.015	-0.0001	-0.069*	**0.099*****
	(1.13)	(0.46)	(-0.97)	(-0.05)	(0.11)			(-2.95)	(1.22)	(2.11)	(1.57)	(-0.01)	(-1.73)	(13.97)
Alt. hed. measure	0.015*	0.009	-0.003	0.012	-0.009	-0.049	**-0.021*****	**0.041*****	-0.003	**-0.071****	**-0.014*****	**-0.046*****	0.041*	-0.014
	(1.95)	(1.03)	(-0.19)	(0.50)	(-0.41)	(-0.90)	(-2.63)	(3.39)	(-0.21)	(-1.98)	(-4.62)	(-4.60)	(1.73)	(-1.30)
FX only			**-0.034*****	0.007			**0.049*****		**-0.033****	0.001	0.008	0.015	**0.036****	**0.043*****
			(-3.38)	(0.50)			(5.78)		(-2.46)	(0.09)	(1.28)	(0.90)	(2.42)	(6.06)
IR only	-0.027*	0.033*	**0.052****	**-0.055*****	-0.092*		**-0.021*****	-0.012	-0.010	**-0.029*****	**-0.007****	**-0.025****	**0.034*****	0.002
	(-1.78)	(1.74)	(2.22)	(-3.07)	(-1.93)		(-4.79)	(-0.61)	(-0.56)	(-3.51)	(-1.99)	(-2.23)	(3.72)	(0.13)
CP only	**0.037****	**0.050*****	**0.073*****		-0.016	0.040			-0.023	**-0.073*****	0.012	-0.011		**0.061*****
	(2.53)	(3.06)	(4.21)		(-0.20)	(0.21)			(-0.69)	(-2.78)	(1.39)	(-0.84)		(7.31)
Ex ante exposure	0.014	-0.009	-0.030	**0.088*****	**0.080*****	-0.044*	-0.054	**0.043****	0.010	-0.033	-0.016	**0.041*****	-0.025*	**-0.050*****
	(0.50)	(-1.34)	(-1.03)	(2.74)	(4.06)	(-1.70)	(-1.20)	(2.32)	(0.47)	(-0.94)	(-1.17)	(4.98)	(-1.86)	(-7.15)
Avg. year	0.003*			**0.008*****		-0.005	0.004			0.002			-0.001	**0.009*****
	(1.94)			(2.89)		(-1.44)	(0.88)			(0.49)			(-0.21)	(5.01)
Panel data			-0.055	**-0.069****	**-0.099*****	-0.093	0.084			-0.013			**0.072****	
			(-1.57)	(-2.30)	(-3.63)	(-1.39)	(1.15)			(-0.38)			(2.28)	
Survey data	-0.004	-0.060*	-0.004	**0.240*****	-0.050			0.022	0.008	0.060	**-0.096*****	**0.020****	**-0.168*****	
	(-0.10)	(-1.79)	(-0.12)	(8.28)	(-1.43)			(1.16)	(0.34)	(0.88)	(-5.77)	(2.25)	(-3.32)	
Fixed effects			0.017	0.008	-0.006	-0.011	**-0.125****	0.010						
			(0.86)	(0.33)	(-0.19)	(-0.66)	(-2.28)	(0.96)						

Predicted sign	(1) CPX [+]	(2) DIY [+]	(3) DRA [+]	(4) FSA [+]	(5) FSZ [+/–]	(6) GDF [+/–]	(7) ICR [–]	(8) LIQ [–]	(9) MTB [+]	(10) OOS [–]	(11) PRO [–]	(12) RAD [+]	(13) SOS [+]	(14) TLC [+]
Endogeneity	**-0.256*****	-0.022	0.039	**-0.306*****	0.068*			**-0.130*****		-0.172*	0.030	0.006	**0.055*****	
	(-8.08)	(-0.68)	(1.33)	(-3.43)	(1.92)			(-5.36)		(-1.78)	(1.06)	(0.24)	(6.30)	
Selection bias	0.024	-0.097*	0.016	**0.074*****	-0.084		**0.178****	**-0.057*****	0.000	**-0.125*****	-0.026	0.015	**-0.084****	-0.127*
	(0.76)	(-1.93)	(0.51)	(3.59)	(-1.37)		(2.34)	(-4.90)	(0.00)	(-5.62)	(-0.51)	(0.81)	(-2.39)	(-1.70)
Control EXP	**0.032*****	-0.005	**-0.045*****		-0.004		-0.002	-0.014*	0.021*	0.039	**0.026*****	-0.005	**0.032****	**0.038*****
	(3.04)	(-0.63)	(-4.93)		(-0.20)		(-0.17)	(-1.82)	(1.70)	(1.39)	(4.09)	(-0.51)	(2.16)	(5.78)
Control ASI	0.001	**0.069*****	0.001	-0.054	0.028	0.009	0.023	**0.024****	**-0.048*****	0.026	**0.017****		**0.018****	0.011*
	(0.23)	(6.39)	(0.03)	(-1.59)	(1.34)	(0.30)	(1.60)	(2.56)	(-2.76)	(1.51)	(2.18)		(2.05)	(1.66)
Control MAV	-0.001	**0.038*****	0.036*	**-0.043*****	-0.001	**-0.242****	-0.004	**-0.047*****	**0.031*****		**-0.034*****	0.016		-0.011
	(-0.05)	(3.37)	(1.72)	(-6.13)	(-0.01)	(-2.44)	(-1.07)	(-3.05)	(4.81)		(-3.09)	(1.40)		(-1.28)
Control OFH	**0.171*****	**0.129*****	-0.005	**-0.049****	0.045	-0.047	0.329***	0.071**	0.049		**0.067*****	0.015	**0.119*****	-0.085
	(7.59)	(4.09)	(-0.17)	(-2.17)	(1.00)	(-0.66)	(4.67)	(2.57)	(1.50)		(3.32)	(0.67)	(3.36)	(-1.44)
Control GDF			-0.004	**-0.255*****	-0.029			0.027	**-0.027****	**-0.078****	**-0.123*****	**-0.145*****	0.016	0.055*
			(-0.07)	(-14.90)	(-0.50)			(0.76)	(-2.36)	(-2.23)	(-7.24)	(-10.72)	(0.78)	(1.66)
Top journal				**-0.110*****	**-0.066*****	0.070	**0.024*****	-0.019		**0.094*****			**0.056*****	**0.027*****
				(-9.55)	(-2.84)	(1.45)	(3.54)	(-1.47)		(8.83)			(2.83)	(3.44)
Adj. R^2	0.39	0.56	0.40	0.63	0.58	0.74	0.59	0.32	0.31	0.57	0.20	0.51	0.45	0.42
#Obs.	152	207	459	174	476	37	80	286	235	151	149	165	250	178
#Studies	24	37	79	35	85	13	14	65	50	25	27	27	39	29

Notes: This table reports the results of Eq. (4). Regional dummies with less than fifteen observations are not included to avoid estimates suffering from small-sample bias. The model is 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. Columns represent the fourteen determinants that are most commonly examined in the hedging literature, with definitions reported in Tab. 1. Definitions of the explanatory variable can be found in Tab. 2 and 3. Coefficients for structural and methodological heterogeneity that are statistically significant, at least at the 5 % level, are highlighted in bold face.

Asterisks indicate statistical significance: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 9. No. of significant results (<0.05): Geographical heterogeneity

	FIN	UND	TAX	MNG	SUB	EXP	EOS
Panel A: Decision to hedge							
Europe	[0/5]	– [1/4]	[0/1]	+/– [2/2]	+ [2/3]	– [1/3]	[0/1]
East Asia & Pacific	– [1/5]	– [1/3]	[0/1]	+ [1/2]	– [1/2]	[0/2]	[0/1]
Rest of the world	[0/2]	[0/2]			+/– [2/2]	– [2/3]	[0/1]
Global	– [3/4]	– [1/2]		+ [1/1]	[0/2]	– [1/2]	– [1/1]
Panel B: Extent of hedging							
Europe	+/– [4/4]	– [2/3]	+ [1/1]	[0/1]	+ [1/2]	– [1/2]	+ [1/1]
East Asia & Pacific	– [1/3]	[0/3]	[0/1]	– [1/1]	+ [1/2]	[0/2]	+ [1/1]
Rest of the world	[0/2]	[0/2]			+ [1/1]	[0/1]	[0/1]
Global	– [2/3]	[0/2]		[0/1]	+ [1/1]	[0/1]	+ [1/1]

Notes: This table summarizes the results for the regional differences reported in Tab. 7 and 8. Results of the hedging determinants are aggregated for each hedging hypothesis as defined in Tab. 1. The first digit in brackets represents the number of significant effects (at least at the 5% level) from the multivariate MRA results. The second digit in brackets is the total number of hedging determinants with results reported in the analysis of heterogeneity. The sign shown before brackets refers to the dominating sign of the effect on the decision to hedge (Panel A) and the extent of hedging (Panel B). Signs of the MRA results from Tab. 7 and 8 are counted as positive (negative) if the coefficient is identical (the opposite) to the predicted sign of the hedging determinant. A positive (negative) sign in Panel A/B indicates that this effect is stronger (weaker) in a certain world region as compared to North America.

FIN = Financial distress costs; UND = Underinvestment; TAX = Tax benefits; MNG = Managerial risk aversion; SUB = Hedging substitutes; EXP = Risk exposure; EOS = Economies of scale.

Table 10. No. of significant results (<0.05): Methodological heterogeneity

	Panel A: Decision to hedge		Panel B: Extent of hedging		Panel C: Full sample	
Industry differences						
Single industry	+ [3/13]	23%	+ [5/10]	50%	+ [8/23]	35%
Hedging variable						
Op. hedging included	– [5/12]	42%			– [5/12]	42%
Risk reduction only	+/– [4/13]	31%	+ [3/12]	25%	+ [7/25]	28%
Alt. hedging measure			+ [5/14]	36%	+ [5/14]	36%
Foreign exchange risk	– [5/14]	36%	– [5/10]	50%	– [10/24]	42%
Interest rate risk	– [4/14]	29%	+ [7/13]	54%	+ [11/27]	41%
Commodity risk	+ [4/13]	31%	+ [5/10]	50%	+ [9/23]	39%
Data characteristics						
Ex ante exposure	– [1/14]	7%	+ [5/14]	36%	+ [6/28]	21%
Avg. year	+ [7/11]	64%	+ [2/7]	29%	+ [9/18]	50%
Panel data	– [4/14]	29%	– [3/7]	43%	– [7/21]	33%
Data from survey	– [7/14]	50%	+ [4/11]	36%	– [11/25]	44%
Estimation characteristics						
Fixed effects	+/– [6/13]	46%	+ [1/6]	17%	+ [7/19]	37%
Endogeneity	+ [2/12]	17%	+/– [4/10]	40%	+ [6/22]	27%
Logit	– [5/12]	42%			– [5/12]	42%
Cragg			+ [5/13]	38%	+ [5/13]	38%
Specification characteristics						
Control EXP	– [2/7]	29%	+ [5/12]	42%	+ [7/19]	37%
Control ASI	+ [6/14]	43%	– [5/13]	38%	+ [11/27]	41%
Control MAV	– [7/11]	64%	+ [6/12]	50%	– [13/23]	57%
Control OFH	+ [3/10]	30%	+ [5/13]	38%	+ [8/23]	35%
Control GDF	– [2/11]	18%	– [5/10]	50%	– [7/21]	33%
Publication characteristics						
Top journal	+ [6/11]	55%	– [6/8]	75%	– [12/19]	63%

Notes: This table summarizes the results for the methodological differences reported in Tab. 7 and 8. Results of the single hedging determinants are aggregated for each moderator variable defined in Tab. 2. The first digit in brackets represents the number of significant effects (at least at the 5% level) from the augmented MRA results. The second digit in brackets is the total number of hedging determinants with results reported in the augmented MRA. The sign shown before brackets refers to the dominating sign of the effect on the decision to hedge (Panel A) and the extent of hedging (Panel B). Signs of the MRA results from Tab. 7 and 8 are counted as positive (negative) if the coefficient is identical (the opposite) to the predicted sign of the hedging determinant. A positive (negative) dominating sign indicates that this moderator has a positive (negative) overall impact on the decision to hedge (Panel A) and the extend of hedging (Panel B).