Online supplementary material for the article

'Corporate financial hedging and firm value: A meta-analysis'

Appendix A. List of primary studies included in the meta-analysis

ID	Author(s)	Start year	End year	No. of estimates	Estimated hedging premium				
					Mean	Median	Min.	Max.	Std. Dev.
1	Adam and Nain (2005)	1999	1999	9	0.188	0.209	-0.054	0.412	0.168
2	Afza and Alam (2016)	2004	2010	13	0.120	0.058	0.007	0.525	0.165
3	Ahmed et al. (2014)	2005	2012	66	0.003	0.009	-0.181	0.145	0.068
4	Alam and Gupta (2018)	2008	2015	12	0.159	0.124	-0.067	0.525	0.141
5	Allayannis and Weston (2001)	1990	1995	35	0.041	0.042	-0.063	0.108	0.039
6	Ayturk et al. (2016)	2007	2013	18	0.003	0.002	-0.122	0.294	0.085
7	Bae et al. (2016)	2002	2010	2	-0.004	-0.004	-0.005	-0.003	0.001
8	Bae et al. (2018)	2005	2010	2	0.283	0.283	0.052	0.514	0.327
9	Bai et al. (2016)	2008	2015	3	0.361	0.412	0.183	0.487	0.159
10	Bashir et al. (2013)	2006	2010	9	-0.007	-0.014	-0.263	0.220	0.150
11	Belghitar et al. (2008)	1995	1995	10	0.129	0.141	-0.024	0.204	0.062
12	Belghitar et al. (2013)	2002	2005	10	-0.024	-0.021	-0.095	0.022	0.037
13	Berrospide et al. (2008)	1997	2005	4	0.132	0.129	0.123	0.147	0.011
14	Brunzell et al. (2011)	2007	2007	3	0.462	0.463	0.398	0.525	0.064
15	Carter et al. (2006)	1992	2003	36	0.060	0.062	-0.066	0.230	0.062
16	Chang et al. (2016)	2001	2010	3	-0.130	-0.121	-0.224	-0.044	0.090
17	Chen and King (2014)	1994	2009	2	0.170	0.170	0.029	0.311	0.200
18	Chen and Shao (2010)	2007	2009	8	0.122	0.116	0.056	0.202	0.062
19	Chen et al. (2011)	1998	2001	6	-0.063	-0.041	-0.263	0.025	0.105
20	Choi et al. (2013)	2001	2006	16	0.224	0.159	-0.030	0.525	0.192
21	Chou and Lai (2013)	2005	2010	3	-0.078	-0.083	-0.260	0.109	0.184
22	Clark and Judge (2009)	1995	1995	34	0.186	0.146	0.116	0.411	0.076
23	Clark and Mefteh (2010)	2004	2004	7	0.133	0.089	0.060	0.385	0.113
24	Clark et al. (2007)	2004	2004	6	0.033	0.053	-0.054	0.064	0.046
25	Dionne et al. (2013)	1993	1999	8	0.130	0.133	0.096	0.161	0.024
26	Disatnik et al. (2014)	2002	2007	3	0.040	0.045	-0.008	0.084	0.046
27	dos Santos et al. (2017)	2006	2014	45	0.046	0.029	-0.053	0.299	0.067
28	Elsawaf (2005)	1993	2000	82	0.144	0.101	-0.096	0.525	0.140
29	Fauver and Naranjo (2010)	1991	2000	16	-0.130	-0.143	-0.263	0.001	0.085
30	Gleason et al. (2005)	1998	1998	5	0.034	0.034	0.033	0.034	0.000
31	Hagelin et al. (2007)	1997	2001	6	0.152	0.112	-0.029	0.525	0.207
32	Jankensgård (2015a)	2009	2009	6	0.148	0.154	0.069	0.206	0.045
33	Jankensgård (2015b)	2000	2008	1	-0.166	-	-	-	-
34	Jankensgård et al. (2014)	2009	2009	4	-0.016	-0.018	-0.021	-0.006	0.007
35	Jin and Jorion (2006)	1998	2001	18	-0.018	-0.021	-0.098	0.045	0.038
36	Jin and Jorion (2007)	1991	2000	4	-0.116	-0.108	-0.189	-0.057	0.060
37	Jorge and Augusto (2012)	2007	2007	2	-0.081	-0.081	-0.084	-0.078	0.004
38	Kapitsinas (2008)	2004	2006	16	0.117	0.089	-0.090	0.438	0.131
39	Khediri (2010)	2000	2002	6	-0.021	-0.019	-0.132	0.087	0.072
40	Khediri and Folus (2010)	2001	2001	5	-0.057	-0.047	-0.085	-0.031	0.024
41	Kim et al. (2006)	1998	1998	3	0.008	0.008	0.000	0.017	0.009

42	Kim et al. (2014)	1992	2004	22	0.161	0.155	-0.127	0.525	0.157
43	Kim et al. (2017)	2003	2013	15	0.035	0.067	-0.128	0.205	0.103
44	Korkeamäki et al. (2016)	2000	2015	4	0.029	0.028	0.021	0.041	0.008
45	Li et al. (2014)	2007	2007	5	-0.020	0.003	-0.263	0.135	0.147
46	Lievenbrück and Schmid (2014)	1995	2005	6	-0.102	-0.139	-0.263	0.115	0.166
47	Lookman (2004)	1992	2000	28	0.006	-0.004	-0.058	0.105	0.048
48	Luo (2016)	2007	2013	6	0.230	0.289	0.073	0.332	0.118
49	MacKay and Moeller (2007)	1985	2004	26	-0.006	-0.032	-0.113	0.142	0.088
50	Magee (2013)	1996	2000	11	0.031	0.021	-0.096	0.120	0.057
51	Manchiraju et al. (2014)	2007	2012	1	0.027	0.027	0.027	0.027	-
52	Marami and Dubois (2013)	1998	2005	12	0.124	0.065	-0.001	0.335	0.128
53	Meredith (2002)	1996	1998	7	-0.050	-0.053	-0.129	0.051	0.053
54	Mohammad (2014)	2006	2010	1	0.080	-	-	-	-
55	Nain (2005)	1999	1999	4	0.142	0.108	0.008	0.344	0.143
56	Nguyen and Faff (2007)	1999	2000	22	-0.149	-0.177	-0.263	0.005	0.094
57	Nguyen and Faff (2010)	1999	2000	12	-0.051	-0.029	-0.197	0.106	0.084
58	Nova et al. (2015)	2005	2013	12	-0.006	-0.006	-0.226	0.080	0.077
59	Panaretou (2014)	2003	2010	30	0.070	0.063	-0.084	0.195	0.061
60	Pérez-González and Yun (2013)	1997	2007	58	0.154	0.095	-0.166	0.525	0.145
61	Phan et al. (2014)	1998	2009	64	-0.020	-0.030	-0.205	0.224	0.099
62	Pierce (2015)	2008	2008	1	0.004	-	-	-	-
63	Pramborg (2004)	1997	2001	12	0.080	0.133	-0.086	0.163	0.095
64	Rosietta and Oktavia (2011)	2001	2009	1	0.051	-	-	-	-
65	Rossi and Laham (2008)	1996	2005	61	0.127	0.116	0.004	0.525	0.095
66	Treanor et al. (2013)	1994	2006	27	0.023	0.046	-0.084	0.096	0.058
67	Treanor et al. (2014)	1994	2008	5	0.046	0.055	0.025	0.066	0.018
68	Wang et al. (2010)	2002	2008	13	0.182	0.189	0.091	0.239	0.049
69	Weiying and Jian (2010)	2007	2007	1	-0.107	-	-	-	-
70	Xiang and Bi (2015)	2009	2013	1	0.024	-	-	-	-
71	Zhou et al. (2012)	2007	2010	1	0.095	-	-	-	-
Overall		**1985**	**2015**	**1016**	**0.064**	**0.053**	**-0.263**	**0.525**	**0.134**

Notes: This table reports an overview of the 71 studies included in the meta-analysis sample.

Appendix B. Calculation of the hedging premium from statistics reported in the primary studies

From the sample of collected primary studies, we extract the marginal effects of hedging on firm value as well as the corresponding measure of precision (standard errors or *t*-statistics). In addition, we observe the type of hedging variable (dummy or continuous measure) and the specification of the model (level-level or log-level). Finally, sample mean values of the firm value proxy and the continuous hedging variable are obtained from the descriptive statistics of the studies. Table B.1 summarizes the calculation of the hedging premiums based on the extracted results.

Table B.1. Computation of hedging premiums

	Q	$Ln(Q)$	Observations
$HD \in \{0,1\}$	$HP = \hat{\beta}/\bar{Q}_{NH}$	$HP = Exp(\hat{\beta}) - 1$	628
$HC \in [0,1]$	$HP = \hat{\beta}(\overline{HC}_H/\bar{Q}_{NH})$	$HP = Exp(\hat{\beta} \cdot \overline{HC}_H) - 1$	259
Observations	302	585	887

Notes: HD = Hedging dummy variable, HC = Continuous hedging variable, HP = Hedging premium, $\hat{\beta}$ = Estimated marginal effect of hedging on firm value (see also Eq. (1)), Q = Measure of firm value, H = Group of hedging firms, NH = Group of non-hedgers.

The hedging premium quantifies the average firm value difference between the group of hedgers and non-hedgers in relation to the firm value of non-hedgers ($(\bar{Q}_H - \bar{Q}_{NH})/\bar{Q}_{NH}$). In the first case ($HD$, Q), the observed regression coefficient $\hat{\beta}$ from Eq. (1) in the main paper measures the value differences between hedgers and non-hedgers. Hence, we just have to divide this value by the sample mean of the non-hedgers group ($\bar{Q}_{NH}$) to receive the percentage value increase through hedging. If this value is not reported in the primary study, we requested them from the authors. Otherwise, we use the full sample mean of firm value (hedgers and non-hedgers) as proxy. For the second case (HD, $LN(Q)$), the estimated regression coefficient directly exhibits the percentage markup in logarithmic scale. Thus, we take the exponential value of it (minus 1) to derive the hedging premium. For case three (HC, Q) and four (HC, $LN(Q)$), we follow Carter et al. (2006) as well as Phan et al. (2014) and evaluate the value premium for an average hedging firm by multiplying the primary study regression coefficients with the sample mean values of the continuous hedging variable for the hedgers group $\overline{HC}_H$. Afterwards, we conduct the same transformations as for case one and two.

The corresponding standard errors of the hedging premiums are calculated using the t-statistics of the marginal effects reported in the primary studies:

$$SE(HP) = \frac{HP}{t} \quad \text{(B1)}$$

where t is the reported t-statistic of $\hat{\beta}$.

In addition to Eq. (1) in the main paper, other models analyze interaction terms between the hedging variable and other firm characteristics (e.g. capital expenditure). A model with one interaction can be formulized as:

$$Y_{it} = \alpha + \beta H_{it} + \delta H_{it} Z_{it} + \gamma X'_{it} + \eta_i + \zeta_t + \varepsilon_{it} \quad \text{(B2)}$$

where Z denotes an interaction variable. Other variables and subscripts are the same as in Eq. (1). In case of interaction terms, the hedging premiums are evaluated at the sample mean of the interacting variable. If sample means of the interacting variables are unreported, we asked the primary study authors to provide them. Otherwise effects are not considered in the sample. The calculation of the hedging premiums for the four cases with one interacting variable is summarized in Tab. B.2.[1]

Table B2.2. Computation of hedging premiums in firm value models with one interaction term

	Q	$Ln(Q)$	Observations
$HD * Z$	$HP = \hat{\beta}/\bar{Q}_{NH} + \hat{\delta}(\bar{Z}/\bar{Q}_{NH})$	$HP = EXP(\hat{\beta}) - 1 + EXP(\hat{\delta} \cdot \bar{Z}) - 1$	62
$HC * Z$	$HP = \hat{\beta}(\overline{HR}_H/\bar{Q}_{NH}) + \hat{\delta}(\overline{HR}_H \cdot \bar{Z}/\bar{Q}_{NH})$	$HP = EXP(\hat{\beta} \cdot \overline{HR}_H) - 1 + EXP(\hat{\delta} \cdot \overline{HR}_H \cdot \bar{Z}) - 1$	67
Observations	51	78	129

Notes: HD = Hedging dummy variable, HC = Continuous hedging variable, HP = Hedging premium, $\hat{\beta}$ = Estimated marginal effect of hedging on firm value (see also Eq. (1)), Q = Measure of firm value, H = Group of hedging firms, NH = Group of non-hedgers, Z = Interaction variable. Observations counts refer to the total number of observations with interaction terms for this group (i.e. also observations with more than one interaction term are included).

Finally, the corresponding standard errors for the hedging premiums from Tab. B.2 are approximated using the delta method (Papke and Wooldridge, 2005; Valentine, 1979).

[1] The calculation of the hedging premiums is analogously performed for models with more than one interaction term (33 observations in total).

Appendix C. Estimation of the meta-regression model

For the application of the meta-regression model from Eq. (2) in the main paper, we consider the following econometric issues[2]:

Heteroscedasticity. The meta-regression model exhibits heteroscedasticity, as the estimates' standard errors depend on the sample size, which varies from study to study. It is an established approach in MRA research to use weighted least squares (WLS) to obtain efficient estimates (Stanley and Doucouliagos, 2012). The common weight is the reciprocal of the squared standard errors of the hedging premiums (Stanley et al., 2010). This implies that more precise and thus more reliable statistical estimates (those with lower standard errors) receive a larger weight in the regression. Indeed, there is a current debate about inverse variance weighting, as it indirectly puts larger weights on studies reporting more estimates. To avoid such unintentional weighting, we also employ the interaction between the inverse of the number of estimates reported per study and the inverse of the estimates' variance for weighting. This approach assigns equal weights to studies independently of the number of reported estimates.

Within-study dependency. As outlined in the data section, we collect all estimates for the hedging premium reported in each study to maximize data availability and to avoid biases arising from subjective ex-ante selection.[3] By implication, standard errors are likely to be inflated in a pooled cross-study regression because of their dependency at the study level.[4] To control for this issue, we adopt robust standard errors in our analyses with clusters at the level of the individual studies (Froot, 1989).

Between-country dependency. The clustering method at the study-level presumes the clusters themselves to be independent. As the data samples used in different primary studies may overlap, the assumption of cluster-independence is violated. To consider such dependencies, we treat data sets from different studies as similar if they examine the same country (e.g. two different studies use data from US companies). Besides the study-level clustering, standard errors are additionally clustered at the country-level following the two-way clustering approach by Cameron et al. (2011).[5]

[2] In addition, we present a more general discussion of the major criticisms of meta-analysis in the online appendix S1.
[3] Bijmolt and Pieters (2001) reveal in a simulation study that the inclusion of the variation within multiple estimates per study outperforms approaches with a single value included.
[4] This point is equivalent to the issue of correlated residuals in panel data regressions across multiple firms and time periods (Petersen, 2008).
[5] For a recent application of two-way clustering in meta-analysis, see also Havranek and Irsova (2017).

Appendix D. Criticisms of meta-analysis

As any other empirical method, also meta-analysis comes with limitations, which are outlined here together with a discussion on how we address these issues.

Unpublished and low-quality studies should be excluded. Our meta-sample includes both observations published in top journals of the field, but also from studies not published in leading outlets as well as unpublished work. An alternative approach by Slavin (1986, 1995) is the 'best practice synthesis' that only considers 'good' studies. However, the obvious caveat is how to decide what a 'good' study is. Thus, this approach comes with strong subjectivity for selection of included studies. Moreover, focusing on top journals only would lead to a significantly smaller data set and a reduction of variation in the collected estimates, which is indeed necessary for the statistical identification of drivers that are responsible for the wide variation of hedging-firm value effects. Therefore, we follow Stanley and Doucouliagos (2012: 19) and rather 'err on the side of inclusion' of all studies that are in line with our inclusion criteria. Moreover, we account for various differences in research methods, models, and data in the meta-regression, hence all factors for quality. In addition, we account for quality also through the weighting scheme that assigns larger weights to more precise estimates. Thus, taken statistical precision as a measure for quality, all observations are weighted by quality.

A large-sample primary study is more powerful than meta-analysis. Meta-analysis accumulates the current status of the literature and uncovers the determinants of variation in existing empirical findings via statistical analysis. Thereby, it manifests several distinctive features compared to primary studies. Especially in the hedging literature, it is challenging to construct data samples covering many countries over several years due to difficulties in manual data collection and limited availability of hedging data. Even if possible, results would still rely on the individual study design, such as the coded hedging data, variable definitions, model specification, and estimation methods. On the meta-level, we can control for the impact of these idiosyncratic characteristics of research design and the various factors that might induce biases. Moreover, bringing together a variety of studies from different authors minimizes the random sampling error by averaging across many estimates for the hedging-firm value nexus. Additionally, detecting and controlling for publication selection bias can never be done on the level of an individual study, as ‘publication selection is caused by the process of conducting empirical research itself’ (Stanley and Doucouliagos, 2012: 4).

Collected estimates are not independent. In contrast to the aggregation of medical trials, for which meta-analysis was originally designed for, the regression results collected in economics are usually not independent, as authors use similar data sets. The sources of dependencies in a meta-study are similar to a primary study. For example, in a primary study, a global panel data set causes non-independencies, due to clustering of observations taken from the same country, identical time period, or multiple observations of the same firm across several years. On the meta-level, we encounter non-independent observations, as we collect multiple estimates per study (within-study dependency), authors from different studies might examine similar data for similar companies and countries (between-study dependency), or models of the same study might include more than one hedging measures, e.g. for different risk exposures (within-model dependency). Thus, the issue of non-independent samples is likely not worse in a meta-study as compared to financial economics research in general. To handle potential dependence, meta-regression analysis applies the same remedies as a primary study to account for different sources of non-independent observations. To accommodate the problem of correlated effect sizes, our meta-regression models are estimated with robust errors clustered at the study-level and the country-level. Moreover, we include a control variable in the meta-regressions to consider estimates taken from the same model (*Control for other risk exposures*).

Meta-analysis compares apples with oranges. Meta-analysis in economics always examines heterogenous estimates that are produced by different methods and data sets. We explicitly control for these differences by the various moderator variables induced in the meta-regression. Moreover, to maximize the comparability of observations in our sample, we transform the regression estimates from the primary studies in such a way that they present the percentage change in firm value due to hedging. This value is comparable within and between studies.

Studies reporting many estimates dominate the analysis. Due to the unbalancedness of the meta-data set, studies reporting many different estimates get more weight in the meta-regression. As a robustness analysis, we also weight the regressions by the inverse of the number of estimates reported in each study. However, at the same time, this approach comes up with caveats as approach assigns equal weight to each study. This means, in contrast to precision-weighting, estimates are treated similar independent of their quality. Therefore, we prefer weighing by inverse variance and see the other weighting approaches as robustness analysis.

Appendix E. Correlation matrix across country-level variables

	Deriv. market vol.	Stock trading vol.	Trade magnitude	OECD member	Rule-of-law	Shareholder rights	Creditor rights	Ownership concentration	Time to resolve insolvency	Financial risk	Composite risk	Tax rate
Deriv. market vol.	1.00											
Stock trading vol.	0.10	1.00										
Trade magnitude	0.50	-0.14	1.00									
OECD member	0.21	0.50	-0.05	1.00								
Rule-of-law	0.31	0.54	0.01	0.93	1.00							
Shareholder rights	0.48	-0.53	0.57	-0.19	-0.19	1.00						
Creditor rights	-0.10	0.66	-0.43	0.72	0.76	-0.63	1.00					
Ownership concentration	-0.24	-0.67	0.26	-0.81	-0.88	0.36	-0.85	1.00				
Time to resolve insolvency	-0.28	-0.65	0.06	-0.74	-0.83	0.47	-0.83	0.85	1.00			
Financial risk	0.25	0.09	0.36	-0.12	-0.05	-0.05	-0.11	0.06	-0.15	1.00		
Composite risk	0.21	0.59	0.17	0.56	0.71	-0.30	0.51	-0.55	-0.62	0.27	1.00	
Tax rate	-0.58	-0.33	-0.32	-0.57	-0.57	-0.20	-0.39	0.50	0.62	-0.09	-0.18	1.00

Notes: This table reports correlation coefficients across the country-level variables defined in Table 2 of the manuscript.

Appendix F. Comparing FX premiums after matching on interest rate and commodity hedging

	(1) Interaction term	(2) Subsample
Foreign exchange hedgers *x* Control for other risk exposures	0.005 (0.68)	
Foreign exchange hedgers	0.017*** (3.05)	0.011*** (2.81)
Joint estimation	-0.021*** (-5.29)	
Constant	0.047 (1.60)	0.310*** (5.83)
Other controls from Tab. 3 included	Yes	Yes
No. of studies	71	18
No. of primary observations	1016	307

Notes: This table reports the results for the same regression model as reported in Column 2 in Table 3 of the main paper. Unreported variables are identical as in Table 3, reported coefficients refer to the alternative variables included for robustness analysis. Column 1 includes an interaction term between the foreign exchange hedgers dummy and the dummy variable indicating whether multiple risk exposures are estimated in the same primary regression (suggesting that the reported hedging premiums do not suffer from a bias due to the omission of other hedging exposures). Column 2 is based on a reduced sample of all estimates observed from models with multiple risk exposures estimated in the same primary regression.

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

Appendix G. Impact of accounting changes and measurement on the continuous hedging measure

	(1) Breakpoints for major accounting changes	(2) Breakpoints for major accounting changes	(3) Breakdown by measurement of continuous hedging
Issue of FAS 133 in 1998	0.037***		
	(4.92)		
Issue of IAS 39 in 2003	0.019***		
	(2.67)		
Effective date of FAS 133 in 2000		0.024***	
		(3.04)	
Effective date of IAS 39 in 2005		0.015***	
		(2.76)	
Fair values			-0.022*
			(-1.80)
Actual hedge ratios			-0.015*
			(-1.88)
Other measures			0.053***
			(4.05)
Constant	0.086***	0.074***	0.031
	(4.05)	(3.43)	(1.42)
Other controls from Tab. 3 included	Yes	Yes	Yes
No. of studies	40	40	40
No. of primary observations	326	326	326

Notes: This table reports the results for the same regression model as reported in Column 2 in Table 3 of the main paper. Unreported variables are identical as in Table 3, reported coefficients refer to the alternative variables included for robustness analysis. Column 1 includes two breakpoint variables referring to the issuance year of major accounting changes relevant for the reporting of hedging instruments (FAS 133 and IAS 39) Colum 2 refers to the year when the accounting changes became effective. The omitted base category is the time period before 1998 (Column 1) and before 2000 (Column 2). The breakpoint is assigned to the hedging premiums from the primary studies based on the average sample year examined in each study. Column 3 breaks down the continuous hedging variable in the different categories of measuring the extent of hedging. The omitted base group are notional amounts of hedging instrument reported in annual reports.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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