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Meta-analysis of the impact of financial constraints on firm performance

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Abstract

A large number of studies have investigated the relationship between financial constraints and firm performance. However, due to heterogeneity in study design factors, such as choice of measures for constraints and performance, control variables, estimation methods and study sample, the empirical results have been mixed. To mitigate this issue, this paper reports a meta-analysis of the association between financial constraints and firm performance. To assess the overall direction of the relationship and the sources of heterogeneity, we apply meta-analytic methods to 26 studies (providing 189 effect sizes) on the association between financial constraints and financial performance in listed companies. Our result shows that, overall, there is a positive relationship between financial constraints and firm performance. In addition, meta-regression results suggest that return on assets (ROA) and return on equity (ROE) as measures of financial performance, and external finance and size as measures of financial constraints, have a significant negative impact on the relationship between financial constraints and firm performance relative to the mean impact on effect size. Similarly, all of North America and Asia as regional differences, control of size and corporate governance as control variables, and journal quality as strength of results, also have a significant negative impact. On the other hand, market value

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as a measure of financial performance, and the Whited & Wu index as a measure of financial constraints, have significant positive impact relative to the mean impact. Similarly, cross-country and Europe as regional differences, and publication status as strength of results, all have significant positive impact. Given that firm performance is of fundamental importance to investors, this study therefore helps researchers and policymakers to understand the variation in the empirical results on the impact of financial constraints.

Key words: Firm performance; Investment policy; Financial constraints; Meta-analysis

JEL classification: M40, M41, M4

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1. Introduction

A number of studies have shown that financial constraints impact on investment policy, which in turn may affect firm performance. As firm performance is a key interest to current and potential investors and to policy makers, it is important to investigate the factors influencing performance. However, some researchers have found a positive relationship between financial constraints and firm performance (e.g., Kaplan & Zingales, 1997; Li, 2011; Livdan *et al*., 2009; Zhao, 2016; Stikkelman, 2010; Whited & Wu, 2006) but other researchers have found a negative relationship (e.g., Campello & Chen, 2010; Chan *et al*., 2010; Chen & Wang, 2012; Hennessy *et al*., 2007; Lamont *et al*., 2001). Therefore, this study conducts a meta-analysis of the impact of financial constraints on firm performance. The difficulty in interpretation of the varied results observed in the extant studies is compounded by the changes that have taken place over time in corporate financing behaviour, and the variation in results hampers progress in understanding the extent, relevance and drivers of the relationship. A meta-analysis usefully aims to reconcile the differences found across different studies and to provide an objective conclusion about the financial constraints–firm performance relationship.[1]

As indicated above, numerous researchers have examined the effect of financial constraints on firm performance but, to date, the empirical evidence has been mixed. The studies have used different measures of the degree of financial constraints and of firm performance. Therefore, it is important to encode the statistical findings and, thus, to provide a consistent basis on which to compare the different studies. Lipsey and Wilson (2001) mention the

[1]Khlif and Chalmers (2015) encourage accounting researchers to do a meta-analysis, as there is a scarcity of meta-analytic reviews in some accounting fields.

following primary advantages of meta-analysis. Meta-analysis: (i) is a useful technique for summarising research findings; (ii) it represents key study findings in a sophisticated manner by encoding the strength and direction of each study; (iii) it allows an analytically precise examination of the relationship between study findings; and (iv) it provides an organised way of handling detailed information from a large number of research findings under review.

This study uses meta-analysis to provide an overall view of the results found in the individual empirical studies. Meta-analysis pools the results reported in individual studies to enable a generalisation to be made and to improve both statistical power and validity that may be absent from individual studies. No paper has come to our notice that has used meta-analysis to investigate the impact of financial constraints on firm performance. This is a significant gap in the literature as a number of studies have shown that the economic consequences of financial constraints influence investment policy, which in turn may affect firm performance. As firm performance is a key interest for potential investors and policy makers, it is important to investigate the factors influencing performance. Although many researchers have investigated the impact of financial constraints, the results of the studies have been mixed in terms of the direction of the impact of financial constraints on firm performance. Therefore, the findings of this study have the potential to indicate the impact of access to finance on firm performance, and to investigate the factors that cause differences in results reported in empirical studies.

This study follows several meta-analysis papers, including those of Ahmed and Courtis (1999), Orlitzky *et al*. (2003), Ahmed *et al*. (2013), van Essen *et al*. (2015), Wang and Shailer (2015, 2018), Hay and Knechel (2017) and Opare *et al*. (2019). Based on these papers, the differences observed across the studies analysed may arise from a variety of factors, including population differences, sampling error or bias. To investigate this, at first, the relevant theoretical papers are systematically reviewed. Then meta-analysis techniques are used to integrate the different empirical results and to analyse the relationship between financial constraints and firm performance. Finally, the study examines the differences in research design which may cause differences in the empirical results.

The rest of this study is structured as follows. In Section 2 we review the research evidence on the impact of financial constraints on firm performance and sets up the hypotheses. Section 3 outlines the meta-analysis procedure and the meta-regression model is described. Section 4 presents the results and analysis of the findings. Finally, Section 5 provides a summary and limitations, and concludes the study.

2. Prior research evidence and hypotheses

This section reviews the literature related to the impact of financial constraints, discusses the different measures of financial constraints and firm

performance, and also reviews the literature on the impact of financial constraints on firm performance.

2.1. Impact of financial constraints

Financial constraint refers to the accessibility of funding to undertake desired investments. According to Chen (2016), financial constraints reflect the difficulties a company faces when it has funding needs, but cannot successfully obtain funding. Financial constraints may occur owing to credit constraints, corporate tax, inability to borrow, inability to issue equity, unavailability of bank loans or illiquidity of assets (Cheng *et al.*, 2014; Hennessy & Whited, 2007; Lamont *et al.*, 2001).[2]

In a market with no frictions, investors and managers would have access to the same quality of information about firms' financial activities. However, in the real world, the cost of external financing could be higher than the costs of internal funding (Myers & Majluf, 1984; Pellicani & Moccellin, 2010), and some financial market frictions might prevent a firm from funding all desired investments. Nevertheless, in the main, firms experiencing financial constraints are going concerns. The study, therefore, focuses on financial constraints, not financial distress.

Prior research shows that financial constraints both influence, and are influenced by, investment decisions, financing, dividend policy and corporate value (Chen, 2016). According to Musso and Schiavo (2008), financial constraints play a significant role in determining the probability of firm survival, as access to external funds increases firm growth in the short run. Similarly, Aghion *et al.* (2007) show the impact of financial development on firm entry, size at entry and post-entry performance of new firms. They find that access to external finance has a significant impact on the entry of small firms and that it improves market selection by allowing small firms to compete on an equal footing. Winker (2006) and Becchetti and Trovato (2002) also demonstrate a similar result and argue that the perceived credit constraint limits innovation expenditures and overall investment. In another study, Carpenter and Petersen (2002) analyse the growth of 1,600 small US firms and find that the availability of internal finance certainly constrains asset growth. They argue that firms able to raise more external funds than others manage to grow faster. Thus, the level of attention that researchers have given to financial constraints over the past decade is to be expected.

2.2. Development of financial constraints measure

The traditional approach to identifying financially constrained firms dates back to the late 1980s. Fazzari *et al.* (1987) demonstrate that investment

[2]Another possible factor is the ownership structure of the firm. For example, Ergün and Doruk (2020) find that while financial constraints limited growth for non-family firms, this did not apply to family firms.

spending varies with the availability of internal funding (cash flow) when firms face financial constraints. Some studies have identified several problems with the findings of Fazzari *et al*. (1987). In particular, Kaplan and Zingales (1997) express severe doubt about investment–cash flow sensitivity as a measure of financial constraints, and they introduce a new index to measure financial constraints, the KZ index, based on five factors, or indicators, of external funding barriers. The five factors are cash flow, Tobin's Q, debt to capital, dividends to book assets, and cash.

Almeida *et al*. (2004) construct an alternative index, the ACW index, based on a firm's payout ratio, size, bond rating and commercial paper rating. Whited and Wu (2006) propose yet another index, the WW index, based on six firm characteristics associated with financial constraints, such as firm size, industry sales growth, firm sales growth, cash flow, dividends and leverage.

Hadlock and Pierce (2010) argue that only firm size and age should be considered. The authors dispute the validity of the KZ index and the WW index, and provide evidence that some of the factors included in the indexes are not significantly related to constraints. Although two of the factors, leverage and cash flow, from the KZ and the WW indexes, are significantly related to financial constraints, these variables may lead to under-detection of the presence of constraints in firms with low leverage or low cash flow. Hadlock and Pierce (2010) thus propose a new index, the SA index, and show that small and young firms are more financially constrained compared with large firms and old firms.

Arguing for an entirely different approach, Hoberg and Maksimovic (2015) developed a text-based measure for financial constraints. The authors consider that use of words such as 'delay', 'abandon', 'curtail' and 'construction' in the 10-K Liquidity and Capital Resources subsection of Management Discussion and Analysis indicates the presence of financial constraints. They construct four scores based on continuous constraint variables for each firm (hereafter, the 'HM text-based measure'). These are the 'Delay Investment Score', the 'Equity Focus Delay Investment Score', the 'Debt Focus Delay Investment Score', and the 'Private Placement Focus Delay Investment Score'. The authors score delayed investment based on the average vocabulary (list of words mentioned above) used by firms, while controlling for the presence of standard text. Bodnaruk *et al*. (2015) show that the more managers are concerned about future financial constraints, the more they will disclose through text in the 10-K filings and they, therefore, extend the HM text-based approach to compile a list of 184 constraint-related words from all 10-K filings, from which the commonly used words are: 'required', 'obligations', 'impairment', 'covenants', 'requirements', 'permitted', 'comply' and 'imposed'. The authors use the percentage of these words as a measure of financial constraints, the BLM index. However, the Hoberg and Maksimovic (2015) and the Bodnaruk *et al*. (2015) text-based measures of financial constraints are comparatively new and have not been commonly used. A summary of the proxies used for financial constraints in the literature is given in Table 1.

Table 1
Measurements of financial constraints used in the literature

Study	Measurement of financial constraints
Fazzari *et al.* (1987)	Dividend payout ratio
Devereux and Schiantarelli (1990)	Age, Size
Hoshi *et al.* (1991)	Group membership
Bond and Meghir (1994)	Dividends over capital stock + share issues
Chirinko and Schaller (1995)	Age, Concentration of Ownership, Group membership
Gilchrist and Himmelberg (1995)	Dividend payout ratio, Size, Bond rating
Kaplan and Zingales (1997)	Qualitative data from financial reports
Kadapakkam *et al.* (1998)	Size
Lamont *et al.* (2001)	KZ index
Becchetti and Trovato (2002)	Survey data
Campa and Shaver (2002)	Group membership
Baker *et al.* (2003)	KZ index
Almeida *et al.* (2004)	Dividend payout ratio, Size, Bond rating, Commercial paper rating
Greenaway *et al.* (2007)	Liquidity, Credit rating
Cleary (2006)	Size, Dividend payout ratio
Whited and Wu (2006), Baños-Caballero *et al.* (2014)	Dividend policy, Size, Group membership
Hennessy *et al.* (2007)	KZ index, WW index
Hadlock and Pierce (2010)	Size and Age, WW index
Campello and Chen (2010), Chan *et al.* (2010), Stikkelman (2010), Chen and Wang (2012)	KZ index, WW index
Hoberg and Maksimovic (2015)	Text-based measure
Baños-Caballero *et al.* (2014)	WW index
Khatami *et al.* (2015)	KZ index
Bodnaruk *et al.* (2015)	Text-based measure, SA index, KZ index
Zhao (2016)	KZ index
Jin *et al.* (2018)	External finance

2.3. Common measures of firm performance

Return on assets (ROA), return on equity (ROE), stock return, Tobin's Q, market to book, market value and sales growth are the commonly used measures of firm performance in corporate finance studies (see, e.g., Xu *et al.*, 2005; Firth *et al.*, 2006; Wei, 2007; Ting, 2008; O'Connell & Cramer, 2010; Lin *et al.*, 2011; Chari *et al.*, 2012). Return on assets and return on equity are measures that indicate the earnings produced from capital investment and the earnings produced from equity, and are the most common accounting-based performance measures. Change in sales is another indicator of firm performance and shows the growth in sales over a particular period. Standard market performance measures include Tobin's Q, stock return, market to book and market value. Tobin's Q is derived from the value maximisation problem of the firm, and the Q-statistic captures the extra benefit the firm obtains from an additional unit of capital (Bond & Söderbom, 2013; Hennessy *et al.*, 2007; Tobin, 1969).

The stock market return is a market-based measure that shows the relative change in the market price of the stock over a period of time. Different types of stock return measures are used, for example, excess return, measures based on the Capital Asset Pricing Model, the Fama and French four and five factor models, buy and hold abnormal returns, cumulative abnormal returns, and Carhart abnormal returns. Another measure, the market-to-book ratio, is calculated by dividing the current closing price of the stock by the current quarter's book value per share. Here, the market value is the current stock price of all outstanding shares and the book value is the amount of the firm's assets minus its liabilities. The market-to-book ratio is used to compare a business's net assets that are available, in relation to the market price of its stock. Market value also represents the firm's financial position and can provide an indication of investors' perceptions of the firm's prospects.

These different measures of firm performance can result in apparently different impacts of financial constraints on firm performance. Wang and Shailer (2015) note that accounting measures use historical data, and are subject to managerial manipulation and differences in accounting procedures, whereas market performance measures are more forward-looking and reflect investors' expectations. Demsetz and Villalonga (2001) argue that market performance measures are affected by investor sentiment but are, nevertheless, more likely to be reliable than historical accounting measures. Therefore, it is important to analyse the different measures separately and, also, to test whether the choice of accounting or market performance measures influences the relation between financial constraints and firm performance.

2.4. Moderating effect of other factors

In addition to the choice of measures for firm performance and financial constraints, there are other factors that likely influence the variation across the

studies on the impact of financial constraints on firm performance. For example, different selection of control variables, different estimation methods used in the studies, different regional areas investigated in the studies, and different strength of results (publication status, journal quality, year of publication, sample size and number of years covered) are among the possible reasons for the mixed results across the studies. Therefore, it is important to investigate the moderating effect of all these variables in addition to the choice of measures for firm performance and financial constraints.

2.5. *Association between financial constraints and firm performance*

Numerous prior studies provide substantial evidence that financial constraints have a significant role in strategic decision-making by affecting the firm's investment decisions directly (Cleary, 1999; Cleary *et al*., 2007; Kaplan & Zingales, 1997; Stein, 2003). Kaplan and Zingales (1997) find that the investment and firm value relationship is more sensitive in constrained firms. Baker *et al*. (2003) split their sample into different quintiles according to the KZ index, and find extensive evidence that, compared with the least constrained firms, the most constrained firms are three times more sensitive in the investment-to-Q relationship. In contrast, Cooper and Ejarque (2003) show that financial frictions have no impact on the investment–profitability relationship. Almeida and Campello (2007), show that the degree of the tangibility of constrained firms' assets increases the sensitivity of cash flow to investment.[3]

Almeida *et al*. (2004) find that only financially constrained firms focus on liquidity to maximise firm value, which shows the direct link between financial constraints and firm value. Using the simulated method of moments, Hennessy and Whited (2007) provide evidence that, for both small and large firms, financial constraints have a negative impact on firm value. The authors argue that financially constrained firms face higher costs of equity and bankruptcy, and this limits a firm from achieving the desired capital structure. Financially constrained firms forego valuable investment opportunities, and this decreases the firm value. In contrast to the Hennessy and Whited (2007) findings, Stikkelman (2010) finds that as financial constraints increase, so does firm value. The author investigates the effect of financial constraints on the value of non-financial publicly traded firms in France according to firm size. Stikkelman (2010) shows that the magnitude of the positive relationship between financial constraints and firm value is stronger for large firms compared with medium-sized firms. The author also argues that the relationship differs across countries owing to differences in the institutional characteristics of different countries.

[3]Note that the present study considers the impact of financial constraints only on listed firms and therefore does not address the impact on unlisted firms, in particular, family firms as reported on in Ergün and Doruk (2020).

There are also mixed results for the impact of financial constraints on stock return. The debate begins with Lamont *et al.* (2001), who find that financial constraints decrease stock returns for growing manufacturing firms. Chan *et al.* (2010) develop an index to measure financial constraints and provide evidence of a negative association between financial constraints and stock returns. Bavarsad *et al.* (2013) and Campello and Chen (2010) find strong support for this finding. Bavarsad *et al.* (2013) also show that firm size is the primary driver of the negative relationship between financial constraints and stock return for firms listed on the Tehran stock exchange. In contrast, Whited and Wu (2006) find that more financially constrained firms earn higher stock returns on average. The authors argue that financial constraints have a positive influence on firm value. Livdan *et al.* (2009) find strong support for the findings of Whited and Wu (2006). However, in a recent study, Li and Luo (2019) argue that the crucial driver of the relationship between financial constraints and stock returns is stock liquidity.

In summary, it can be concluded that there are conflicting findings on the impact of financial constraints on firm performance. However, a broad view of the findings suggests the following hypotheses for this study:

H1: Financial constraints have a significant impact on firm performance.

H2: Measure choice, estimation methods, regional difference, control variable used, and the strength of results all have significant impacts on the relationship between financial constraints and firm performance.

3. Sampling procedure for meta-analysis

The analysis is divided into the following steps: (i) identify relevant studies with results that can be used as effect sizes; (ii) categorise the papers according to the different measures of firm performance, and retain only the papers that analyse common measures of firm performance, such as, ROA, ROE, stock return, Tobin's Q, market-to-book, market value; and, similarly, measures of financial constraints such as cash flow, size, the KZ, SA, WW and ACW indexes, and external financing indexes; (iii) calculate the effect sizes for the selected studies; (iv) estimate the population mean effect size; (v) test the heterogeneity of the effect sizes; and (vi) use meta-regressions to investigate potential sources of heterogeneity that can be identified from the selected studies.

3.1. Identify relevant studies

To identify the studies for the meta-analysis, an exhaustive search using keywords and terms – such as financial constraints, financial frictions, capital constraints, financial constraints and firm performance, financial constraints

and ROA, financial constraints and firm value, financial constraints and Tobin's Q, financial constraints and stock return, and financial constraints and market-to-book – was conducted in order to identify relevant studies in Google Scholar, Science Direct, Emerald, JSTOR, EBSCO and the Victoria University of Wellington Library. Also, the reference lists of identified studies were used to obtain other relevant studies. Among the identified studies, those that did not report on empirical studies were excluded. The following criteria were applied for each study to be included in the sample of studies:

1 The paper is not an earlier version of another paper included in the sample.
2 The samples in the reported study are of publicly listed firms. Restricting the scope of papers to publicly listed firms should increase the comparability of the impact of financial constraints on financial performance measures used across different countries.
3 The study has firm performance as the dependent variable.
4 The study reports the relevant regression results.

This process yielded a sample of 26 primary studies 'published' from 2001 to 2018 with 189 independent usable regressions. The studies cover 11 jurisdictions (Australia, China, France, Germany, India, Japan, Latin America, UK, USA, Vietnam and cross-country) and span the data years 1963–2016. The studies produce more than one regression result, by using different measures of firm performance or financial constraints, alternative model specifications, different years, different regions or different control variables. This study did not apply any exclusion criteria based on the apparent quality of the primary studies; however, journal quality as a study characteristic was included in analysing the sources of heterogeneity in the effect sizes.

It is important to note that three types of missing data have a potential effect on the paper selection process: (i) missing significance level, (ii) missing sample size and (iii) omitted model parameters (Wang & Shailer, 2015). In this study, all the papers selected report the significance level of the results and sample size.

3.2. Calculate effect size

To calculate effect sizes (*ES*) and other statistics, the present study employs the procedures and models in Rosenthal (1991) and Lipsey and Wilson (2001). Effect size indicates the degree of association between the key variables and, in principle, is measured by the product moment correlation coefficient (*r*), which indicates both direction and magnitude of relations, as well as being scale-free (Lipsey & Wilson, 2001). However, the correlation coefficient is usually not

reported and, therefore, the reported t-value, or z-statistic, or p-value is used to estimate the effect size.[4]

Given the t-value, the effect size is given by

$$ES_r = \sqrt{\left[t^2/\left(t^2 + df\right)\right]} \tag{1}$$

where df is the degrees of freedom. If the study does not report t-values but reports parameter estimates and standard errors, the t-value is first calculated as follows:

$$t = \frac{b}{s} \tag{2}$$

where b is the parameter estimate and s is the standard error.

If the z-statistic is given, the effect size is obtained from:

$$ES_r = \sqrt{\left(z^2/n\right)} \tag{3}$$

where n is the number of observations in the study sample.

The correlation coefficient has problematic statistical properties and thus the Fisher Z transformation is applied to all the estimated effect sizes (Lipsey & Wilson, 2001).

3.3. Estimate the weighted mean effect size and standard error

The weighted mean effect size and standard error are then calculated based on the random effects model (Borenstein *et al.*, 2007). This assumption is particularly appropriate where the studies analysed vary in terms of the period studied and the countries studied; in that case, there will not be a common effect size; rather, the different studies will vary in terms of underlying true effect size. The random effects model assumes that, beyond sampling error, there is excess heterogeneity from differences in the effect size estimates. The variance of the effect sizes in a random effects model is given by $\nu_i + \tau^2$, where ν_i is the within-study variance associated with sampling error and τ^2 is the estimate of the between-study variance.

Estimation of the weighted mean effect size and standard error for the random effects model starts with the estimation of τ^2 from the values estimated for the weights, and the Q-statistic. The Q-statistic provides a test for identifying excess variance (that is, fixed effects) in a sample of effect sizes. The

[4]To estimate effect size from the p-value, use can be made of a web-based effect-size calculator developed by Professor David. B. Wilson. This web-based calculator is based on the book *Practical Meta-Analysis* by Lipsey and Wilson (2001). https://www.campbellcollaboration.org/escalc/html/EffectSizeCalculator-R7.php

formulas for estimation of the weights and Q-statistic and the subsequent steps to obtain the mean effect size and standard error are shown in Table 2, Panels A and B.

Having obtained an estimate of τ^2, the weights for the random effects model are set equal to the reciprocal of $(\nu_i + \tau^2)$. The weighted mean effect size for a given measure is then computed as the sum of the products of each effect size and its weight, scaled by the sum of the weights. The mean standard error is computed as the square root of the sum of the weights. A confidence interval for the weighted mean effect size can then be calculated and, to test the significance of the mean effect size, the z-statistic is computed by dividing the mean effect size by the mean standard error.

The fail-safe number to identify the 'File Drawer' problem has also been calculated. This is a test to check for publication bias, following Rosenthal (1991). In this study, the 'fail-safe number' is the number of studies that would be required to overturn a conclusion drawn from a significant relationship between financial constraints and firm performance.

3.4. Examine the heterogeneity of the effect sizes

To examine the sources of heterogeneity in the meta-analysis results, a meta-regression has been conducted, as an extension to the standard meta-analysis. The relevant information on the study characteristics likely to be sources of the heterogeneity – measure choices, control variables, estimation methods, regional differences and strength of reported results – were coded for the regression.

3.4.1. Measurement choices

Variation in the measurement choices employed is likely to be a key determinant of variation in the reported results on the impact of financial constraints on firm performance.

The studies analysed employed seven common measures of *firm performance* and the frequency of use of the measures was as follows: (i) accounting-based performance measures: *ROA* (55), *ROE* (18) and *SG* (1), and (ii) market-based performance measures: *SR* (39), *TOBINS_Q* (35), *MTB* (39) and *MV* (2). In this study the different measures were analysed separately and, as in Wang and Shailer (2018), also in sets as accounting- or market-based performance measures, by including a dummy variable equal to 1 if the regression uses an accounting-based performance measure, and 0 otherwise. *CF* (21), *EXT_FIN* (18), the *KZ* index (41), *SA* index (3), *SIZE* (72), *WW* index (18) and *ACW* index (16) were used as the measures of *financial constraints* in the regression (with the frequency of use shown in parentheses).

Table 2
Description of formulas for the meta-analysis assuming (A) fixed effect model to be amended and (B) random effect model

Name of formula	Calculation	Description
Panel A: Fixed effect model		
Effect size using correlation	$ES_r = r$	*ES* represents effect size and *r* is the product-moment correlation coefficient
Effect size using *t*-statistic	$ES_r = \sqrt{\frac{t^2}{(t^2+df)}}$	*t* is the *t*-statistic and *df* is the degrees of freedom given by $n - 1$ where *n* is the sample size
Effect size using *z*-statistic	$ES_r = \sqrt{\frac{Z^2}{N}}$	*Z* is the *z*-statistic and *N* is the total sample size
Z-transform effect size	$Z_r = 0.5log_e\left[\frac{1+ES_r}{1-ES_r}\right]$	ES_{z_r} is *z*-transformed effect size
Standard error	$SE_{z_r} = \frac{1}{\sqrt{n_i-3}}$	SE_{z_r} is standard error for each calculated effect size and n_i is the sample size for each study
Inverse variance	$w_i = \frac{1}{SE^2_{z_r}}$	w_i is the weight given to the sample size of each study
Weighted mean effect size	$\overline{ES} = \frac{\Sigma(w_i ES_i)}{\Sigma w_i}$	$\overline{ES}$ is the mean effect size calculated for all effect sizes in the meta-analysis. This is the main statistic of interest to capture the aggregate effect of the test variable on the dependent variable
Standard error of the mean	$SE_{\overline{ES}} = \frac{1}{\sqrt{\Sigma w_i}}$	$SE_{\overline{ES}}$ this is the standard error of the mean computed as the square root of the sum of the inverse variance weights
Panel B: Random effect model		
Chi-square statistic	$Q = \Sigma w_i\left(ES_i - \overline{ES}\right)^2$	This is for the homogeneity test based on the *Q*-statistic, which is distributed as a chi-square with $k - 1$ degrees of freedom where *k* is the number of effect sizes in the study
Tau squared	$\tau^2 = \frac{Q-df}{\Sigma w_i - \frac{\Sigma w_i^2}{\Sigma w_i}}$	This is an estimate of the between-study variance. *Q* is the *Q*-statistic and *df* is the degrees of freedom
Weight	$w_i^* = \frac{1}{v_i^*}$	This is the weight assigned to each study where v_i^* is the total variance for each study
Total variance	$v_i^* = v_i + \tau^2$	The total variance includes the within-study variance for study *i* plus the between-studies variance, tau-squared
Weighted mean effect size	$\overline{ES}^* = \frac{\Sigma\left(w_i^* ES_i\right)}{\Sigma w_i^*}$	$\overline{ES}^*$ is the mean effect size calculated assuming a random effect model
Variance of mean effect size	$v^* = \frac{1}{\Sigma w_i^*}$	This is the reciprocal of the sum of the weights

(continued)

Table 2 (continued)

Name of formula	Calculation	Description
Standard error of mean effect size	$SE_{\overline{ES}^*} = \sqrt{v^*}$	$SE_{\overline{ES}^*}$ is the standard error of mean effect size computed as the square root of the variance of mean effect size
Lower limit	$\overline{ES}_l^* = \overline{ES}^* - 1.96\left(SE_{\overline{ES}^*}\right)$	$\overline{ES}_l^*$ is the lower limit given by subtracting the product of the critical z-value and the desired confidence interval from the mean effect size
Upper limit	$\overline{ES}_u^* = \overline{ES}^* + 1.96\left(SE_{\overline{ES}^*}\right)$	$\overline{ES}_u^*$ is the upper limit given by adding the product of the critical z-value and the desired confidence interval to the mean effect size
z-statistic	$Z^* = \frac{\left\lvert\overline{ES}^*\right\rvert}{SE_{\overline{ES}^*}}$	This tests the significance of the mean effect size. $\left\lvert\overline{ES}^*\right\rvert$ is the absolute value of the mean effect size and $SE_{\overline{ES}^*}$ is the standard error of the mean effect size
Fail-safe number	$X = (k/2.706)\left[k(Z^*)^2 - 2.706\right]$	This calculates the number of studies that would make significant results become insignificant. k is the number of studies and Z^* is the z-statistic

Sources: Opare *et al.* (2019); Lipsey and Wilson (2001).

3.4.2. Control variables

A range of control variables were used in the regressions reported in the primary studies. Based on their similarities, the common firm-specific control variables were identified: size, leverage, growth, firm and year fixed effects, industry fixed effects, tangibility, research and development expenses, liquidity, market-based performance, country effects and corporate governance.

3.4.3. Estimation methods

The studies use a variety of statistical models, such as firm fixed effects, year fixed effects, industry fixed effects, GMM, OLS, pooled OLS, clustered OLS, random effect cross-sectional regression, probit model, advanced panel regression, one-way sort and neutralised sort.

3.4.4. Regional difference

The studies focus on a particular region, or conduct a cross-country analysis. Different regional areas may have a significant impact on the relationship between financial constraints and firm performance owing to the differences in investors' behaviour or country laws. Therefore, the studies were divided into different countries (Australia, Cross-country, Europe, North America and Asia) and were analysed separately for the impact of region on the relationship.

3.4.5. The strength of results

There are several additional factors that may affect the relationship between firm performance and financial constraints. These factors are indicators of the strength of the regression results reported in the studies included for the meta-analysis. The factors listed below were identified as other potential sources of heterogeneity.

Publication status. Publication bias is a major concern in the meta-analysis literature. Some authors argue that studies that report statistically significant results, or findings that fit with the particular interest of the editors and reviewers, are more likely to be published than studies with non-significant results (Rosenthal, 1991; Duval & Tweedie, 2000; Scargle, 2000; Pomeroy & Thornton, 2008; Wang & Shailer, 2015; 2018). Some meta-studies exclude unpublished papers, because such papers lack a final review process that might have changed the results (Habib, 2012; Hay *et al.*, 2006). To mitigate this publication bias, both published and unpublished papers were included in the study, as publication status may have a significant impact on the effect size estimates. The sample of 26 papers in this study includes two studies (Le, 2016;

Stikkelman, 2010) that had not been published in a journal, and one paper that had no journal ranking (Zhao, 2016).

Journal quality. A dummy variable was included to control for the relative quality of the primary studies as indicated by journal ranking. Journal ranking is crucial, as it is likely to be a strong indicator of both the quality and the reliability of the effect size results. For coding, ABDC ranking was used, as issued by the Australian Business Deans Council. The ranking categories are; A*, A, B and C, where the highest quality is A*. Based on this ranking, the study has 135 effect sizes from 21 studies published in A*- or A-ranked journals, and 54 effect sizes from five studies, either published in lower ranked journals or not published.

Year of publication. In the regression, the year of publication was included to test whether the year of publication has any relationship with the reported results. It is more likely for studies on financial constraints to be published in later years, as more data have become available, and more researchers have developed an interest in this area of research.

Sample size. The sample size in the studies ranges from 365 to 65,681 firm-year observations. The sample size is a significant part of meta-analysis as it gives weight to the effect size. The larger the sample size, the more representative the result would be expected to be. The studies that involve cross-country analysis, or focus on US firms, have a larger sample size than do the other studies.

The number of years covered. The sample period in the studies ranges from 2 to 44 years, with an average of around 16 years. As with sample size, studies that cover longer periods would tend to be more representative.

3.5. Meta-regression model

The meta-regression model for examining sources of heterogeneity in the effect sizes, and testing the second hypothesis (H2), is:

$$Z_r = \beta_0 + \Sigma\beta_1 \mathrm{FP_M} + \Sigma\beta_2 \mathrm{FC_M} + \Sigma\beta_3 \mathrm{CV} + \Sigma\beta_4 \mathrm{SM}$$

$$+\Sigma\beta_5 RD + \Sigma\beta_6 SR + \mu, \mu \sim N\left(0, \nu_\iota + \tau^2\right) \quad (4)$$

where Z_r is the Fisher transformed effect size for financial constraints on firm performance. FP_M is a vector of dummy variables for different measures of firm performance (*ROA*, *ROE*, *SR*, *TOBINS_Q*, *MTB*, *MV* and *SG*); FC_M is a vector of dummy variables for different measures of financial constraints (*CF*, *EXT_FIN*, *KZ*, *SA*, *SIZE*, *WW* and *ACW*); CV is a vector of dummy variables for the selected control variables (*C_SIZE*, *LEV*, *GROWTH*, *FIRM_FE*, *YEAR_FE*, *INDUSTRY_FE*, *TANGIBILITY*, *RD*, *LIQUIDITY*, *M_PERFORMANCE*, *COUNTRY_EFFECT* and *C_GOVERNANCE*); SM is a vector of dummy variables representing estimation methods (*FE*, *GMM*, *OLS*, *OTHER_EM*, *RE* and *CROSS_REG*); RD is a vector of dummy variables representing regional differences (*AUSTRALIA*, *CROSS_COUNTRY*, *EUROPE*, *NORTH_AMERICA* and *ASIA*); and SR is a vector of dummy variables indicating the strength of results (*S_SIZE*, *J_QUALITY*, *PUB_YEAR*, *PUB_STATUS* and *Y_COVERED*). The variables are defined in Table 3.

To estimate the random-effects meta-regression model (*REMR*), the Knapp–Hartung approach, which adjusts the standard error of the parameters, was used, to derive an unbiased estimator of the variance (Knapp and Hartung, 2003). For the robustness test, the *REMR* model was estimated by omitting variables with a few effect sizes and by grouping the choice of measure for firm performance and financial constraints.

4. Results and analysis

In this section, the summary statistics, the regression results and the robustness test results are discussed in detail.

4.1. Summary of the studies

Table 4, Panels A and B, summarise the sample of studies that were included in the meta-analysis. Table 4, Panel A, provides a summary of all papers collected and their sources. It also shows that 14 papers focused on the US, only one on Latin America, one on Australia, four on Asia, two on Europe, and four on multiple countries. Most of the papers were relatively recent.

Table 4, Panel A, also shows the journal quality of individual papers and the number of effect sizes collected from each of the papers. All the US-based papers were published in highly ranked journals (12 papers in A*-ranked and two papers in A-ranked journals). The results show that the highest number of effect sizes came from Jin *et al.* (2018) and Nguyen *et al.* (2016) (35 and 32 respectively).

Table 4, Panel B, shows the number of effect sizes collected from the different journals and their rankings. It demonstrates that the highest number of effect sizes, 34, came from the journal *International Review of Economics and Finance* (ABDC ranking A). The second highest number of effect sizes, 31, came from

Table 3
Variable definitions

Variable	Description
Dependent variable	
Fisher_Z	Fisher *Z*-transformed effect size
Independent variables	
Firm performance measure (*FP*)	Categorical variable based on different firm performance proxies
ROA	Dummy is 1 if the effect size estimate is based on ROA as a measure of firm performance
ROE	Dummy is 1 if the effect size estimate is based on ROE as a measure of firm performance
SR	Dummy is 1 if the effect size estimate is based on stock return as a measure of firm performance
TOBINS_Q	Dummy is 1 if the effect size estimate is based on Tobin's Q as a measure of firm performance
MTB	Dummy is 1 if the effect size estimate is based on the market-to-book ratio as a measure of firm performance
MV	Dummy is 1 if the effect size estimate is based on market value as a measure of firm performance
SG	Dummy is 1 if the effect size estimate is based on sales growth as a measure of firm performance
ACC_MEASURE	Dummy is 1 if the effect size estimate is based on accounting-based performance (ROA, ROE, and SG)
Financial constraints measurement (*FC*)	Categorical variable based on different financial constraint measures
CF	Dummy is 1 if the effect size estimate is based on cash flow as a measure of financial constraints
EXT_FIN	Dummy is 1 if the effect size estimate is based on other external finance indexes (External finance index and ZFC index) as a measure of financial constraints
KZ	Dummy is 1 if the effect size estimate is based on the KZ index as a measure of financial constraints
SA	Dummy is 1 if the effect size estimate is based on the SA index as a measure of financial constraints
SIZE	Dummy is 1 if the effect size estimate is based on firm size as a measure of financial constraints
WW	Dummy is 1 if the effect size estimate is based on the WW index as a measure of financial constraints
ACW	Dummy is 1 if the effect size estimate is based on the ACW index as a measure of financial constraints
Estimation method	Categorical variable based on different statistical model
FE	Dummy is 1 if the primary study regression model uses firm fixed effects
GMM	Dummy is 1 if the primary study regression model uses the GMM method
OLS	Dummy is 1 if the primary study regression model uses the OLS method

(continued)

Table 3 (continued)

Variable	Description
OTHER_EM	Dummy is 1 if the primary study effect size is collected from correlation coefficient, *p*-value, probit model, one-way sort method, neutralised method or advance panel regression
RE	Dummy is 1 if the primary study regression model uses random effects
CROSS_REG	Dummy is 1 if the primary study regression model uses cross-sectional regression
Regional difference	Categorical variable based on difference in country setting
AUSTRALIA	Dummy is 1 if the primary study's sample size is from Australia
CROSS_COUNTRY	Dummy is 1 if the primary study's sample size is cross-country
EUROPE	Dummy is 1 if the primary study's sample size is from Europe
NORTH_AMERICA	Dummy is 1 if the primary study's sample size is from the USA and Canada
ASIA	Dummy is 1 if the primary study's sample size is from Asia
Control variables	
C_SIZE	Dummy is 1 if the primary study includes a control variable for size of a firm
LEV	Dummy is 1 if the primary study includes a control variable for leverage of a firm
GROWTH	Dummy is 1 if the primary study includes a control variable for growth of a firm
FIRM_FE	Dummy is 1 if the primary study includes a control variable for firm fixed effects
YEAR_FE	Dummy is 1 if the primary study includes a control variable for year fixed effects
INDUSTRY_FE	Dummy is 1 if the primary study includes a control variable for industry fixed effects
TANGIBILITY	Dummy is 1 if the primary study includes a control variable for tangibility of a firm
RD	Dummy is 1 if the primary study includes a control variable for research and development expense of a firm
LIQUIDITY	Dummy is 1 if the primary study includes a control variable for cashflow and liquidity of a firm
M_PERFORMANCE	Dummy is 1 if the primary study regression controls for market-to-book or Tobin's Q.
COUNTRY_EFFECT	Dummy is 1 if the primary study regression controls for country-based economic effect
C_GOVERNANCE	Dummy is 1 if the primary study regression controls for corporate governance elements (e.g. stakeholder engagement)
Strength of results	
S_SIZE	Log of sample size of the effect size estimate
J_QUALITY	Dummy is 1 if the primary study is published in a high-quality journal (A*- and A-ranked journal)
PUB_YEAR	The year a paper was published or written for unpublished paper
PUB_STATUS	Dummy is 1 if the study is published in a journal
Y_COVERED	Number of years in the sample window

Table 4
Summary of studies included in the meta-analysis and journal quality rankings

Author and year	Country	Sample period	Sample size (*N*)	Journal ranking	No. of effect sizes
Panel A: Summary of studies included in the meta-analysis					
Almeida and Campello (2007)	USA	1971–2000	17,880	A*	8
Álvarez and Bertin (2016)	Latin America	1999–2013	7,239	A	1
Baker *et al.* (2003)	USA	1980–1999	52,101	A*	1
Billett and Mauer (2003)	USA	1990–1998	4,204	A*	6
Bodnaruk *et al.* (2015)	USA	1997–2011	51,533	A*	3
Borisova and Brown (2013)	USA	1980–2009	36,923	A*	1
Baños-Caballero *et al.* (2014)	UK	2001–2007	1,606	A	6
Campello and Chen (2010)	USA	1963–2006	65,681	A*	8
Chan *et al.* (2010)	Australia	1975–2004	4,470	A	3
Chen and Wang (2012)	USA	1968–1995	4,710	A*	9
Cleary (2006)	CC	1987–1997	365	A*	7
Haider *et al.* (2018)	CC	1999–2000	8,232	A	1
Hennessy et al. (2007)	USA	1968–2003	1,723	A*	4
Jin *et al.* (2018)	CC	2000–2014	Varies	A	35
Khatami *et al.* (2015)	USA	1985–2013	Varies	A	3
Lamont *et al.* (2001)	USA	1968–1997	1,056	A*	9
Le (2016)	USA	1982–2009	13,536	Unpublished	1
Li (2011)	USA	1975–2007	Varies	A*	2
Martínez-Sola *et al.* (2013)	USA	2001–2007	3,055	A	6
Dal Maso *et al.* (2018)	CC	2002–2014	Varies	A	12
Nguyen *et al.* (2016)	Vietnam	2008–2013	1,638	B	32
Sasidharan *et al.* (2015)	India	1991–2011	5,603	B	2

(continued)

Table 4 (continued)

Author and year	Country	Sample period	Sample size (*N*)	Journal ranking	No. of effect sizes
Stikkelman (2010)	France	1999–2008	Varies	Unpublished	18
Whited and Wu (2006)	USA	1975–2001	1,390	A*	6
Zhao and Xiao (2019)	China	2010–2016	11,865	A	3
Zhao (2016)	China	2002–2009	6,515	Not Ranked	2

Journal	No. of effect sizes	ABDC Ranking
Panel B: Journal quality rankings included in meta-analysis		
Emerging Markets Review	1	A
Applied Economics	6	A
Australian Economic Paper	31	B
International Review of Economics and Finance	34	A
International Review of Financial Analysis	3	A
Journal of Banking & Finance	8	A*
Journal of Business Research	6	A
Journal of Environmental Management	12	A
Journal of Financial and Quantitative Analysis	3	A*
Journal of Financial Economics	14	A*
Journal of International Financial Markets, Institutions & Money	1	A
Journal of Money, Credit and Banking	8	A*
Modern Economy	2	n/a
Pacific-Basin Finance Journal	3	A
The Journal of Finance	4	A*
The Quarterly Journal of Economics	1	A*
The Quarterly Review of Economics and Finance	2	B
The Review of Financial Studies	31	A*
Unpublished papers	19	n/a
Total	189	

the journals *The Review of Financial Studies* (ABDC ranking A*) and *Australian Economic Papers* (ABDC ranking B).

4.2. Distribution of effect size results by primary studies

Table 5 reports the distribution of effect size results for each of the primary studies, and summarises the effect size results for the relationship between financial constraints and firm performance. Here, the studies are listed in alphabetical order of the lead author for each dimension. Khatami *et al.* (2015) and Baker *et al.* (2003) reported large mean (within-study) effect sizes (mean $ES = 0.163$ and mean $ES = 0.153$, respectively). On the other hand, Campello and Chen (2010) reported the smallest mean effect size (mean $ES = -0.008$). Overall, analysis of Table 5 shows that there are seven negative effect sizes and 19 positive effect sizes with an overall mean effect size of 0.037 and *p*-value of 0.056.

4.3. Mean effect size results by measure for firm performance, measure for financial constraints, estimation methods and regional differences

Table 6 reports the variation in effect size by choice of measures for firm performance and financial constraints and also by estimation method and regional differences. Panel A shows that studies using *ROA* as the measure of firm performance have the highest mean effect size of 0.050, and *MTB* the smallest mean effect size of 0.0265. Panel B shows that studies using *EXT_FIN* as the measure of financial constraints have the highest mean effect size of 0.110, and the *WW* Index the smallest negative mean effect size. Panel C reports a summary of effect sizes by different estimation methods. The table shows that studies using *RE* as the estimation method have the highest mean effect size: 0.083 and *OTHER_EM* the lowest mean effect size: −0.0080. Panel D reports a summary of effect sizes by different regional areas. Here, Asia has the highest mean effect size: 0.054, and Europe has the smallest mean effect size: 0.009.

4.4. Count of positive and negative effect sizes by subsections

Table 7 shows that, of the 189 effect sizes across the individual studies, 126 are positive while 63 are negative. *MTB* (31) as a measure of firm performance, *SIZE* (45) as a measure of financial constraints, *OLS* (49) as an estimation method and *NORTH_AMERICA* (47) as a regional area have the highest number of positive effect sizes in each subsection. *ROA* (26) as a measure of firm performance, *SIZE* (27) as a measure of financial constraints, *OLS* (32) as an estimation method and *CROSS_COUNTRY* (29) as a regional area, have the highest number of negative effect sizes in each subsection.

4.5. Overall summary of effect size results (using random effects)

Table 8 provides a summary of the effect size results (using random effects), and also the results of the publication bias test. The overall mean effect size for the relationship between financial constraints and firm performance is 0.0034, significant at the 1 percent level (*z-statistic* = 4.19). The results thus show that, overall, financial constraints have a positive and significant impact on firm performance. However, there is clearly variation among the effect size results. The sources of this variation are investigated in the meta-regression analysis. Table 8 also reports the result of the test for publication bias. The fail-safe number is 4,359, whereas the tolerance level is only 140.[5] As the fail-safe number is much greater than the reasonable tolerance level, publication bias can be eliminated.

Table 5
Within-study mean effect size by primary studies

Author and year	Mean effect size
Almeida and Campello (2007)	0.0375
Álvarez and Bertin (2016)	0.049
Baker *et al.* (2003)	0.1527
Billett and Mauer (2003)	0.0161
Bodnaruk *et al.* (2015)	0.0058
Borisova and Brown (2013)	−0.0173
Baños-Caballero *et al.* (2014)	−0.0171
Campello and Chen (2010)	−0.0078
Chan *et al.* (2010)	0.0359
Chen and Wang (2012)	0.0549
Cleary (2006)	−0.0517
Haider *et al.* (2018)	−0.0453
Hennessy *et al.* (2007)	−0.0122
Jin *et al.* (2018)	0.0622
Khatami *et al.* (2015)	0.1634
Lamont *et al.* (2001)	0.094
Le (2016)	0.0356
Li (2011)	0.0239
Martínez-Sola *et al.* (2013)	0.0135
Dal Maso *et al.* (2018)	0.0059
Nguyen *et al.* (2016)	0.064
Sasidharan *et al.* (2015)	0.0044
Stikkelman (2010)	0.0351
Whited and Wu (2006)	−0.05
Zhao and Xiao (2019)	0.0445
Zhao (2016)	0.0703

[5]The tolerance level is calculated as $Y = (5*K) + 10$, where K is the number of studies.

4.6. Meta-regression results

The various sources of heterogeneity were examined using the random effects meta-regression model, Equation (1) above. The set of dummy variables representing the choice of measures used is such that each observation scores on exactly one of the dummies and, therefore, estimation of the model runs into the problem of perfect multicollinearity. The usual approach to estimation is then to exclude one of the dummy variables, with the result that the coefficients obtained on the included dummy variables show the impact of those variables relative to the impact of the excluded variable. However, the results differ depending on which variable is excluded and, therefore, they are difficult to interpret. Hence, the approach introduced in Suits (1984) has been applied, which provides coefficients for all the dummy variables, and these indicate the effect of each variable relative to the mean effect of the set of variables. This technique is applied in the case of the measures of firm performance and financial constraints, estimation methods and regional differences. The meta-regression results are reported in Tables 9 and 10.

In Panel A of Table 9, all the measures are reported separately to show the impact of the choice of each measure on effect size. The adjusted R^2 value shows that the variables explain 39.26 percent of the heterogeneity. The I^2 (98.31 percent) is an indicator of the variability that is not attributable to sampling error (Ringquist, 2013, p. 123).

4.6.1. Choice of measures

Among the choice of measures of firm performance, *ROA* (coefficient = −0.103; *t*-value = −3.684; $p = 0.000$) and *ROE* (coefficient = −0.094; *t*-value = −2.737; $p = 0.007$) both have a significant and negative impact on effect size relative to the mean impact on effect size. The impact of both *ROA* and *ROE* is significant at the 1 percent level. On the other hand, *MV* (coefficient = 0.265; *t*-value = 2.861; $p = 0.005$) has a positive impact relative to the mean impact on the effect size. The impact of *MV* is also significant at the 1 percent level.

Among the choice of measures of financial constraints, *EXT_FIN* (coefficient = −0.071; *t*-value = −2.144; $p = 0.033$) and *SIZE* (coefficient = −0.054; *t*-value = −2.213; $p = 0.028$) both have a significant and negative impact at the 5 percent level. On the other hand, *WW* (coefficient = 0.100; *t*-value = 3.793; $p = 0.000$) has a significant and positive impact at the 1 percent level relative to the mean impact on effect size.

4.6.2. Estimation methods

None of the estimation methods have a significant impact relative to the mean impact on effect size.

Table 6
Summary of *ES* results by measurement of firm performance, financial constraints, statistical models and regional difference

Panel A:		**Panel B:**		**Panel C:**		**Panel D:**	
Measurement of *FP*	Mean *ES*	**Measurement of *FC***	Mean *ES*	**Estimation methods**	Mean *ES*	**Regional difference**	Mean *ES*
ROA	0.0503	*CF*	0.0469	*FE*	0.0461	*AUSTRALIA*	0.0452
ROE	0.0322	*EXT_ FIN*	0.1102	*GMM*	0.0752	*CROSS_COUNTRY*	0.0459
SR	0.0402	*KZ*	0.0565	*OLS*	0.0441	*EUROPE*	0.0090
TOBINS_Q	0.0271	*SA*	0.0781	*OTHER_EM*	−0.0080	*NORTH_AMERICA*	0.0313
MTB	0.0265	*SIZE*	0.0195	*RE*	0.0828	*ASIA*	0.0544
MV	0.0317	*WW*	−0.0002	*CROSS_REG*	0.0061		
SG	0.0731	*ACW*	0.0010				

The variables are defined in Table 3.

Table 7
Count of positive and negative effect sizes by subsections

Classification	+ *ES*	−*ES*	Total	Classification	+ *ES*	−*ES*	Total	Classification	+ *ES*	−*ES*	Total	Classification	+ *ES*	−*ES*	Total
Measurement of *FP*				Measurement of *FC*				Estimation methods				Regional difference			
ROA	29	26	55	*CF*	19	2	21	*FE*	25	7	32	*AUSTRALIA*	1	3	4
ROE	6	12	18	*EXT_FIN*	1	17	18	*GMM*	12	4	16	*CROSS_COUNTRY*	19	29	48
SR	30	9	39	*KZ*	33	8	41	*OLS*	49	32	81	*EUROPE*	22	5	27
TOBINS Q	27	8	35	*SA*	2	1	3	*OTHER_EM*	20	10	30	*NORTH AMERICA*	47	22	69
MTB	31	8	39	*SIZE*	45	27	72	*RE*	9	1	10	*ASIA*	37	4	41
MV	2	0	2	*WW*	16	2	18	*CROSS_REG*	11	9	20				
SG	1	0	1	*ACW*	10	6	16								

The variables are defined in Table 3.

Table 8
Summary of effect size results (using random effects) and publication biased test

Particulars	Outcomes
Mean *ES*	0.0034
SE (Mean *ES*)	0.0008
*Z** stat	4.1895
p-value	0
Fail-safe number (*X*)	4,358.77
Tolerance level (*Y*)	140

4.6.3. Regional difference

Regional differences could have a significant impact on the variation in the findings, because of differing legal and institutional settings. The results show that *NORTH_AMERICA* and *ASIA* have significant and negative impact relative to the mean impact on effect size. Here, *NORTH_AMERICA* is significant at the 10 percent level and *ASIA* is highly significant at the 1 percent level. On the other hand, *CROSS_COUNTRY* (coefficient = 0.151; *t*-value = 3.134; $p = 0.002$) and *EUROPE* (coefficient = 0.099; *t*-value = 2.672; $p = 0.008$) both have significant but positive impacts relative to the mean at the 1 percent level. Given the large number of studies that focus on the US, it might seem surprising that *NORTH_AMERICA* does not yield a highly significant coefficient.

4.6.4. Control variables

Among the control variables, *C_SIZE* (coefficient = −0.061; *t*-value = −1.72; $p = 0.087$) and *C_GOVERNANCE* (coefficient = −0.150; *t*-value = −1.74; $p = 0.084$) have significant and negative impact relative to the mean impact at the 10 percent level.

4.6.5. Strength of results

J_QUALITY (coefficient = −0.344; *t*-value = −5.20; $p = 0.000$) and *PUB_STATUS* (coefficient = 0.484; *t*-value = 4.20; $p = 0.000$) both have a significant impact relative to the mean impact. *J_QUALITY* has a negative impact and *PUB_STATUS* a positive impact, both at the 1 percent level.

The above discussion of the results is summarised in Panel B of Table 9.

Overall, the results suggest that the variation in effect size for the association between financial constraints and firm performance is due to the different choice of measures for firm performance and financial constraints, regional differences, control variables and the strength of results of the studies. In summary, the meta-regression results suggest that *ROA* and *ROE*, as measures

Table 9
Random effect meta-regression (with Knapp-Hartung modification) and summary of regression results

Fisher_Z	Coefficient	*t*-value
Panel A: Random effect meta-regression with Knapp-Hartung modification		
Measurement of *FP*		
ROA	−0.103***	−3.684
ROE	−0.094***	−2.737
SR	0.071	1.586
TOBINS_Q	−0.045	−1.493
MTB	−0.040	−1.416
MV	0.265***	2.861
SG	−0.055	−0.617
Measurement of *FC*		
CF	0.032	1.117
EXT_FIN	−0.071**	−2.144
KZ	0.034	1.514
SA	−0.056	−1.163
SIZE	−0.054**	−2.213
WW	0.100***	3.793
ACW	0.014	0.435
Estimation methods		
FE	0.022	0.833
GMM	0.031	1.156
OLS	0.014	0.706
OTHER_EM	−0.023	−1.045
RE	0.008	0.269
CROSS_REG	−0.051	−1.086
Regional difference		
AUSTRALIA	−0.044	−0.940
CROSS_COUNTRY	0.151***	3.134
EUROPE	0.099***	2.672
NORTH_AMERICA	−0.049*	−1.844
ASIA	−0.158***	−3.975
Control		
C_SIZE	−0.061*	−1.720
LEV	−0.010	−0.190
GROWTH	−0.029	−0.410
FIRM_FE	0.012	0.320
YEAR_FE	0.014	0.400
INDUSTRY_FE	0.027	0.710
TANGIBILITY	0.037	0.890
RD	0.000	−0.010
LIQUIDITY	−0.029	−0.790
M_PERFORMANCE	−0.022	−0.460
COUNTRY_EFFECT	−0.010	−0.310
C_GOVERNANCE	−0.150*	−1.740

(continued)

Table 9 (continued)

Fisher_Z	Coefficient	*t*-value
Strength of result		
S_SIZE	−0.015	−0.690
J_QUALITY	−0.344***	−5.200
PUB_YEAR	−0.003	−0.830
PUB_STATUS	0.484***	4.200
Y_COVERED	−0.002	−0.910
CONSTANT	8.349	0.810
Number of ES	189	
tau-squared (τ^2)	0.0070	
I^2	98.31%	
Adj R^2	39.26%	

Factors influencing the relationship	Summary of results
Panel B: Summary of regression results	
(i) Measures of firm performance	• *ROA* and *ROE* have a significant negative impact on effect size (*ES*) relative to the mean impact on *ES* • *MV* has a significant positive impact on *ES* relative to the mean impact on *ES*
(ii) Measures of financial constraints	• *EXT_FIN* and *SIZE* have a significant negative impact on *ES* relative to the mean impact on *ES* • *WW* has significant positive impact on *ES* relative to the mean impact on *ES*
(iii) Estimation methods	• No impact
(iv) Regional difference	• *NORTH_AMERICA* and *ASIA* have a significant negative impact on *ES* relative to the mean impact on *ES* • *CROSS_COUNTRY* and *EUROPE* have significant positive impact on *ES* relative to the mean impact on *ES*
(v) Control variables	• *C_SIZE* and *C_GOVERNANCE* as a control variable have a significant negative impact on *ES* relative to the mean impact on *ES*
(vi) Strength of results	• *J_QUALITY* has a significant negative impact on *ES* relative to the mean impact on *ES* • *PUB_STATUS* has a significant positive impact on *ES* relative to the mean impact on *ES*

This table reports regression analysis of sources of heterogeneity in the effect size for financial constraints on firm performance. The dependent variable is *Fishers_Z*. The variables are defined in Table 3. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

Table 10
Robustness test

Fisher_Z	Coefficient	*t*-value
Measurement of *FP*		
ACC_MEASURE	−0.062**	−2.110
Measurement of *FC*		
CF	0.032	1.121
EXT_FIN	−0.083**	−2.519
KZ	0.053**	2.382
SA	−0.047	−0.949
SIZE	−0.027	−1.118
WW	0.093***	3.605
ACW	−0.020	−0.610
Estimation methods		
FE	0.009	0.319
GMM	0.022	0.818
OLS	0.032	1.613
OTHER_EM	−0.016	−0.650
RE	−0.003	−0.103
CROSS_REG	−0.044	−0.963
Regional difference		
AUSTRALIA	−0.056	−1.173
CROSS_COUNTRY	0.148***	3.202
EUROPE	0.049	1.317
NORTH_AMERICA	−0.031	−1.179
ASIA	−0.110***	−3.105
Control		
C_SIZE	−0.016	−0.490
LEV	−0.071	−1.560
GROWTH	0.072	1.100
FIRM_FE	0.005	0.130
YEAR_FE	0.001	0.020
INDUSTRY_FE	−0.002	−0.050
TANGIBILITY	0.040	0.980
RD	−0.013	−0.260
LIQUIDITY	0.005	0.140
M_PERFORMANCE	0.001	0.010
COUNTRY_EFFECT	−0.031	−0.930
C_GOVERNANCE	−0.082	−1.020
Strength of result		
S_SIZE	−0.02	−0.940
J_QUALITY	−0.226***	−3.680
PUB_YEAR	−0.003	−0.760
PUB_STATUS	0.258***	2.680
Y_COVERED	0	0.080
CONSTANT	8.52	0.75
Number of *ES*	189	
tau-squared (τ^2)	0.0077	
I^2	98.52%	
Adj R^2	33.72%	

This table reports regression analysis of sources of heterogeneity in the effect size for financial constraints on firm performance. The dependent variable is *Fisher_Z*. The variables are defined in Table 3. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

of financial performance and *EXT_FIN* and *SIZE*, as measures of financial constraints, have a significant negative impact on the relationship between financial constraints and firm performance relative to the mean impact on effect size. Similarly, all of *NORTH_AMERICA* and *ASIA* as regional differences, *C_SIZE* and *C_GOVERNANCE* as control variables, and *J_QUALITY* as strength of results, also have a negative impact. On the other hand, *MV*, as a measure of financial performance, and *WW*, as a measure of financial constraints, have significant positive impact relative to the mean impact. Similarly, *CROSS_COUNTRY* and *EUROPE* as regional differences, and *PUB_STATUS* as strength of results, all have significant positive impact. In particular, regarding the choice of measure of firm performance, where *ROA* and *ROE* are used, the effect size significantly decreases relative to the mean impact on effect size. In contrast, *MV* has the opposite effect. Regarding the choice of measure of financial constraints, where *EXT_FIN* and *SIZE* are used, the effect size significantly decreases relative to the mean impact on effect size. In contrast, the WW index as a measure of financial constraints has the opposite effect. In terms of the regional difference, where *CROSS_COUNTRY* and *EUROPE* are used, the effect size significantly decreases relative to the mean impact on effect size. In contrast, *NORTH_AMERICA* and *ASIA* have the opposite effect. In terms of the control variables, where *C_SIZE* and *C_GOVERNANCE* are used, the effect size significantly decreases relative to the mean impact on effect size. Among the factors affecting the strength of results, *J_QUALITY* and *PUB_STATUS* plays an important role. The higher the *J_QUALITY*, the lower the effect size relative to the mean impact on effect size. On the other hand, *PUB_STATUS* has the opposite effect.

4.7. Robustness test

4.7.1. Grouping the measurement choice

Table 10 shows the result of simplifying the coding of the set of measures for firm performance. Following Wang and Shailer (2018), a dummy variable was included to divide the set of measures for performance into accounting-based and market-based performance. The R^2 value reported in Table 10 shows that the variables explain 33.72 percent of the heterogeneity. The results are discussed below.

Choice of measures. Among the choice of measures of firm performance, *ACC_MEASURE* (coefficient = −0.062, *t*-value = −2.11, $p = 0.037$) has a negative impact on effect size, which illustrates that accounting-based measures have a significant negative impact relative to the market-based measures, but only at the 5 percent level of significance. The results for the choice of measures of financial constraints are qualitatively similar to the results for the main test. The results for the estimation methods, regional differences, controls and strength of results are also qualitatively similar to the results for the main test.

The *REMR* model was also estimated by omitting variables with only a small number of effect sizes. However, the results were qualitatively similar to the main results and therefore are not reported.

5. Conclusion

This study examines the impact of financial constraints on firm performance. The findings show that, on average, there is a positive relationship between financial constraints and firm performance. However, as shown in the summary of results in Panel B of Table 9, there is significant variation in effect size (both in sign and significance) for the relationship between financial constraints and firm performance. The findings from the meta-regression analysis suggest that variation in the results found in empirical studies is attributable principally to differences in the choice of measures for both firm performance and financial constraints, to regional differences, to control variable difference and to measures indicating the strength of the results. The robustness test of the main meta-regression results supports the main results.

From the choice of firm performance measures, *ROA* and *ROE* have significant negative impacts on the relationship between financial constraints and firm performance relative to the mean level of impact, whereas only *MV* has a significant positive impact on the relationship relative to the mean level of impact among the choice of measures. In terms of the measures for financial constraints, external finance and size have a significant negative impact relative to the mean, whereas the WW index has a highly significant positive impact relative to the mean level. Overall, the results indicate that variation in the measures for financial constraints contributes to the variation in the results found in previous studies.

The study does not show any significant impact on the variation in effect sizes as a result of the choice of estimation method used in the sample studies. However, among the different regional areas addressed in the sample studies, North America, Asia, Europe, and the block of countries used in cross-country studies, all show a significant impact on the variation in effect size relative to the mean. In the previous studies, where the sample is from North America or Asia the impact is negative, whereas for Europe and cross-country the impact is positive. In terms of the control variables, studies that control size and corporate governance show a significant and negative impact on the variation in effect size relative to the mean. Among the factors affecting the strength of the results, journal quality and publication status demonstrate a significant impact. The higher the journal quality, the lower the impact on effect size. On the other hand, publication status has the opposite effect.

The robustness test show that accounting-based measures of firm performance have a significant negative impact on the relationship relative to the market-based measures. This is broadly consistent with the baseline analysis.

The study has an important policy implication as it can help to understand the reasons behind the conflicting results found across studies and, in

particular, the differences in the direction of the relationship between financial constraints and firm performance in different country settings. The use of the treatment introduced by Suits (1984) to solve the dummy variable problem is an important and novel addition to the meta-analysis methodology used in accounting studies. The literature review provides a broader overview of the impact of financial constraints and the necessity for further development of the measures of financial constraints. For firm performance, accounting-based measures and market-based measures should be considered and analysed separately as the choice of measure influences the outcomes. Additionally, the findings strongly suggest the need for further research on particular country settings rather than cross-country analysis, as regional differences have a significant impact on the performace–constraints relationship.

A high proportion of this study sample examined US firms, and focused on relatively short sample periods. This suggests that future research should provide additional evidence on other countries to enable decisions to be made based on the evidence unique to a particular country setting. Therefore, it also suggests the need for additional studies using recent data and, if history repeats, new measures of financial constraints will continue to be developed.

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