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# Macroeconomic Impact of Basel III: Evidence from a Meta-Analysis\*

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## Abstract

We present a meta-analysis of the impact of higher capital requirements imposed by regulatory reforms on the macroeconomic activity (Basel III). The empirical evidence derived from a unique dataset of 48 primary studies indicates that there is a negative, albeit moderate GDP level effect in response to a change in the capital ratio. Meta-regression results suggest that the estimates reported in the literature tend to be systematically influenced by a selected set of study characteristics, such as econometric specifications, the authors' affiliations, and the underlying financial system. Finally, we document a significant positive publication bias.

JEL Codes: E51, E44, G28.

Keywords: Meta-analysis, publication bias, banking, loans, capital requirements, Basel III.

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## 1. Introduction

In light of the 2008 financial crisis, global regulators agreed on a substantial increase in capital and liquidity requirements for financial institutions. As bank failures and bailout programs have compellingly shown, major international banks entered the crisis with inadequate capital levels relative to their risk exposure (Admati *et al.*, 2013a and 2013b). In December 2010, with regard to the regulatory deficiencies revealed by the crisis, the Basel Committee on Banking Supervision (BCBS) announced extensive reforms to strengthen the resilience of the financial system, known as Basel III (BCBS, 2010a). There are indeed strong arguments that the Basel reforms will make the banking system safer, reducing bank risk-taking *ex ante* (Kim and Santomero, 1988; Holmstrom and Tirole, 1997) and the probability of bank default *ex post* (Dewatripont and Tirole, 1994; Gambacorta and Mistrulli, 2004). At the same time, we observe a consensus among policymakers and financial sector participants that the implementation of the Basel rules will impose significant costs on the banking system and the broader economy (IIF, 2011).

Assessing the economic trade-off between economic development and systemic financial stability has become a core concern of the post-crisis era. Despite a growing empirical literature over on the topic, we still know surprisingly little about effects of macro-prudential policy. While there is general agreement that capital regulation will be costly, the arguments behind this view remain opaque (Noss and Toffano, 2016). The empirical evidence on macro-financial linkages presents also an ambiguous picture. Although most Basel III impact studies find robust negative effects, results are surprisingly heterogeneous (ranging from negligible to substantial impact). In light of these drawbacks, this paper aims to explain the heterogeneity of results by analyzing its determinants in a systematic and explicit way, applying meta-analysis techniques. To the best of

our knowledge, this is the first study conducting a meta-analysis on this topic. Synthesizing the empirical evidence from a unique dataset of more than 312 estimates reported in 48 primary studies (see Appendix, Table A.1), the findings suggest that, on average, there is a negative, albeit moderate GDP level effect in response to a marginal change in the capital ratio. The GDP level is expected to decrease by about 0.20% as a response to an increase in the capital ratio by 1 percentage point. In contrast to the theoretical discussion, all reported study estimates are negative. However, as we show, the empirical results of the surveyed studies are driven by various study characteristics (e.g. the econometric methodology and their regional focus). Moreover, statistical evidence can be found that the estimates of the surveyed studies may be distorted by significant publication bias.

The contribution of this paper is twofold. First, the assessment of regulatory impacts is of high policy interest. We provide a systematic review that allows us to draw a more coherent picture. The meta-results may be more reliable compared to individual studies that are highly selective and biased. Second, we identify substantial caveats in the calibration of regulatory impacts. While the previous meta-analysis, in general, did not concentrate on simulation studies, we discuss the methods how to assess publication bias for those analyses. Finally, we differ between strong and negligible effects, which is also a novel approach in meta-analysis.

The remainder of this paper is structured as follows. Section 2 presents a short literature review on the assessment of regulatory impacts. Section 3 introduces the meta-analysis framework. Section 4 presents the meta-dataset and meta-statistics. Section 5 shows that publication bias analysis is more important than initially expected. As a part of this discussion, we discuss how to measure quality or preciseness for simulation studies. Section 6 presents the standard meta-analysis, while its robustness is discussed in Section 7. Moreover, the robustness

analysis discusses the differences between studies reporting strong and negligible effects. Section 8 concludes.

## **2. Measuring regulatory impacts**

Any assessment of the macroeconomic impact of the Basel reforms requires an understanding of the linkage between capital regulation, bank behaviour and the real economy. This is a field that has largely been neglected in the past decades (Friedman, 1991). As a consequence, the empirical literature on regulatory impacts still lacks a unified theoretical framework. In light of the financial crisis, the predominant role of bank capital became obvious and is recently integrated into macro models through several transmission channels. The bank balance sheet channel reflects that adverse shocks to financial institutions' balance sheets (due to internal losses or external policy changes) result in significant contractions in credit supply and economic growth (BCBS, 2011). While the traditional bank lending channel (Bernanke and Gertler, 1995) focuses on explicit monetary policy shocks, the bank capital channel assumes that banks cut down lending in response to exogenous shocks to their capitalization (Van den Heuvel, 2008; Meh and Moran, 2010). These shocks may either arise from financial sector shocks (e.g. fluctuations in asset prices) or may be attributed to regulatory capital requirements.

Within this framework, an introduction of higher regulatory capital requirements, as envisaged in Basel III, will lead to a transitional shortfall in bank capital (in form of a gap between actual and target capital ratio). This effect may be reinforced by procyclicality if asset losses and risk weights increase in economic downturns. As a shortfall will be sanctioned by regulators, it will then force banks to react by changing their resource allocation and loan pricing to increase their capital levels at least until they reach the regulatory minimum. In general, banks

are expected to either increase their interest margins or cut down lending. There are, however, alternative strategies that will not affect the lending channel (e.g. if banks cut down expenses).

Recently, a variety of econometric methodologies have been developed to evaluate the impact of the Basel reforms. The most frequently used models, especially by central banks, follow a two-step approach (proposed by MAG, 2010a). In a first step, satellite models are used to predict banks' adjustment to achieve the minimum capital ratio. The proxy variables (changes in lending volumes and credit spreads) obtained from satellite models may later serve as input factors into large-scale (semi-structural or DSGE-based) macroeconomic policy models provided by policy institutions (e.g. the QUEST model at the European Commission; Roeger and Veld, 2004). The two-step approach tackles the issue that, while policy models are a powerful tool for forecasting purposes, a direct investigation of macro-prudential policy changes is not possible in many cases. Satellite models themselves rely on either explicit regression-based approaches (whenever appropriate bank-level data is available) or simpler accounting-based approaches (in the absence of such data). Within the regression-based approaches econometric inferences are either drawn from changes in lending volumes, as proposed by the target capital ratio model (Hancock and Wilcox, 1993 and 1994; Francis and Osborne, 2009) or from changes in credit spreads based on the credit spread model (Barrell, 2009).

The target capital ratio model first calculates the gap between the actual and the target capital ratio and derives a 'distance-from-target variable that is then used to regress the responses of different balance sheet items. Similarly, the credit spread model is based on spread effects from elasticities that are estimated from historical data. Most spread models rely on panel regressions, whereby a quarterly change in lending spreads is regressed on increased capital requirements and other control variables. In contrast, accounting-based models mainly rely on simple balance sheet

identities by a loan pricing model that derives the lending spreads that keep the ROE constant (Elliott, 2009; Slovik and Courneade, 2011). While this approach is intuitive, the degree of pass-through is a critical assumption and interaction effects are not captured.

An alternative approach are DSGE models that explicitly feature a banking sector and allow to derive the steady-state impact of increased capital requirements on the real economy (Meh and Moran, 2010; Angelini and Gerali, 2011), however, results are highly sensitive to the calibration of parameters. Partial equilibrium models that focus on the credit market represent a less complex alternative (De Nicolo, 2015). Reduced-form models (VAR, VECM, ECM) estimate a long-term relationship between a small set of macro variables using bank data and allow to disentangle demand and supply factors of the lending channel (Angelini et al., 2011; Gambacorta, 2011). Moreover, there are some models relying on a simple production function, calibrating the elasticity of output to changes in firm's cost of capital (BoE, 2010; Miles et al., 2011). Finally, large-scale macro models of central banks and other institutions are used (Locarno, 2011). While two-step approaches (MAG, 2010b) are commonly accepted and yield similar and robust results, the use of alternative approaches is relatively new, leading to a high degree of uncertainty.

### **3. Meta-regression methodology and sources of result heterogeneity**

A comprehensive meta-analysis combines a variety of statistical techniques that are useful in reviewing and evaluating the empirical literature in a specific field of research. As such, it is a powerful instrument to assess variation among reported results, hereby determining the impact of study characteristics and providing a type of consensus (Stanley, 2001; Stanley and Jarrell, 2005). Recently, there is a growing number of meta-analyses on economic policy issues, for instance on business cycle correlation (Fidrmuc and Korhonen, 2006 and 2015), international monetary

economics (Havránek and Iršová, 2011, Havránek et al., 2015) or labor economics (Card *et al.*, 2010). In contrast, the meta-analysis approach is new in banking and finance. Feld *et al.* (2013) present e.g. a meta-analysis on a capital structure choice.

In general, any meta-analysis is based on the regression between a summary statistic (the dependent variable) and a set of study characteristics (the independent variables), drawn from each paper. A meta-regression model is therefore given by

$$\widehat{bsl}_{ki} = \mu + \sum_{l=1}^L \beta_l D_{lki} + u_{ki}, \quad (1)$$

where  $\widehat{bsl}$  refers of Basel III impact in study  $k$  and  $D_l$  represents variables describing selected study characteristics, while  $u$  is the error term.

A crucial point for any meta-analysis is the comparability of reported effects, e.g.  $\widehat{bsl}$ . Following the literature, we measure the impact of higher capital requirements on the real economy as percentage change in the level of GDP in response to a 1 percentage point change in the capital-to-asset-ratio (BCBS, 2010; MAG, 2010). This can be referred to as the marginal effect of increased capital ratios (irrespective of underlying model classes). However, some studies use alternative input factors (e.g. 1.3 percentage point increase in capital ratios to cover the whole Basel III impact, as proposed by BCBS, 2010b). Hence, the effect size reported in primary studies must be at least transformable to a marginal effect. Several authors suggest that the effects may be linearly convertible into a marginal effect across models (MAG, 2010; Angelini *et al.*, 2015).

Evaluating the existing literature, we expect five variable groups to affect the reported estimate. These groups contain variables related to the publications, the authors, the regions, the model classes and further modelling assumptions. With the exception of the publication year variable, which is demeaned (deviation from the mean publication year), all other variables are



binary. The exact variable definitions can be found in Appendix (Table A.2) and descriptive statistics in Table A.3. In the first group, we include variables for the publication year and the publication format (journal, working paper or other format, e.g. policy reports). While the publication year may detect a trend in the analysis, the publication format accounts for possible quality differences. The second group includes dummy variables accounting for authors' affiliation (academic, banking or public sector and specific organizations), as political interests and expectations may affect the reported results.

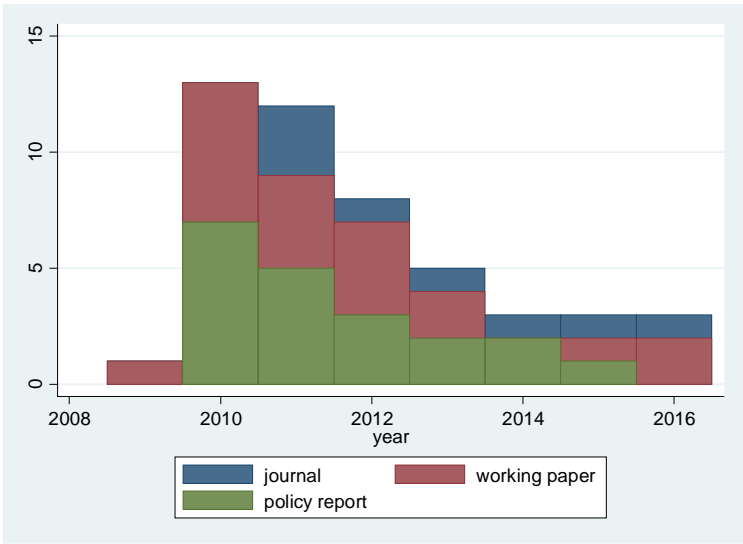
Third, the regional focus of the study may result in cross-country variations, as different countries are expected to be more or less affected by higher capital requirements (Cosimano and Hakura, 2011). On the one hand, we distinguish between bank-based and market-based financial systems (Levine and Zervos, 1998; Levine, 2002). In general, bank-based systems may be more affected by banking regulation (Beck and Levine, 2002 and 2004). On the other hand, La Porta et al. (1998) categorize countries with respect to their legal origins. Fourth, different estimation methods may drive the results. Finally, further modelling assumptions are considered, as a longer phase-in period, as well as a long-term estimate and favorable monetary policy may reduce the effects of higher capital requirements.

#### **4. Dataset and meta-statistics**

We review 48 primary studies on the macroeconomic cost of higher capital requirements. A full list of the reviewed studies is presented in Appendix, Table A.1. The underlying selection process can be described as follows. Relevant studies were identified searching the EconLit database, IDEAS, Google Scholar, and ScienceDirect. In addition, important journals and working paper series were scanned. To identify all relevant studies, we used a variety of search

key words (i.e., ‘capital requirements’, ‘capital ratio’, and ‘Basel III’) as of May 2016. The main selection criterion requires that potential studies report estimates of the GDP level effect in response to a marginal change in the capital ratio. Otherwise, this marginal effect must at least be linearly convertible from the reported result. In order to avoid overrepresentation, only the most recent version of a paper is included (e.g. earlier working paper versions are ignored), with the exception of revised papers providing significantly different results. Furthermore, only recent papers (Basel III impact studies) are included, as methods of previous studies are not directly comparable. Finally, this meta-analysis follows the standard approach of including all estimates provided by one study (Stanley, 2001, 2005, and 2008). In particular, there is *a priori* no clear criterion suggesting which estimate to include. Moreover, a variation in one dimension *ceteris paribus* may be valuable for meta-regressions and the within-study variance will be used as a measure for precision in our publication bias analysis.

**Figure 1: Number of publications by year and publication format**



Note: Data for 2016 are available only from January to May 2016.

Source: Own estimations.

Figure 1 presents the number of publications by year and the publication format. In the first years after the Basel announcement, there has been a surge of interest. Moreover, policy reports and working paper dominated the discussion in the first years. Most of the working papers have reached high attention and are assumed to be of relatively high quality. With regard to the authors' affiliations, public sector organizations seem to participate more actively in the regulation debate. Most studies are published by central banks, followed by the IMF.

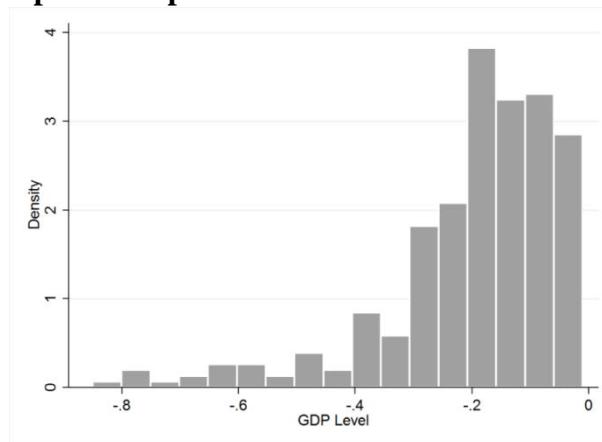
Table 1 reports meta-statistics for the overall dataset and selected subsamples. The descriptive statistics show already several important findings. First, the average estimated macroeconomic impact of higher capital requirements across all studies and observations is negative, albeit moderate. On average, each percentage point increase in the capital ratio leads to a 0.20% GDP level decrease in the long-run. Second, the estimated effect ranges from -0.85% to -0.01%, thus, there are no positive values. This is a surprising finding as theoretical papers do not clearly predict a negative effect (e.g., Van den Heuvel, 2008). Third, strong variations across selected variable groups can be identified. On average, public sector studies tend to report negligible impact of Basel regulations as compared to banking sector studies. Similarly, market-based financial systems are generally found to be less affected by Basel III than the bank-based financial systems. Moreover, results vary for different legal origins and the model classes employed in the primary studies. However, the reported results do not substantially vary for different years (descriptive statistics are available upon request). Finally, the meta-sample distribution of regulation effect estimates (Figure 2) is negatively skewed. In general, researches tend to discard positive estimates too often. This finding is further investigated in the publication bias analysis.

**Table 1: Meta-statistics for selected variable groups**

Variables	No of obs.	Mean	Std. Dev.	Min	Max
<b>A. Meta-statistics for the total sample</b>					
	312	-0.198	0.009	-0.85	-0.01
<b>B. Meta-statistics by authors' affiliations</b>					
BIS	87	-0.194	0.104	-0.56	-0.04
Central Bank	65	-0.175	0.147	-0.85	-0.01
IMF	57	-0.141	0.116	-0.50	-0.01
European Institution	36	-0.189	0.097	-0.39	-0.05
OECD	15	-0.153	0.064	-0.30	-0.04
FSA	2	-0.060	0.028	-0.08	-0.04
Public sector	262	-0.174	0.117	-0.85	-0.01
Banking sector	28	-0.425	0.275	-0.80	-0.04
Academic sector	22	-0.193	0.099	-0.42	-0.01
<b>C. Meta-statistics by financial system</b>					
Bank-based system	238	-0.206	0.147	-0.80	-0.01
Market-based system	74	-0.171	0.176	-0.85	-0.01
<b>D. Meta-statistics by legal origin</b>					
English origin	80	-0.173	0.173	-0.85	-0.01
French origin	43	-0.171	0.129	-0.64	-0.01
German origin	33	-0.226	0.203	-0.80	-0.01
Scandinavian origin	11	-0.180	0.132	-0.50	-0.06
Other origin	145	-0.213	0.138	-0.78	-0.03
<b>E. Meta-statistics by model class</b>					
Regression-based	77	-0.212	0.119	-0.65	-0.04
Median estimate	20	-0.164	0.077	-0.36	-0.09
Mean estimate	19	-0.225	0.103	-0.54	-0.11
Accounting-based	60	-0.288	0.228	-0.80	-0.01
VAR	19	-0.319	0.169	-0.85	-0.04
DSGE	35	-0.133	0.116	-0.45	-0.01
Macro-structural	72	-0.124	0.085	-0.35	-0.01
Production function	10	-0.080	0.045	-0.15	-0.01

Source: Own estimations.

**Figure 2: Histogram of reported impact of Basel III**



Source: Own calculations.

## 5. Publication bias analysis

### 5.1 Proxy for average precision of surveyed studies

In the first part of our analysis, we evaluate whether publication selection bias is present in the empirical literature on Basel III impacts. Publication bias is a common phenomenon in scientific research, whereby results are more likely to be published if they are statistically significant or theoretically desirable and this might, in turn, induce a selection process of empirical findings that biases the *true* population parameter. As a result, the knowledge about a particular economic relationship is clearly limited. One common approach for detecting publication selection bias is to analyze the relationship between the reported result and its precision (Card and Krueger, 1995; Stanley and Doucouliagos, 2012). If there is no publication bias, there should be no systematic relationship between reported results and their precision. However, the presence of publication bias will induce a correlation between the estimate and its precision. We expect a relatively strong ‘consensus’ that capital regulation has adverse effects on GDP, although the economic theory does not clearly support a negative effect (VanHoose, 2007).

A conventional proxy for precision is the inverse of the standard error,  $1/SE$ . However, since this analysis includes various model classes, standard errors are not available in many cases,

especially in simulation studies. Nevertheless, precision can be proxied by other quality indicators. We propose an alternative measure for precision using the within-studies standard deviation in order to deal with quality differences in more comprehensive way. To the best of our knowledge, previous studies did not discuss publication bias in simulations studies. Thus, our approach provides an extension of the methodology of publication bias analysis.

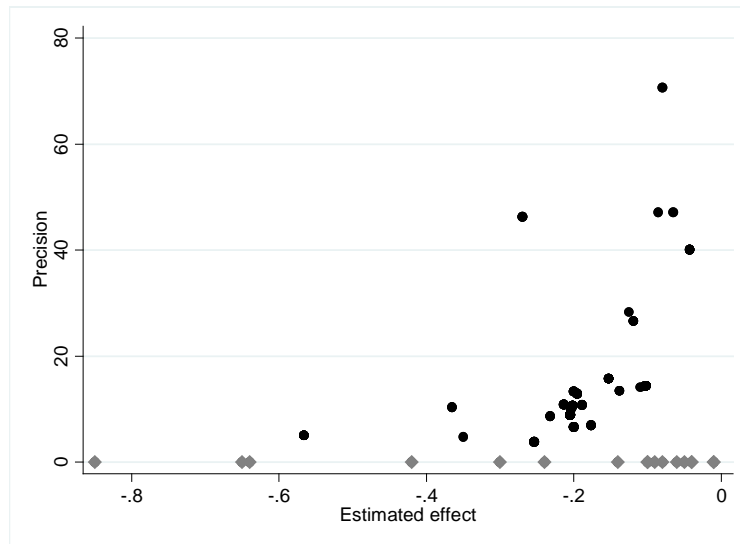
In particular, we propose the average precision of studies,  $APS$ , which uses the standard deviation,  $SD_k = \frac{1}{N_k} \sum_i (\widehat{bsl}_{ki} - \overline{bsl}_k)$  of  $N$  results reported by an  $k$  study,  $bsl_i$ . This approach reflects that the studies with lesser reported differences present more reliable findings. In contrast, less precise studies are associated with a higher variation of reported results. Standard deviation is, however, not defined for studies reporting only one estimate. In this case, we set the precision proxy to zero, assuming that these studies were conducted with a comparably low methodological rigor. The definition of the precision variable is summarized as

$$APS_k = \begin{cases} \frac{1}{SD_k} & \text{if } N_k > 1 \\ 0 & \text{if } N_k = 0 \end{cases} \quad (2)$$

## 5.2 Funnel plots and funnel asymmetry tests

Funnel plots represent the most intuitive way to visualize publication selection bias. A funnel graph is a scatter diagram that plots the precision of the reported effect on the vertical axis against the measured effect size on the horizontal axis (Sutton *et al.*, 2000a and 200b). In the absence of publication bias, the estimates should be randomly and symmetrically distributed around the ‘true’ effect. The plot is expected to resemble an inverted funnel, with the more precise estimates being located close to the ‘true’ effect. In contrast, publication bias may be significant if the funnel plot appears asymmetric in case of directional selection or hollow and wide.

**Figure 3: Funnel plot, Average Effects of Basel III**



*Note:* The precision variable is defined as the inverse within-studies standard deviation. For  $N = 1$  the precision indicator is set to zero (diamond symbols).

Source: Own estimations.

The funnel plot relying on our *APS* measure for reported studies is displayed in Figure 3. Two important findings emerge from its visual investigation. First, the figure does not resemble an inverted funnel, but appears asymmetrically skewed to the left, which implies a downward bias in the surveyed literature. The literature shows strong selective reporting as researchers discard higher (especially positive) estimates too often. The shape becomes even more apparent as points with the precision set to zero (for  $N=1$ ) are not considered (diamond symbols). Obviously, some studies report estimates close to zero, but they are avoiding positive estimates. This lopsided plot is even more remarkable as the theoretical literature does not clearly support a one-sided, negative effect of higher capital ratios. Nonetheless, even in case of a clearly negative effect, the estimates should vary symmetrically around most precise estimates. Second, the effect magnitude is not clear. While the average of all 312 estimates is about  $-0.20$ , the most precise estimates are only  $-0.05$  percentage of GDP. Hence, single studies tend to overestimate the effect

size. While the average result seems to be significant in economic terms, the most reliable studies report only a negligible impact of Basel III.

In order to test for publication bias in a more formal way (Card and Krueger, 1995; Ashenfelter *et al.*, 1999), we use funnel asymmetry test (FAT). As far as we have only average proxy of study precision, we use a simple meta-regression of average estimates and corresponding average precision

$$\overline{bsl}_k = \alpha APS_k + bsl + \varepsilon_{ki}, \quad (3)$$

where  $\overline{bsl} = \frac{1}{N} \sum_i \widehat{bsl}_i$  is the average reported effect,  $bsl$  stands for the ‘true effect’, coefficient  $\alpha$  show the publication bias and  $\varepsilon$  is the error term. If there is no evidence for publication bias, the coefficient  $\alpha$  should be not significantly different from zero, given that the estimates vary symmetrically around the ‘true effect’. In contrast, publication bias can be detected if  $\alpha$  is non-zero and significant. The error term  $\varepsilon$  is, however, expected to be heteroscedastic as studies rely on different econometric specifications. To address the issue of quality differences among studies and to obtain efficient estimates, the standard approach is refined using weighted least squares (WLS). Most WLS specifications use the inverse standard errors as weights, giving more weight to more precise estimates. We use the number of reported estimates as a measure for precision, and thus as weights in the WLS specification. The corresponding FAT test for  $\alpha = 0$  detects publication bias if its null hypothesis of no publication bias can be rejected (Egger *et al.*, 1997).

Table 2 presents OLS and WLS versions of FAT test with robust standard errors at the study-level. We exclude studies with only one estimate in specification (3) and (4), since this measurement is less reliable. The FAT results confirm fully the findings derived from the funnel plots for studies reporting more than only one estimate, which reject the null hypothesis of no publication bias.



**Table 2: Funnel asymmetry test (study average)**

	(1)	(2)	(3)	(4)
	OLS	WLS	OLS	WLS
Publication bias, $\alpha$	-0.465	-1.035	-1.242***	-1.396**
	(0.385)	(0.522)	(0.416)	(0.647)
Observations	48	48	26	26
R <sup>2</sup>	0.026	0.230	0.475	0.464

*Note:* WLS - weighted tests using the number of reported estimates. Robust standard errors are in parentheses. \*\*, and \*\*\* denote significance at the 5%, and 1% level, respectively.

*Source:* Own estimations.

## 6. Meta-regression analysis

We estimate meta-regressions according to equation (1). Our model selection strategy is based on the specific-to-general approach, whereby we include the sets of variables describing specific publication criteria. First, we start with publication characteristics (see Table 3). The coefficient for the publication year is positive but insignificant. Policy reports of banks and other private institutions report significantly negative impact of Basel III, while other publication types remain insignificant. Second, the coefficients for the authors' affiliations reveal high heterogeneity between the estimates. Compared to academic sector publications, banking sector studies report significantly lower estimates. Hence, these studies tend to predict a more negative impact of higher capital ratios on the real economy. On the other hand, the coefficients for most public sector institutions, especially for the financial supervision authorities, show significantly positive signs. These results seem to confirm the hypothesis that general expectations and interests may affect the reported effect size.

**Table 3: Meta-regression, model selection and preferred specification**

	(1)	(2)	(3)	(4)	(5)	(6)
	Publication <sup>a</sup>	Author <sup>b</sup>	Region <sup>c</sup>	Model <sup>d</sup>	Definitions	Preferred
Publication year	0.008 (0.008)					
Journal	-0.020 (0.044)					
Working paper	0.018 (0.029)					
Public policy report	-0.011 (0.030)					
Bank policy report	-0.274*** (0.057)					
Banking sector		-0.233*** (0.056)				-0.181*** (0.049)
BIS		-0.001 (0.024)				0.081*** (0.025)
Central Bank		0.018 (0.028)				0.073*** (0.021)
IMF		0.051** (0.026)				
Europ. Institution		0.004 (0.026)				0.096*** (0.028)
OECD		0.040 (0.026)				0.140*** (0.029)
FSA		0.133*** (0.025)				0.153*** (0.040)
Bank-based system			-0.022 (0.053)			-0.060*** (0.021)
French origin			0.022 (0.052)			
German origin			-0.033 (0.060)			
Scandinavian origin			0.013 (0.062)			

**Table 3 (Continued)**

	(1) Publication <sup>a</sup>	(2) Author <sup>b</sup>	(3) Region <sup>c</sup>	(4) Model <sup>d</sup>	(5) Definitions	(6) Preferred
Other origin			-0.020 (0.050)			
Mean estimate				-0.012 (0.027)		
Median estimate				0.049** (0.022)		
Accounting-based models				-0.075** (0.033)		
VAR models				-0.107*** (0.041)		-0.097** (0.039)
DSGE models				0.080*** (0.024)		0.069*** (0.024)
Macro-structural models				0.088*** (0.017)		0.124*** (0.023)
Production function models				0.132*** (0.019)		0.148*** (0.028)
Long-term estimate					-0.028* (0.017)	
Long implem. horizon					0.064* (0.035)	
Monetary policy offset					0.107*** (0.020)	0.101*** (0.018)
Intercept	-16.515 (15.823)	-0.193*** (0.021)	-0.172*** (0.021)	-0.212*** (0.014)	-0.252*** (0.031)	-0.244*** (0.025)
Observations	312	312	312	312	312	312
R <sup>2</sup>	0.256	0.234	0.020	0.201	0.092	0.438

*Note:* \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% level, respectively. Robust standard errors are in parentheses. Reference categories (omitted variables): <sup>a</sup> other publication format; <sup>b</sup> academic sector; <sup>c</sup> market-based system for financial systems and English origin for legal origins; <sup>d</sup> Regression-based approach.

*Source:* Own estimations.

Third, the regional focus of primary studies may play a major role, thus confirming the hypothesis of cross-country heterogeneity (e.g., Cosimano and Hakura, 2011). The estimated coefficient for the bank-based financial system is significantly negative. In accordance with the financial literature, this result suggests that bank-based financial systems may be more affected by tighter capital regulation. On the contrary, the legal origins provide highly ambiguous results. Within this group, English origin countries are used as a reference category. While German and Scandinavian origin countries tend to be more affected by Basel regulations, only the residual category ('other origin') is marginally significant.

Fourth, the choice of a certain model class has a significant effect on the estimated effect size in primary studies. Within this control variable group, the regression-based approach is used as a reference category. The coefficient for the VAR model shows a significantly negative coefficient meaning that these models tend to report large effects. Thus, our meta-analysis confirms the findings by several authors whereby reduced-form models predict more negative effects (MAG, 2010b; De Nicolo, 2015). In contrast, the coefficients for the DSGE models, the macro-structural models, the production function models and the median estimates are significantly positive. This effect is relatively strong for macro-structural models and predictions based on a production function. The coefficient for the mean estimate does not significantly differ from regression-based estimates, thus confirming the hypothesis that regression models are reliable.

Finally, the modeling assumptions do not show any significant effects, except for the monetary policy variable. Hence, studies assuming the existence of favorable accompanying monetary policy report less negative effects compared to studies without such a monetary policy channel. Monetary policy is therefore expected to offset the potentially adverse effects. Altogether, the findings are in line with the hypotheses stated in the previous sections.

**Table 4: Robustness analysis, estimation methods**

	(1)	(2)	(3)	(4)	(5)
	WLS	MR	RR	CFE	SRE
Banking sector	-0.175** (0.072)	-0.220*** (0.040)	-0.369*** (0.026)	-0.200** (0.074)	-0.166** (0.079)
Central Bank	0.055 (0.033)	0.080*** (0.030)	0.085*** (0.019)	0.058 (0.041)	0.051 (0.038)
FSA	0.160*** (0.042)	0.080 (0.071)	0.145** (0.064)	0.161 (0.170)	0.148*** (0.035)
BIS	0.055 (0.047)	0.070** (0.031)	0.074*** (0.020)	0.061** (0.029)	0.059 (0.044)
European Inst.	0.036 (0.039)	0.070* (0.037)	0.073*** (0.024)	0.092** (0.045)	0.087*** (0.030)
OECD	0.124*** (0.037)	0.130*** (0.046)	0.118*** (0.030)	0.139*** (0.047)	0.125*** (0.026)
Bank-based	-0.042 (0.039)	-0.040* (0.021)	-0.026* (0.014)	-0.098 (0.172)	-0.064** (0.030)
VAR	-0.179 (0.111)	-0.090** (0.035)	-0.083*** (0.023)	-0.089 (0.064)	-0.088* (0.046)
DSGE	0.140*** (0.046)	0.070** (0.029)	0.069*** (0.019)	0.095*** (0.030)	0.059 (0.046)
Macro-structural	0.088* (0.052)	0.120*** (0.031)	0.113*** (0.020)	0.118*** (0.030)	0.101*** (0.039)
CES models	0.178*** (0.034)	0.130*** (0.040)	0.125*** (0.030)	0.143*** (0.042)	0.138*** (0.031)
Monetary policy	0.064* (0.035)	0.100*** (0.022)	0.078*** (0.014)	0.095*** (0.021)	0.087*** (0.022)
Intercept	-0.243*** (0.032)	-0.240*** (0.036)	-0.249*** (0.023)	-0.205 (0.144)	-0.227*** (0.032)
No. of obs.	312	312	312	312	312
R <sup>2</sup> / Pseudo R <sup>2</sup>	0.426	0.237	0.728	0.455	0.147

Note: Column (1) to (5) present robustness analysis methods. WLS – weighted least squares regression. MR – median regression. RR – Cook’s distance robust regression. CFE – country fixed effects regression. SRE – study random effects regression. Robust standard errors are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% level, respectively.

Source: Own estimations.

Finally, we look for a preferred specification to obtain a reliable but parsimonious model. In particular, only the variables that are significant at least at the 5% level are included into the preferred specification. In practice, the least significant variables are dropped one by one, finally obtaining the preferred model. The preferred specification hence excludes the variables for the bank policy report, accounting-based models, long-term estimates and the long horizon.

## **7. Robustness analysis**

### **7.1 Alternative estimation methods**

In order to control for different specification issues, five robustness checks are performed (see Table 4). First, column (1) relies on the weighted least squares (WLS) method using the precision of each parameter estimate (defined by the inverse number reported estimates) as weights. We hereby account for relative quality differences within the standard specification, giving more weight to more precise and reliable estimates. Second, column (2) presents median regression (MR) that minimizes the sum of absolute residuals to reduce the effect of large outliers on the estimated coefficients. Third, we present a robust regression based on Cook's (1977) distance measure (RR) that underweights the largest outliers (3). Fourth, the specification in column (4) controls for country-fixed effects (CFE). Finally, column (5) includes random effects for the underlying studies (SRE) to deal with potential cross-sectional dependence between estimates in the same study (Thompson and Sharp, 1999) and hence is expected to be a more reliable specification.

In general, the robustness checks do not change the results of the preferred estimation with regard to the included explanatory variables. Nearly all coefficients remain unchanged and retain their signs and significance. However, there are some exceptions for the country-fixed effects

(CFE) and the study-random effects (SRE) specification. First, the coefficient for the authors affiliated with central banks becomes insignificant in both specifications. Furthermore, the coefficient for the Financial Services Authority and for bank-based systems are insignificant in the CFE model, while the coefficients for BIS-authors and DSGE models are insignificant in the SRE specification. Overall, the results are not found to be sensitive to estimation methods.

## 7.2 Meta-probit models of large effects

The standard meta-regressions presented in the previous sections suggest that the reported estimates of the primary studies tend to be mainly influenced by econometric modeling issues and the authors' affiliations. Moreover, publication bias is playing an important role in the literature on Basel III. Given the empirical evidence presented so far, it can be hypothesized that some studies try to support institutional views in presented publications on this topic. To investigate this issue more deeply, we estimate probit models whether the reported results can be considered as important from the policy point of view. Therefore, the reported effects are now regrouped into two categories, strong and negligible effects. To the best of our knowledge, this is the first meta-analysis proposing probabilistic models for non-negligible effects.

In particular, using the reported effects of Basel III as measured so far by variable  $bsl$ , we define a new variable,  $strong$ , that takes value 1 if there is a strong effect, and 0 if negligible effects are reported,

$$strong_{ki} = \begin{cases} 1 & \text{if } bsl_{ki} < -0.25 \\ 0 & \text{if } bsl_{ki} \geq -0.25 \end{cases} \quad (4)$$

**Table 5: Meta-probit regression of large effects**

	(1)	(2)	(3)	(4)	(5)	(6)
	Publication <sup>a</sup>	Author <sup>b</sup>	Region <sup>c</sup>	Model <sup>d</sup>	Definitions	Preferred
Publication year	-0.012 (0.021)					
Journal	-0.059 (0.117)					
Working paper	-0.046 (0.103)					
Public policy report	0.090 (0.120)					
Bank policy report	0.443** (0.143)					
Banking sector		0.373* (0.146)				0.164 (0.158)
BIS		-0.009 (0.101)				-0.229** (0.085)
Central Bank		0.019 (0.107)				-0.168* (0.066)
IMF		-0.073 (0.096)				
Europ. Institution		0.023 (0.119)				-0.188*** (0.057)
OECD		-0.171* (0.086)				-0.226*** (0.030)
Bank-based system			0.141 (0.138)			0.135* (0.058)
French origin			-0.106 (0.141)			
German origin			-0.026 (0.171)			
Scandinavian origin			-0.124 (0.142)			
Other origin			-0.051 (0.167)			
Mean estimate				0.027 (0.107)		



**Table 5 (Continued)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Publication <sup>a</sup>	Author <sup>b</sup>	Region <sup>c</sup>	Model <sup>d</sup>	Definitions	Preferred
Median estimate				-0.163*		
				(0.065)		
Accounting-based models				0.086		
				(0.075)		
VAR models				0.328*		0.290*
				(0.129)		(0.135)
DSGE models				-0.128*		-0.136*
				(0.063)		(0.060)
Macro-structural models				-0.204***		-0.278***
				(0.051)		(0.065)
Long-term estimate					0.082	
					(0.049)	
Long implementation horizon					-0.136	
					(0.080)	
Monetary policy offset					-0.225***	-0.210***
					(0.042)	(0.047)
	312	310	312	302	312	300
	0.078	0.066	0.012	0.109	0.059	0.219
	-159.74	-161.27	-171.14	-151.87	-163.01	-132.64

*Note:* \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% level, respectively. Marginal probability effects evaluated at the means. Robust standard errors are in parentheses. Reference categories (omitted variables): <sup>a</sup> other publication format; <sup>b</sup> academic sector; <sup>c</sup> market-based system for financial systems and English origin for legal origins; <sup>d</sup> Regression-based approach. Variables FSA and CES were dropped because they predict failure perfectly.

*Source:* Own estimations.

The threshold for the identification of strong effects is identified as approximately the lowest quartile of the distribution of reported effects. Moreover, histogram in Figure 2 shows that the histogram of reported effects is characterized by a discontinuity of the distribution at this

threshold level. Moreover, the meta-regression for strong effects of Basel III should be estimated by logit and probit models of the following form,

$$P(\text{strong}_{ki} = 1) = \mu + \sum_{l=1}^L \beta_l D_{lk} + \omega_k + \varepsilon_{ki}, \quad (5)$$

In general, the findings confirm the results of the previous analyses (see Table 5). Authors affiliated with central banks, BIS, European institutions, and the OECD show a significantly lower probability to publish large effects. As before, public sector studies tend to avoid a publication of strong effects. However, there is no robustly significant result that banking sector studies show higher probabilities to report strong effects. Bank-based financial systems show a higher probability to report strong effects, but the coefficient is relatively low and only marginally significant. Moreover, DSGE models and macro-structural models are less likely to report strong effects, but the former coefficient is only weakly significant. In turn, VAR models show a higher probability to publish large effects. Finally, studies that include a type of monetary policy offset are less likely to show strong effects.

## 8. Conclusions

The impact of financial reforms has become a core concern of the post-crisis era. Public policy debates focus on the question whether the new Basel rules will impose significant costs on the banking system and the broader economy. Despite a growing number of studies on this topic, especially in recent years, the empirical literature has reached highly ambiguous and inconclusive results. To tackle this issue, this paper synthesizes the empirical evidence from a unique dataset of 48 primary studies. We use meta-analysis techniques to identify the sources of heterogeneity.

Our meta-analysis of 48 primary studies provides three key findings. First, we find, on average, a relatively moderate effect on the real economy in response to a change in minimum

capital requirements. The GDP level is expected to decrease by about -0.20% in response to one percentage point increase in the capital ratio. The concern that financial regulation will greatly harm the economy is hence not reflected in most empirical studies. Second, studies in this field of research tend to be highly sensitive to specific modelling assumptions.

There is a high degree of uncertainty surrounding the estimates of primary studies. Our meta-analysis documents that this heterogeneity has also a significant impact on the main results. In general, the estimates are mainly driven by modelling choices (with DSGE and macro models tending to estimate lower impacts, compared to regression-based and VAR models) and the regional focus (with bank-based financial systems showing stronger effects compared to market-based systems). Finally, the surveyed studies may be distorted by significant publication bias. This can be attributed to a relatively strong theoretical consensus that tighter capital requirements will affect the real economy adversely.

## Appendix

**Table A.1: List of surveyed studies**

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**Table A.2: Variable descriptions**

<b>Variables</b>	<b>Definitions</b>
<i><b>Dependent variables</b></i>	
Basel	GDP change in response to an increase in capital regulations by 1 percentage points
Strong	Dummy variable: one if Basel is lower than -0.25 percent of GDP, zero otherwise
<i><b>Publications</b></i>	
Publication year	Continuous variable measured as the deviation from the mean publication year.
Journal	Dummy variable: one if a study is published in a journal, zero otherwise.
Working paper	Dummy variable: one if a study is published in a working paper, zero otherwise.
Public policy report	Dummy variable: one if a study is published as a policy report by public institutions, zero otherwise.
Bank policy report	Dummy variable: one if a study is published as a policy report by banks or other private institutions, zero otherwise.
<i><b>Authors</b></i>	
Banking sector	Dummy variable: one if an author is affiliated with the banking sector, zero otherwise.
Central Bank	Dummy variable: one if an author belongs to Central Bank, zero otherwise.
BIS	Dummy variable: one if an author belongs to BIS (Bank of International Settlement), zero otherwise.
IMF	Dummy variable: one if an author belongs to IMF (International Monetary Fund), zero otherwise.
European Institution	Dummy variable: one if an author belongs to European Institution (European Commission / European Parliament), zero otherwise.
OECD	Dummy variable: one if an author belongs to OECD (Organisation for Economic Co-operation and Development), zero otherwise.
FSA	Dummy variable: one if an author belongs to FSA (Financial Services Authority), zero otherwise.
<i><b>Financial systems</b></i>	
Market-based system	Dummy variable: one if a study relies on a market-based financial system, zero otherwise.

**Table A.2 (Continued)**

<b>Variables</b>	<b>Definitions</b>
<i>Legal origins</i>	
English origin	Dummy variable: one if a study is based on an English origin country, zero otherwise.
French origin	Dummy variable: one if a study is based on a French origin country, zero otherwise.
German origin	Dummy variable: one if a study is based on a German origin country, zero otherwise.
Scandinavian origin	Dummy variable: one if a study is based on a Scandinavian origin country, zero otherwise.
<i>Model classes</i>	
Regression-based models	Dummy variable: one if a study is based on a regression-based approach (OLS, ML, GMM, ECM), zero otherwise.
Mean estimate	Dummy variable: one if a study is based on a mean estimate, zero otherwise.
Median estimate	Dummy variable: one if a study is based on a median estimate, zero otherwise.
Accounting-based models	Dummy variable: one if a study is based on an accounting-based approach (balance sheet identities), zero otherwise.
DSGE models	Dummy variable: one if a study is based on a DSGE (dynamic stochastic equilibrium) model, zero otherwise.
VAR models	Dummy variable: one if a study is based on a VAR (vector auto-regression) model, zero otherwise.
Macro-structural models	Dummy variable: one if a study is based on a structural macroeconomic model, zero otherwise.
CES models	Dummy variable: one if a study is based on a CES (constant elasticity of substitution) production function, zero otherwise.
<i>Definitions</i>	
Long-term estimate	Dummy variable: one if a study is based on a long-term estimate, zero otherwise.
Long horizon	Dummy variable: one if a study is based on a long implementation horizon, zero otherwise.
Monetary policy	Dummy variable: one if a study includes active monetary policy, zero otherwise.

**Table A.3: Descriptive statistics**

<b>Variable</b>	<b>Observations</b>	<b>Mean</b>	<b>St dev.</b>	<b>Min</b>	<b>Max</b>
Basel impact	312	-0.198	0.155	-0.850	-0.01
Strong Basel impact	312	0.244	0.430	0	1
Publication year	312	2010	1.482	2008	2015
Journal	312	0.067	0.251	0	1
Working paper	312	0.554	0.498	0	1
Public policy report	312	0.212	0.409	0	1
Bank policy report	312	0.083	0.277	0	1
Other publication	312	0.083	0.277	0	1
Banking sector	312	0.090	0.286	0	1
BIS	312	0.279	0.449	0	1
Central Bank	312	0.208	0.407	0	1
IMF	312	0.183	0.387	0	1
Europ. Institution	312	0.115	0.320	0	1
OECD	312	0.048	0.214	0	1
FSA	312	0.006	0.080	0	1
Academic institution	312	0.071	0.256	0	1
Market-based system	312	0.237	0.426	0	1
Bank-based system	312	0.763	0.426	0	1
French origin	312	0.138	0.345	0	1
German origin	312	0.106	0.308	0	1
Scandinavian origin	312	0.035	0.185	0	1
Other origin	312	0.465	0.500	0	1
English origin	312	0.256	0.437	0	1
Mean estimate	312	0.061	0.240	0	1
Median estimate	312	0.064	0.245	0	1
Accounting-based models	312	0.192	0.395	0	1
VAR models	312	0.061	0.240	0	1
DSGE models	312	0.112	0.316	0	1
Macro-structural models	312	0.231	0.422	0	1
Production function models	312	0.032	0.176	0	1
Regression models	312	0.247	0.432	0	1
Long-term estimate	312	0.715	0.452	0	1
Long implem. horizon	312	0.878	0.328	0	1
Monetary policy offset	312	0.170	0.376	0	1

*Source:* Own calculations.



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