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Central Bank Financial Strength and Inflation: A Meta-Analysis

Mojmír Hampl and Tomáš Havránek*

Abstract

Several empirical studies have reported that financially weak central banks tend to tolerate systematically higher inflation. If the effect were genuine, central banks would have to pay attention to their capital levels and could not treat them as a residuum. In this note, we take stock of this literature using the statistical techniques of meta-analysis. We collect 176 estimates of the effect of central bank financial strength on inflation and observe that 86% of them are negative, suggesting that low capital levels indeed lead to higher inflation. However, we show that the literature is plagued by publication bias, the preferential reporting of intuitive and significant results. When we correct the literature for this bias, we obtain no evidence for any interplay between central bank financial strength and inflation. The result is robust to employing various meta-regression and nonparametric selection models.

Abstrakt

Řada empirických studií tvrdí, že centrální banky s nízkou úrovní vlastního kapitálu tolerují systematicky vyšší inflaci. Pokud tomu tak skutečně je, centrální banky by měly dbát na úroveň kapitálu a nezacházet s ním pouze jako s reziduem svých politik. V tomto článku poskytujeme kvantitativní shrnutí této literatury za pomoci statistických metod meta-analýzy. Analyzujeme 176 publikovaných odhadů efektu finanční síly centrální banky na inflaci a pozorujeme, že 86 % těchto odhadů je záporných, což by skutečně podporovalo tvrzení, že nízká úroveň kapitálu vede k vyšší inflaci. Ukazujeme ale, že tato literatura trpí silnou publikační selektivitou, tedy důrazem na publikaci intuitivních a statisticky významných výsledků. Když literaturu o toto vychýlení očistíme, zjišťujeme, že v průměru neexistuje žádná evidence pro vliv kapitálu centrálních bank na inflaci. Tento výsledek se nezmění, i když použijeme různé regresní a neparametrické modely publikační selektivity.

JEL Codes: C83, E58.

Keywords: Central bank capital, inflation, monetary policy, publication bias, seigniorage.

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Nontechnical Summary

The typical view among central bankers is that central bank capital is a residuum of monetary policy and not a quantity that would be worth investigating on its own. In the last two decades, this traditional view has been challenged by a series of papers authored or coauthored by Peter Stella (Stella, 2003; Kluh and Stella, 2008; Stella 2011). Stella has shown that at least at some periods and for some central banks, capital matters for inflation. This author suggests that financially weak central banks pursue systematically looser monetary policy because they are tempted to achieve higher seigniorage.

In large countries, perhaps, the relation between inflation and central bank capital may be of only academic importance. However, in small open economies the central bank's assets are typically dominated by foreign currency reserves. Consequently, appreciation of the local currency results in an accounting loss on the portfolio of the central bank, and quite often this loss can outweigh seigniorage profits. Such a scenario is particularly realistic for fast-growing economies that have not yet achieved full convergence vis-à-vis developed countries.

In this note, we provide a meta-analysis of the empirical literature on the nexus between central bank financial strength and price stability. We collect not only Stella's papers but also the studies of researchers who have tested the robustness of his findings using different datasets and methods. After correcting the literature for publication bias, we find that the mean estimate in the literature is consistent with the notion that depleting central bank capital does not compromise long-run inflation performance. This finding has important consequences for potential unconventional monetary policy related to Friedman's original idea of helicopter money (see, for example, Hampl, 2018).

1. Introduction

Central bankers have traditionally viewed capital as a residuum of their policies, not a quantity that is important per se. In a series of papers, however, Peter Stella (Stella, 2003; Kluh and Stella, 2008; Stella, 2011) challenged the conventional view and showed that, at least in some subsamples of central banks, capital seems to matter for monetary policy. In particular, Stella argues that financially weak central banks deliver systematically higher inflation. The intuition for such a finding is clear: if a central bank cares about its capital, it might be tempted to tolerate higher inflation and enjoy higher seigniorage. Several other researchers (for example, Adler et al., 2016; Benecká et al., 2012; Pinter, 2017) have followed Stella's lead and investigated the effect in various settings, using different methods and datasets. Although some of the researchers stress that the effect might depend on the specific conditions of data and methods, most of them (with the prominent exception of Benecká et al., 2012) directly or indirectly corroborate Stella's original conclusions.

The relation between central bank capital and inflation performance may be of only academic interest to many central banks in large countries, but it is crucial for small open economies. In small open economies, the central bank's assets tend to be dominated by foreign currency reserves. Consequently, any appreciation of the country's currency leads to an accounting loss on the central bank's portfolio, and the loss can easily outweigh seigniorage profits. The issue is even more problematic for countries that have not completed the process of convergence wtih the most developed countries and that have historically chosen to avoid substantial inflation during the convergence process. In such cases, convergence leads to a steadily appreciating exchange rate and thus to steady accounting losses for the central bank. Thus, it happens that countries such as the Czech Republic, Israel, and Chile have occasionally even displayed negative levels of capital. Of course, a central bank cannot go bankrupt, and the success these three countries have enjoyed while delivering on their inflation targets casts doubt on the general validity of the negative relation between capital and inflation found in the aforementioned econometric studies.

In this note, we collect all empirical estimates of the effect of central bank financial strength on inflation and examine them econometrically using the techniques of meta-analysis. What we do *not* provide here is a detailed narrative literature survey and nuanced discussion of the methodology employed in these studies; readers interested in a such a treatment will want to review Benecka et al. (2012) or, for more recent developments in this area, the introductory sections of Pinter (2017). We find 176 estimates of the effect, out of which 55% are negative and statistically significant and 86% are negative irrespective of significance. At first glance, therefore, the literature seems to be closely aligned with the original results of Stella. On closer inspection, however, we find that the distribution of estimates is far from the one predicted by both the central limit theorem and the properties of the t-distribution (in particular, the independence of estimates on their standard errors). These findings suggest publication selection bias in the literature.

Publication bias arises when different estimates have a different likelihood of being selected for publication based on their sign and statistical significance, all else being equal. Ioannidis et al. (2017) show how publication bias is widespread in economics. Of course, economics is not unique in this respect; John Ioannidis is famous for showing how much bias there is in medical research, for example. Fortunately, all is not lost in that researchers in medicine and econometrics have devised techniques that can identify the strength of publication bias and provide estimates of the mean effect corrected for the bias. That is the main goal of this note, and we show that regardless of which technique one uses, the literature corrected for publication bias implies no evidence for any relation between central bank capital and inflation performance.

2. Dataset

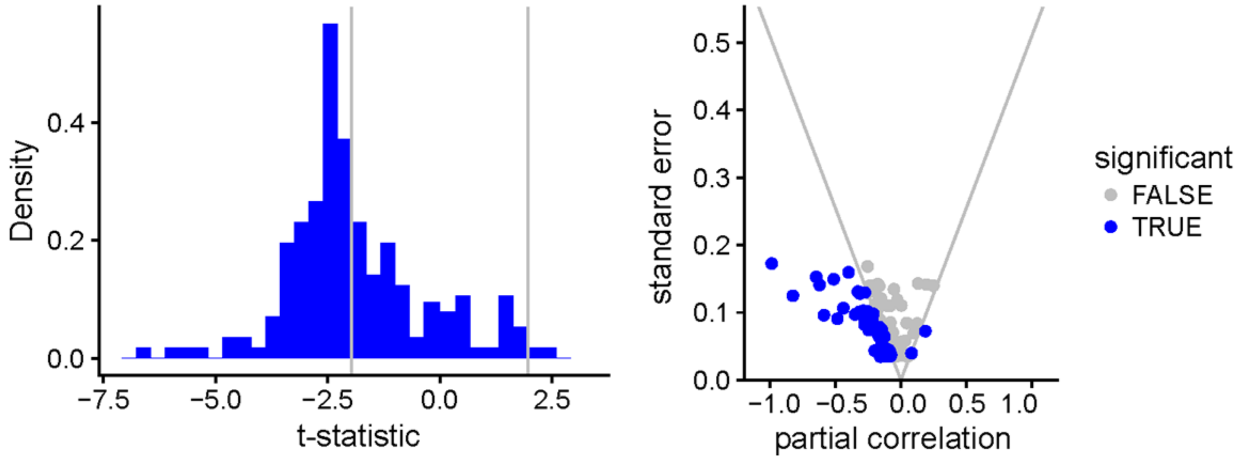
As a first step, we searched for any empirical studies that estimate the nexus between central bank financial strength and inflation performance. We started with the Google Scholar database because it provides powerful full-text search; we looked for studies by using combinations of the following keywords: "central bank capital", "inflation", "central bank financial strength", and "monetary policy". We also inspected the EconLit and Scopus databases, but they did not provide us with any studies on top of what Google Scholar identified. Next, to ensure that we did not miss any important studies, we applied the "snowballing" technique and read through the references and citations of the studies returned from our Google Scholar search.

To be included in the meta-analysis, studies must present an empirical estimate of the effect and the corresponding standard error (or sufficient information so that we can compute the standard error ourselves). Without a standard error, we cannot use up-to-date meta-analysis techniques, so this is a crucial requirement. Apart from this requirement, we follow the advice of Stanley (2001) to rather err on the side of study inclusion in meta-analysis. We include both regression estimates and simple comparisons of groups of central banks with low and high degrees of financial strength (but later in the analysis we also focus on the subsample of the regression estimates). We include both studies that use inflation as the dependent variable and studies that focus on deviations from a historical monetary policy rule (since a negative deviation from the interest rate rule is associated with higher inflation, we multiply these estimates by negative one to ensure basic comparability; again, we later introduce a subset of studies that only focus on inflation).

To use all available information, we also include one study written in Korean. Although neither of us is fluent in Korean, the main regression tables in the paper are presented in English, and Google Translate does a good job at providing us with the necessary context. In total, we collected 176 estimates from nine studies: Adler et al. (2016), Benecka et al. (2012), Ize (2007), Kluh and Stella (2008), Lee and Yoon (2016), Perera et al. (2013), Pinter (2017), Stella (2003), and Stella (2011). We will call these the "primary studies." When we restrict our attention to the subsample of the examinations that focus on the relation between *inflation* (not deviations from an interest rate rule) and central bank financial strength, use regression analysis, control for other characteristics of central banks and are presented in English, we are left with 146 estimates. We will call these the "comparable estimates."

Few estimates in our sample, however, are truly directly comparable. Different studies use different units, definitions of financial strength, and transformations of the variables. Before we proceed with the analysis, it is necessary to convert the estimates into a single common metric. The t-statistic is sometimes used for this purpose in meta-analysis, but the t-statistic depends on sample size and only captures the statistical strength of the relationship. We use the partial correlation coefficient (the partial correlation coefficient is akin to the well-known Pearson correlation coefficient but takes into account the effect of the other variables included in the regression and is described in detail, for example, by Doucouliagos, 2011), which is adjusted for sample size and for which sensible guidelines exist (Cohen, 1988; Doucouliagos, 2011) that can help us evaluate the underlying strength of the relationship. The conversion is straightforward because all the primary studies report the number of observations used in the analysis, so we keep all 176 estimates in our sample.

Figure 1: Distribution of the Reported Estimates



Note: The lines denote the boundaries of statistical significance at the 5% level. A negative partial correlation denotes that researchers find central bank financial strength to support low inflation.

The mean partial correlation coefficient is -0.14, and the median is -0.13 (for the sample of comparable estimates we obtain -0.12 for both the mean and median); both are statistically significant at any reasonable levels. However, correlation coefficients around -0.13 can be considered small according to both Cohen's and Doucouliagos's guidelines. Doucoualigos (2011) shows that approximately 60% of the empirical studies in economics (on any subject) find on average larger effects than 0.13. Nevertheless, 55% of all the estimates in this stream of literature are negative and statistically significant at the 5% level, and 86% of the estimates are negative irrespective of statistical significance. Only two estimates are positive and statistically significant. Nevertheless, Figure 1 casts doubt on the relevance of these simple summary statistics. In particular, a histogram of the t-statistics shows a drastic drop at approximately -2, right at the point at which the estimates cease to be statistically significant. With 176 observations, the central limit theorem should kick in, and we should observe a practically normal distribution of the t-statistics. What is going on here?

3. Publication Bias

The most likely culprit is publication selection. It is notoriously difficult in economics to publish nonsignificant results or results inconsistent with a predominant theory; therefore, authors across various fields have been found to choose which results to report based on the estimates' sign and statistical significance, even in drafts and working papers (Ioannidis et al., 2017; Irsova and Reckova, 2015; Havranek et al., 2015; Havranek et al., 2018c). To be sure, publication bias does not equal data manipulation or fraud and can represent an objectively optimal strategy for authors trying to convey their findings to policymakers (Furukawa, 2018). Moreover, some estimates, though perfectly possible given the sampling error, make little economic sense, so it also makes little sense to build the main conclusion of the paper upon them. However, such selective reporting leads to an exaggeration of the mean reported effect, and any literature review that does not attempt to correct for this bias is incomplete (and likely biased).

In the case of the nexus between inflation performance and central bank financial strength, significantly negative results fit neatly into the mainstream view. Indeed, when the central bank is concerned about its potential or realized losses, it can improve its finances by adopting a more dovish monetary policy compared to what otherwise would be optimal. Nonsignificant results are perhaps less interesting to editors and referees, but they are plausible as well (for example, Hall and Reis, 2015, argue that risks to the financial stability of central banks are remote in practice, although they discuss a scenario in which the decision of the Swiss National Bank to suddenly abandon its peg was influenced by a perceived risk to its financial stability). In contrast, a theory has yet to be developed that would predict a more hawkish stance for financially weak central banks. Perhaps, one can argue that Del Negro and Sims (2015) offer a step in this direction. When economic agents find that the financial strength of a central bank is deteriorating, they expect higher inflation. Given these expectations, the central bank must be more hawkish to deliver on its inflation target. In general, however, significantly positive estimates are considered implausible by most students of the literature. It is worth noting in this context that positive results would be perfectly plausible if we switched the direction of causality: ceteris paribus, higher inflation can be expected to improve central bank financial strength (at least up to a certain point; see, for example, Buiter, 2007). Nevertheless, the discussion in the literature focuses on the opposite causality direction.

However, we cannot observe the estimates that authors choose to hide in their file drawers. Therefore, how can we correct for publication bias? We exploit the property of the methods used by the authors of the primary studies: the ratio of the point estimate of the effect in question to its standard error follows a t-distribution. This property also extends to the partial correlation coefficients. As a consequence, the point estimate and the standard error should be statistically independent quantities. A simple regression of the estimates on their standard errors thus delivers a valid test of publication bias (Egger at al., 1997). The constant of this regression can be interpreted as the mean effect corrected for publication bias (Stanley 2005, 2008; at least when we assume that publication selection is proportional to the standard error); it is the mean effect conditional on the lowest standard error (thus maximum precision) in the literature.

4. Meta-Regression Results

The results of this simple test of publication bias are shown in Table 1. In the first column, we run an ordinary least squares regression. Although we have 176 observations at our disposal for this regression, they are drawn from only 9 studies, and we must consider potential within-study correlation. Because the number of studies is limited, we cannot use classical standard errors clustered at the study level but must employ bootstrapping instead. The result is striking: we find very strong publication bias (according to the classification by Doucouliagos and Stanley, 2013) in favor of negative results and, after correcting for the bias, no underlying relation between central bank financial strength and inflation performance. Studies with low precision tend to select larger negative point estimates, giving rise to the negative correlation.

Table 1: Tests of Publication Bias (all estimates from the primary studies)

	(1) OLS	(2) FE	(3) Study	(4) Precision	(5) IV
Standard error (bias)	-2.354***	-2.392	-2.773***	-2.321***	-2.081***
	(0.589)	(1.708)	(0.441)	(0.380)	(0.405)
Constant (corrected mean)	0.0261	0.0288	0.0428*	0.0238	0.00693
	(0.0316)	(0.0954)	(0.0245)	(0.0197)	(0.0228)
Observations	176	176	176	176	176

Notes: The dependent variable is the partial correlation coefficient. Bootstrapped standard errors are shown in parentheses (accounting for within-study correlation among the estimates). OLS = ordinary least squares regression of estimates on their standard errors. FE = study fixed effects. Study = weighted by the inverse of the number of estimates reported per study; each study has the same weight. Precision = weighted by inverse variance; more precise studies are given more weight. IV = the inverse of the square root of the number of observations is used as an instrument for the standard error. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In the second column we add study-fixed effects to filter out the characteristics idiosyncratic to individual studies (such as study quality). Inevitably, we lose substantial power, not only because we add additional dummy variables but also because we have to omit studies that report only one estimate. The point estimates resulting from this second specification are close to the first one, but their statistical significance decreases threefold. Once again, the corrected mean effect of central bank financial strength on inflation is mildly positive and close to zero.

In the third and fourth columns we employ weighted least squares because plausible arguments can be made for giving certain estimates more weight than others. In particular, some studies report many estimates while, as we have noted, there are some studies with just one estimate. An appealing solution involves weighting the regression by the inverse of the number of estimates reported per study. In this way, each study becomes equally represented. Similar to the baseline OLS results, we obtain evidence for strong and statistically significant publication bias, while the mean underlying effect of central bank financial strength is positive – this time even statistically significant at the 10% level. Next, we weight the estimates by inverse variance. This weighting scheme is widely used in meta-analysis (Stanley and Doucouliagos, 2014) because it offers two intuitive properties: it corrects for the obvious heteroskedasticity present when regressing estimates on their standard errors, and it gives more precise estimates more weight. The results, presented in the fourth column, are for all practical purposes identical to the baseline.

Finally, in the fifth column we present an instrumental variable exercise. The IV specification is crucial to the credibility of our results because in this meta-analysis we do not control for the characteristics of the data and methods employed in the primary studies (given the small number of studies, we do not have sufficient power to do so properly). If a choice of method affects both the point estimate and the standard error in the same direction, the correlation between point estimates and standard errors that we document and present as evidence of publication bias may be spurious. The problem is partly alleviated by the fixed effects estimation, but the endogeneity can easily be of within-study origin, in which case fixed effects do not help. Therefore, we need an instrument for the standard error: a variable that would not be correlated with method choices but would be correlated with the standard error itself. A straightforward candidate is the inverse of the square root of the number of observations in the primary study (following Havranek et al., 2018a; Havranek et al., 2018b) because it is correlated with the standard error by definition (in our dataset, the correlation coefficient exceeds 0.8) but is unlikely to be substantially correlated with the method choices. The IV estimation suggests slightly smaller publication bias compared with the previous cases and a corrected mean effect of central bank financial strength of almost precisely zero.

Table 2: Tests of Publication Bias (comparable estimates)

	(1) OLS	(2) FE	(3) Study	(4) Precision	(5) IV
Standard error (bias)	-2.705***	-2.438	-2.517***	-2.455***	-2.400***
	(0.549)	(1.906)	(0.562)	(0.406)	(0.401)
Constant (corrected mean)	0.0490	0.0321	0.0334	0.0332	0.0298
	(0.0299)	(0.106)	(0.0297)	(0.0205)	(0.0212)
Observations	146	146	146	146	146

Notes: The dependent variable is the partial correlation coefficient. Bootstrapped standard errors are shown in parentheses (accounting for within-study correlation among the estimates). OLS = ordinary least squares regression of estimates on their standard errors. FE = study fixed effects. Study = weighted by the inverse of the number of estimates reported per study; each study has the same weight. Precision = weighted by inverse variance; more precise studies are given more weight. IV = the inverse of the square root of the number of observations is used as an instrument for the standard error. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

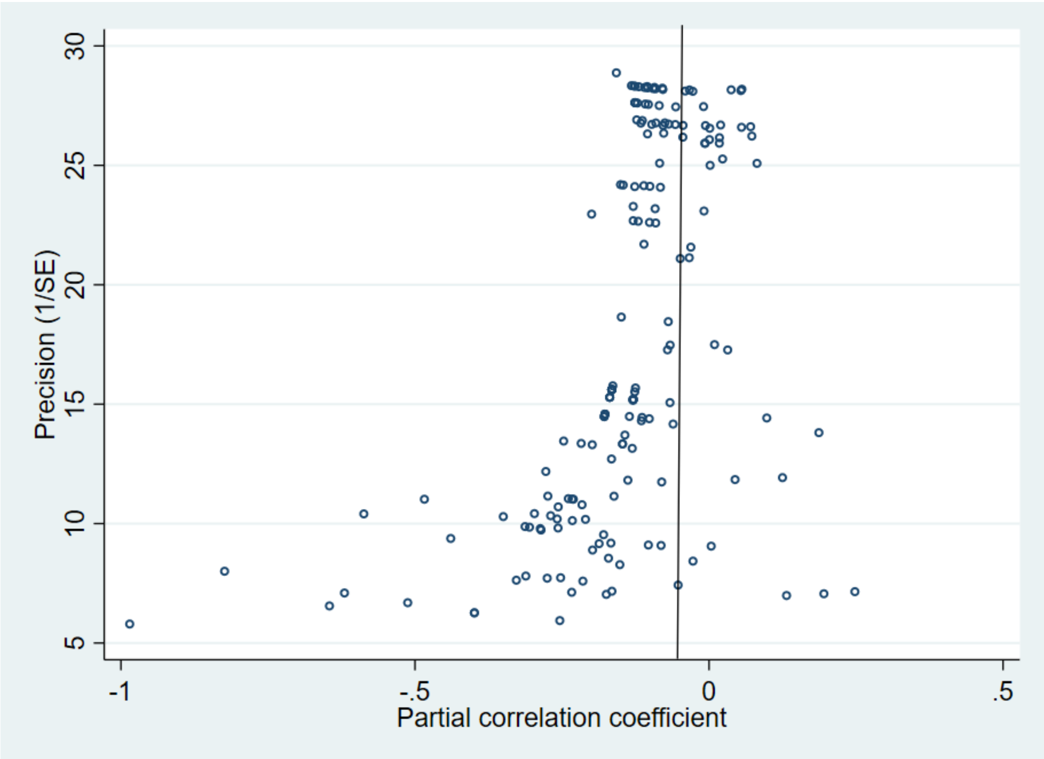
In Table 2, we repeat the analysis described above for the set of comparable estimates (that is, only considering specifications that use inflation as the dependent variable and control for other characteristics of central banks, not just financial strength). Once again, the results are similar to the baseline case, here with somewhat stronger evidence of publication bias.

5. Non-Parametric Estimation

A caveat of our results is that we use a linear approximation of the underlying selection process that gives rise to publication bias (the simple linear regression of the point estimates on their standard errors). In reality, publication bias is a nonlinear function of the standard error, as documented formally by Stanley and Doucouliagos (2014) and, in our case, graphically on the right-hand side of Figure 1. Stanley and Doucouliagos (2014) also show that the problem stemming from the use of the linear approximation disappears when the corrected mean effect approaches zero – this is precisely what we observe in the literature on central bank financial strength and inflation. They recommend using second-order approximation only in the case when the first-order approximation indicates the existence of a nonzero corrected mean.

Recently, Andrews and Kasy (2018) have proposed a nonparametric estimator of the mean effect corrected for publication bias. When applied to our data (which we believe is the first application of this new technique outside the original paper), we obtain a corrected mean estimate of -0.039 with a standard error of 0.018 – thus borderline statistical significance at the 5% level. This is also close to the average of the most precise estimates as shown in the so-called funnel plot (Figure 2; the asymmetry of the funnel plot shows the apparent publication bias because in the absence of publication bias, all imprecise estimates, negative and positive, should be reported with the same frequency and show more dispersion than the densely distributed precise estimates; see Stanley and Doucouliagos, 2010). A partial correlation of -0.039 is considered negligible based on the guidelines of both Cohen (1988) and Doucouliagos (2011).

Figure 2: Funnel Plot



Note: In the absence of publication bias, the estimates should form a symmetrical inverted funnel. Negative estimates denote that researchers find central bank financial strength to support a low-inflation environment. The vertical line denotes the estimate of the underlying mean effect obtained through Andrews and Kasy's (2018) technique.

The technique of Andrews and Kasy (2018) allows us to say more about the sources of publication bias. We compare the ceteris paribus publication probability of the estimates that are significant, respectively, at the 5% level and negative, nonsignificant and negative, nonsignificant and positive, and significant at the 5% level and positive. The estimates that are significant and positive are the most counterintuitive, so it is instructive to normalize the publication probability of this group to one. Consequently, we find that the nonsignificant positive estimates are approximately twice as likely to be published, nonsignificant negative estimates three times as likely to be published, and significant negative estimates 14 times as likely to be published. This formal evidence lines up nicely with what we see in Figure 1 (preference for significant results) and Figure 2 (preference for negative results). In sum, when all the available research is considered and corrected for publication bias, we obtain no evidence of any practically important nexus between central bank financial strength and inflation performance. This observation is corroborated by the fact that several central banks (for example, in Chile, Israel, and the Czech Republic) have provided a low-inflation environment successfully even with occasionally negative levels of capital.

6. Concluding Remarks

In this note, we provide a meta-analysis of the empirical literature on the nexus between central bank financial strength and price stability. After correcting the literature for publication bias, we find that the mean estimate in the literature is consistent with the notion that depleting central bank capital does not compromise long-run inflation performance. This finding has important consequences for potential unconventional monetary policy related to Friedman's original idea of helicopter money (see, for example, Hampl, 2018). We acknowledge that the results of our study should be taken with caution. Due to the small number of available studies we can analyze only 9 papers. However, we believe that with 176 estimates and using appropriate meta-analysis methodology, we provide findings that could be of some interest for central bankers.

Two major qualifications of our results are in order. First, by stressing the importance of publication bias, we do not mean to say that the authors of primary studies would somehow cheat, directly or indirectly. The selective reporting process can be entirely unintentional. Paradoxically, many studies can actually be improved by publication selection. Suppose, for example, that a researcher estimates the effect of central bank capital on inflation using a noisy dataset. Suppose further that the researcher obtains two estimates: one is large and positive (thus unintuitive), the other is close to zero or perhaps slightly negative. In this instance, conventional publication selection favors the latter estimate, and it is indeed more likely that the null result is closer to truth (as we have shown in this note). The problem is that publication selection creates a systematic bias on the level of the entire literature, thereby blurring and distorting the policy message that the literature intends to convey.

The second qualification of our results is a technical one and concerns endogeneity. Throughout the paper, we have chosen to interpret the effect of central bank capital on inflation performance as a causal effect because this is the language most authors in the literature use. We must note, however, that most estimations in the literature make no attempt to move beyond correlation and estimate a truly causal relationship. It is true that those studies that attempt to isolate the causal effect do not generally find much difference from the simple correlation, but one cannot fully discard the idea that, at the level of the entire literature, the treatment of endogeneity matters and might distort our results. The reason is that, of course, higher inflation leads to more financial strength of the central bank via higher seigniorage. Thus, it is possible that the genuine effect estimated in the literature is indeed negative but obscured, with the positive correlation stemming from the opposite causality direction. Nevertheless, the existing data provide little evidence for such an assertion.

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