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Macroeconomic Impacts of FDI in Transition Economies: A Meta-Study[†]

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Abstract: In this paper, we conduct a meta-analysis of the literature that empirically examines the impact of foreign direct investment (FDI) on economic growth in Central and Eastern Europe and the former Soviet Union. We found that existing studies indicate a growth-enhancing effect of FDI in the region as a whole. The results of our meta-regression analysis suggest that the effect size and statistical significance of the reported estimates strongly depend on study conditions. In particular, the estimation period, data type, estimator, and type of FDI variable are important factors that explain the heterogeneity in the empirical results. The degree of freedom and the research quality greatly affect estimates of the FDI variable as well. We also found that the relevant studies fail to present genuine evidence of a non-zero FDI effect due to the presence of publication selection bias and insufficient numbers of empirical evidence. More research is necessary to identify the true effect.

JEL classification numbers: F21, F23, F43, F62, P33

Key words: economic transition, macroeconomic impacts of FDI, meta-analysis, publication selection bias, Central and Eastern Europe, former Soviet Union

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1. Introduction

When the transition toward a market economy began in Central and Eastern Europe (CEE) and the former Soviet Union (FSU), it was widely expected among academic researchers that foreign direct investment (FDI) could play a significant role in economic recovery in this region. Nevertheless, due to disappointing trends in foreign capital inflow in the 1990s combined with various technical constraints, including limited data availability and accessibility, empirical studies of FDI were far from adequate in terms of both quality and quantity throughout the first decade of transition. However, this shortage of studies was greatly ameliorated thanks to active research activities conducted in the 2000s with a remarkable increase of FDI during the same period. Now the number of studies on this topic has reached a certain level, and, thus, it may enable us to draw a general picture regarding the role of FDI in transition economies.

One of the issues of great interest is whether FDI produced sufficient effects to encourage economic growth in the post-communist states. As Doucouliagos et al. (2010) pointed out, however, the economic theory does not support the positive effect of FDI in this respect. In fact, according to the neoclassical growth theory, where FDI is deemed to be a pure factor input, FDI's effects on economic growth in the long term are neutral, although it does affect the national income level. This is because the growth rate will converge in the long run as the marginal product of capital diminishes its returns over time, even if the exogenous increase in capital realized in the form of capital inflow from foreign countries may temporarily expand production.[1]

In contrast, according to the endogenous growth theory, where attention with regard to FDI is focused on its function as a delivery vehicle to transfer excellent technology, knowledge, and know-how accumulated in developed economies, FDI will then be able to have positive effects on long-term economic growth as well as long as it brings about improvements in technology systems and/or human capital in the recipient countries through the contribution of foreign participation in management, the establishment of local subsidiaries by multinational enterprises, the outsourcing of contracts between local and foreign firms, and so forth (Grossman and Helpman, 1991; Aghion and Howitt, 1997). As Borensztein et al. (1998) argue, the growth-enhancing effects of FDI largely depend on the absorption capability of local entities (i.e., domestic firms and workers). Nevertheless, on the assumption of a high level of education and sufficient penetration of modern rationalism in the former socialist bloc, many researchers anticipated that the possibility of such effects would never be low in transition

[1] In sum, from the standpoint of the neoclassical school, FDI would only have a continuing impact on economic growth when it has a positive effect on the technological progress that is exogenous to economic systems.

economies (UNECE, 2001).

However, FDI might rather negatively affect economic growth in the recipient countries if it hampers domestic investment. In fact, Mišun and Tomšík (2002) reported that Poland experienced the crowding out of domestic investment by FDI during the period between 1990 and 2000.[2] Moreover, Kosová (2010) has also found that, in the Czech Republic, the new entry of foreign-affiliated firms significantly pushed up the ex post exit rate of domestic firms during the period between 1994 and 2001. Taking into account the weak management base and backward production technology of former socialist enterprises in comparison with multinational corporations based in developed economies, it is highly likely that such negative external effects took place in many transition economies.

Moreover, as pointed out by Easterly (1993), the exemptions from corporate income tax and other FDI-friendly policies to attract foreign firms might negatively affect economic growth if these measures heavily distort incentives for domestic entities. It is a well-known fact that CEE countries launched extremely preferential policies to induce FDI in a competitive manner (Cass, 2007; Ikemoto et al., 2008). Hence, we cannot rule out the possibility that what Easterly (1993) has called the "adverse incentive effect" might have actually had a negative impact on domestic firms in these states.

As mentioned above, FDI has the potential to bring about both positive and negative macroeconomic effects for the recipient countries, but it is extremely difficult to theoretically predict the respective degree of these countervailing effects, and, thus, economists should leave this issue to empirical research. As we report later, however, the empirical results reported in the previous studies regarding the causality between FDI and macroeconomic growth in CEE and the FSU are too mixed to draw a conclusion by simply looking at them. To overcome this problem, we have conducted a meta-analysis of the literature that examines the macroeconomic impacts of FDI in transition economies. More specifically, we have asked the following questions: What do existing studies tell us about the macroeconomic impact of FDI as a whole? What determines the differences in the empirical evidence reported in these studies? Is there any artificial bias in their publication, and, if there is, are the relevant studies sufficient for identifying the true effects of FDI on economic growth beyond such a bias?

To address these issues, the remainder of this paper is organized as follows: The next section describes our methodology of literature selection and meta-analysis. Section 3 gives an overview of selected studies for meta-analysis. Section 4 demonstrates synthesis of collected estimates. Section 5 performs meta-regression analysis to explore the observed

[2] In this regard, however, Mišun and Tomšík (2002) also reported that Hungary during the period between 1990 and 2000 and the Czech Republic between 1993 and 2000 had both experienced the crowding-in effect of FDI to induce domestic investment.

heterogeneity between studies. Section 6 assesses publication selection bias. Section 7 summarizes the major findings and concludes the paper.

2. Methodology of Literature Selection and Meta-Analysis

In this section, we describe our methods of selecting and coding of relevant studies and for meta-analysis based on the empirical evidence collected.

In order to identify studies related to FDI in the CEE and FSU countries as a base collection, we first searched the Econ-Lit and Web of Science databases for research works that had been registered in the 24 years from 1989 to 2012 that contained a combination of two terms consisting of one from "*foreign direct investment*," "*FDI*," or "*multinational enterprise*" and another one from "*transition economies*," "*Central Europe*," "*Eastern Europe*," "*former Soviet Union*," or the respective names of each CEE and FSU country. Among about 500 studies that we found at this stage, we actually obtained more than 350 studies, or about 70%, of the total. We also searched the references in these 350 or more studies and obtained about 50 additional papers.[3] As a result, we collected nearly 400 studies.

Next, we closely examined the contents of these approximately 400 studies and narrowed the literature list to those containing estimates that could be subjected to meta-analysis in this paper. In the next section, we report its results in detail. During this process, we decided to exclude all unpublished research works. According to Doucouliagos et al. (2012), unpublished working papers might present estimates that cannot be said to be final, and, moreover, these manuscripts are more likely to be insufficient since they had not yet gone through the peer review process. In our judgment, the same concerns can be applied also to the unpublished works obtained by us for this study, to a great extent. Another reason to exclude unpublished works is that we use the quality level of each paper that is evaluated on the basis of external indicators as a weight for a combination of statistical significance levels and as an analytical weight or a meta-independent variable for the meta-regression analysis (MRA). In addition, the following facts also motivate us to take this measure: First, the number of working papers is not very large in our case. Second, these unpublished works are not heavily concentrated in recent years. The latter fact led us to decide that there is no particular concern about overlooking the latest research results due to their exclusion.

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[3] Studies that we gave up obtaining at this stage can be categorized into the following groups: (1) either academic books that are not housed in higher education institutions nor research institutions in Japan or academic journals (including electronic ones) that are not subscribed to by these institutions; (2) studies of which copies could not be obtained from abroad via the respective organizations of the authors; and (3) studies written in languages other than English, Japanese, Russian, or Hungarian.

In this study, we adopted an eclectic coding rule to simultaneously mitigate the following two selection problems: One is the arbitrary-selection problem caused by data collection in which the meta-analyst selects only one estimate per study. The second is over-representation caused by data collection in which all estimates are taken from every study without any conditions. More specifically, we have not necessarily limited the selection to one estimate per study, but multiple estimations have been collected if and only if we could recognize notable differences from the viewpoint of empirical methodology in at least one item of the target regions/countries, data type, regression equation, estimation period, and estimator. Hereafter, K denotes the total number of collected estimates (k=1, 2, ..., K).

Next, we outline the meta-analysis to be conducted in the following sections. In this study, we have employed the partial correlation coefficient (PCC) and the t value to synthesize the collected estimates. The PCC is a measure of association of a dependent variable and the independent variable in question when other variables are held constant. The PCC is calculated in the following equation:

$$r_k = \frac{t_k}{\sqrt{t_k^2 + df_k}}, \quad (1)$$

where t_k and df_k denote the t value and the degree of freedom of the k-th estimate, respectively. The standard error (SE) of r_k is given by $\sqrt{(1-r_k^2)/df_k}$.[4]

The following method is applied for synthesizing PCCs. Suppose there are K estimates. Here, the PCC of the k-th estimate is labeled as r_k, and the corresponding population and standard deviation are labeled as θ_k and S_k, respectively. We assume that $\theta_1 = \theta_2 = \ldots = \theta_K = \theta$, implying that each study in a meta-analysis estimates the common underlying population effect and that the estimates differ only by random sampling errors. An asymptotically efficient estimator of the unknown true population parameter θ is a weighted mean by the inverse variance of each estimate:

$$\bar{R} = \sum_{k=1}^{K} w_k r_k \Big/ \sum_{k=1}^{K} w_k, \quad (2)$$

where $w_k = 1/v_k$ and $v_k = s_k^2$. The variance of the synthesized partial correlation $\bar{R}$ is given by: $1/\sum_{k=1}^{K} w_k$.

[4] A benefit of the PCC is that its use makes comparing and synthesizing collected estimates easier concerning independent variables of which the definitions or units differ. On the other hand, a flaw of the PCC is that its distribution is not normal when the coefficient is close to -1 and +1 (Stanley and Doucouliagos, 2012, p. 25). Fisher's z-transformation $\left(z = \frac{1}{2}\ln\left(\frac{1+r}{1-r}\right)\right)$ is the most well-known solution to this problem. As in overall economic studies, the PCC of each estimate to be used for our meta-analysis is rarely observed to be close to the upper or lower limit, and thus we used the PCC calculated in Eq. (1). Nevertheless we have confirmed that even if a z-transformed PCC is used, the results of meta-analysis in this paper are not greatly different.

This is the meta fixed-effect model. Hereafter, we denote the estimates of the meta fixed-effect model using $\overline{R_f}$. In order to utilize this method to synthesize PCCs, we need to confirm that the estimates are homogeneous. A homogeneity test uses the statistic:

$$Q_r = \sum_{k=1}^{K} w_k \left(r_k - \overline{R_f}\right)^2 \sim \chi^2(K-1), \quad (3)$$

which has a Chi-square distribution with N-1 degrees of freedom. The null hypothesis is rejected if Q_r exceeds the critical value. In this case, we assume that heterogeneity exists among the studies and adapt a random-effects model that incorporates the sampling variation due to an underlying population of effect sizes as well as the study-level sampling error. If the deviation between estimates is expressed as δ_θ^2, the unconditional variance of the k-th estimate is given by $v_k^u = \left(v_k + \delta_\theta^2\right)$. In the meta random-effects model, the population θ is estimated by replacing the weight w_k with the weight $w_k^u = 1/v_k^u$ in Eq. (2).[5] For the between-studies variance component, we use the method of moment estimator computed by the next equation using the value of the homogeneity test statistic Q_r obtained from Eq. (3):

$$\hat{\delta}_\theta^2 = \frac{Q_r - (K-1)}{\sum_{k=1}^{K} w_k^u - \left(\sum_{k=1}^{K} w_k^{u^2} / \sum_{k-1}^{K} w_k^u\right)}. \quad (4)$$

Hereafter, we denote the estimates of the meta random-effects model as $\overline{R_r}$.

Following Djankov and Murrell (2002), we combine t values using the next equation:[6]

$$\overline{T_w} = \sum_{k=1}^{K} w_k t_k \Bigg/ \sqrt{\sum_{k=1}^{K} w_k^2} \sim N(0,1). \quad (5)$$

Here, w_k is the weight assigned to the t value of the k-th estimate. As the weight w_k in Eq. (5), we utilize a 10-point scale to mirror the quality level of each relevant study$(1 \leq w_k \leq 10)$. More concretely, if the concerned study is a journal article, the quality level is determined on the basis of the economic journal's ranking and the impact factor. If it is either a book or a book chapter, the quality level is determined on the basis of the presence or absence of a peer review process and literature information, such as the publisher.[7] Moreover, we report not only the combined t value $\overline{T_w}$ weighted by the quality level of the study, but also the unweighted combined t value $\overline{T_u}$ that is obtained according to the following equation:

$$\overline{T_u} = \sum_{k=1}^{K} t_k \Big/ \sqrt{K} \sim N(0,1). \quad (6)$$

[5] This means that the meta fixed-effect model is a special case based on the assumption that $\delta_\theta^2 = 0$.

[6] Iwasaki (2007) and Wooster and Diebel (2010) also adopt this combination method of the t value.

[7] For more details on the evaluation method of the quality level, see Appendix A of this paper.

By comparing these weighted and unweighted t values, we examine the relationship between the quality level and the level of statistical significance reported by each study.

As a supplemental statistic for evaluating the reliability of the above-mentioned combined t value, we also report Rosenthal's fail-safe N (*fsN*) as computed by the next formula:

$$fsN\ (p = 0.05) = \left(\frac{\sum_{k=1}^{K} t_k}{1.645}\right)^2 - K. \quad (7)^8$$

Following the synthesis of collected estimates, we conduct MRA to explore the factors causing heterogeneity between selected studies. To this end, we estimate the meta-regression model:

$$y_k = \beta_0 + \sum_{n=1}^{N} \beta_n x_{kn} + e_k\,,\ \ k = 1, 2, \cdots, K,\ \ (8)$$

where y_k is the PCC or the t value of the k-th estimate; x_k denotes a meta-independent variable that captures relevant characteristics of an empirical study and explains its systematic variation from other empirical results in the literature; β_n denotes the meta-regression coefficient to be estimated; and e_k is the meta-regression disturbance term (Stanley and Jarrell, 2005).

When selecting an estimator for meta-regression models, we should pay most attention to heterogeneity among selected studies. It is especially true for our case where multiple estimates are to be collected from one study. Therefore, we perform MRA using the following 6 estimators: the cluster-robust ordinary least squares (OLS) estimator that clusters the collected estimates by study and computes robust standard errors; the cluster-robust weighted least squares (WLS) estimator that uses either the above-mentioned quality level of the study, the number of observations, or the inverse of the standard error (1/*SE*) as an analytical weight; the multilevel mixed effects restricted maximum likelihood (RML) estimator; and the unbalanced panel estimator.[9] In this way, we check the statistical robustness of coefficient β_n.

Testing for publication selection bias is an important issue on par with the synthesis of estimates and meta-regression of heterogeneity among different studies. In this paper, we examine this problem by using the funnel plot and the Galbraith plot as well as by estimating

[8] Rosenthal's fail-safe N denotes the number of studies when the average effect size, which needs to be added in order to bring the combined probability level of the entire studies to the standard significance level to determine the presence or absence of effect, becomes equal to zero. The larger value of *fsN* in Eq. (7) denotes the more reliable estimation of the combined t value. For more details, see Mullen (1989) and Stanley and Doucouliagos (2012).

[9] This refers to the random-effects and fixed-effects estimators. The unbalanced panel estimator is selected on the basis of the Hausman test of the random-effects assumption. We also report the result of the Breusch-Pagan test to test the null hypothesis that the variance of the individual effects is zero in order to question whether the panel estimation itself is appropriate. We set the critical value for both of these model specification tests at a 10% level of significance.

the meta-regression model that is designed especially for this purpose.

The funnel plot is a scatter plot with the effect size (in the case of this paper, the PCC) on the horizontal axis and the precision of the estimate (in this case, 1/SE) on the vertical axis. In the absence of publication selection, effect sizes reported by independent studies will vary randomly and symmetrically around the true effect. Moreover, according to the statistical theory, the dispersion of effect sizes is negatively correlated with the precision of the estimate. Therefore, the shape of the plot must look like an inverted funnel. This means that if the funnel plot is not bilaterally symmetrical but is deflected to one side, then it is suspected that there is an arbitrary manipulation in the study area in question in the sense that estimates in favor of a specific conclusion (i.e., estimates with an expected sign) are more frequently published (type I publication selection bias).

Meanwhile, the Galbraith plot is a scatter plot with the precision of the estimate (in the case of this paper, 1/SE) on the horizontal axis and the statistical significance (in this case, the *t* value) on the vertical axis. We use this plot for testing another arbitrary manipulation in the sense that estimates with higher statistical significance are more frequently published, irrespective of their sign (type II publication selection bias). In general, the statistic, $|(\text{the } k-\text{th estimation} - \text{the true effect})/SE_k|$, should not exceed the critical value of ±1.96 by more than 5% of the total estimates. In other words, when the true effect does not exist and there is no publication selection, the reported *t* values should vary randomly around zero, and 95% of them should be within the range of ±1.96. The Galbraith plot tests whether the above relationship can be observed in the statistical significance of the collected estimates, and thereby identifies the presence of type II publication selection bias. In addition, for the above reasons, the Galbraith plot is also used as a tool to test the presence of a non-zero effect.[10]

In addition to the two scatter plots, we also report estimates of the meta-regression models, which are developed to examine the two types of publication selection bias and the presence of the true effect in a more rigorous manner.

We can test for type I publication selection bias by regressing the *t* value of the *k*-th estimate on the inverse of the standard error (1/SE) using the following equation:

$$t_k = \beta_0 + \beta_1(1/SE_k) + v_k, \quad (9)$$

and thereby testing the null hypothesis that the intercept term β_0 is equal to zero.[11] In Eq. (9),

[10] For more details, see Stanley (2005) and Stanley and Doucouliagos (2009).

[11] Eq. (9) is an alternative model to the following meta-regression model that takes the effect size as the dependent variable and the standard error as the independent variable:

$$\text{effect size}_k = \beta_0 SE_k + \beta_1 + \varepsilon_k. \quad (9b)$$

More specifically, Eq. (9) is obtained by dividing both sides of the above equation by the standard error. The error term ε_k in Eq. (9b) does not often satisfy the assumption of being i.i.d.

v_k is the error term. When the intercept term β_0 is statistically significantly different from zero, we can interpret that the distribution of the effect sizes is asymmetric. For this reason, this test is called the funnel-asymmetry test (FAT). Meanwhile, type II publication selection bias can be tested by estimating the next equation, where the left side of Eq. (9) is replaced with the absolute t value:

$$|t_k| = \beta_0 + \beta_1(1/SE_k) + v_k \quad (10)$$

thereby testing the null hypothesis of $\beta_0 = 0$ in the same way as the FAT.

Even if there is a publication selection bias, a genuine effect may exist in the available empirical evidence. Stanley and Doucouliagos (2012) propose examining this possibility by testing the null hypothesis that the coefficient β_1 is equal to zero in Eq. (9). The rejection of the null hypothesis implies the presence of a genuine effect. They call this test the precision-effect test (PET). Moreover, they also state that an estimate of the publication-bias-adjusted effect size can be obtained by estimating the following equation that has no intercept:

$$t_k = \beta_0 SE_k + \beta_1(1/SE_k) + v_k, \quad (11)$$

thereby obtaining the coefficient β_1. This means that if the null hypothesis of $\beta_1 = 0$ is rejected, then the non-zero effect does actually exist in the literature, and that the coefficient β_1 can be regarded as its estimate. Stanley and Doucouliagos (2012) call this procedure the precision-effect estimate with standard error (PEESE) approach.[12] To test the robustness of the regression coefficient, we estimate Eq. (9) to (11) above using not only the OLS estimator, but also the cluster-robust OLS estimator and the unbalanced panel estimator,[13] both of which treat possible heterogeneity among the studies.

To sum up, for testing publication selection bias and the presence of genuine empirical

(independent and identically distributed). In contrast, the error term in Eq. (9), $v_k = \varepsilon_k/SE_k$, is normally distributed, and thus it can be estimated by OLS. Type I publication selection bias can also be detected by estimating Eq. (9b) using the WLS estimator with the inverse of the squared standard error $(1/SE_k^2)$ as the analytical weight and, thereby, testing the null hypothesis of $\beta_0 = 0$ (Stanley, 2008; Stanley and Doucouliagos, 2012, pp. 60–61).

[12] You can see that the coefficient β_1 in Eq. (11) may become the estimate of the publication-bias-adjusted effect size in light of the fact that the following equation is obtained when both sides of Eq. (11) are multiplied by the standard error:

$$\text{Effect size}_k = \beta_0 SE_k^2 + \beta_1 + \varepsilon_k. \quad (11b)$$

When directly estimating Eq. (11b), the WLS method, with $1/SE_k^2$ as the analytical weight, is used (Stanley and Doucouliagos, 2012, pp. 65–67).

[13] To estimate Eqs. (9) and (10), we use either the random-effects estimator or the fixed-effects estimator according to the results of the Hausman test of the random-effects assumption. With regard to Eq. (11), which does not have an intercept term, we report the random-effects model estimated by the maximum likelihood method.

effects, we take the following four steps: First, we test the type I publication selection bias by estimating Eq. (9) to examine the FAT and the type II publication selection bias by estimating Eq. (10). Second, if publication selection bias is detected, we conduct PET to test whether there is a genuine effect in the collected estimates beyond publication selection. Third, in cases where the null hypothesis of the PET is rejected, we obtain an estimate of β_1 in Eq. (11) using the PEESE approach. Finally, if β_1 in Eq. (11) is statistically significantly different from zero, we report β_1 as the estimate of the publication-selection-bias-adjusted effect size. In cases where the null hypothesis of PET is accepted, we judge that the literature in question fails to provide sufficient evidence to capture the genuine effect.[14]

3. Overview of Selected Studies for Meta-Analysis

In accordance with the method of literature selection described in the previous section, we selected a total of 21 studies that contain estimates suitable for meta-analysis in this paper. **Table 1** outlines these studies. In the *Economic Survey of Europe 2001*, the United Nations Economic Commission for Europe pointed out that "studies of the impact of FDI on GDP in the transition economies are lacking" (UNECE, 2001, p. 204) under the background of the scarcity of time series data available for empirical analysis and poor investment results throughout the 1990s. However, as **Table 1** shows, this academic vacuum at the beginning of the new century has been largely filled by subsequent research efforts.

According to our survey results, Barrell and Holland (2000) is a pioneering study that empirically examines the macroeconomic effects of FDI in transition economies. They report a positive and statistically significant correlation between FDI and the total value added per worker in the manufacturing sectors in Hungary, Poland, and the Czech Republic. Since its publication, empirical works in this research area have been published almost every year, with Weber (2011) being the latest. However, as reported in **Table 1**, the target countries for these 21 studies are heavily distorted toward a handful of nations. In fact, the total number of countries covered in these studies is 225, of which 67.1% (151 countries) belong to the CEE countries that joined the EU in either 2004 or 2007. Meanwhile, the share of non-EU CEE and FSU countries, excluding the three Baltic countries, accounted for only 11.1% (25 countries) and 20.8% (47 countries), respectively. Lyroudi et al. (2004) and Apergis et al. (2008) also include Mongolia in their target countries.

Empirical analysis in the 21 studies above covers the 20 years from 1990 to 2009 as a

[14] As mentioned above, we basically followed the FAT-PET-PEESE approach advocated by Stanley and Doucouliagos (2012, pp. 78–79) as the test procedures for publication selection. However, we also included a test of type II publication selection bias using Eq. (10) as our first step as this kind of bias is very likely in the literature regarding FDI in transition economies.

whole. The average estimation period of collected estimates is 10.6 years (median: 11; standard deviation: 3.4). Fifteen studies use panel data, while six studies employ time series data. Sixteen out of the 21 studies use GDP as the benchmark index for the macroeconomic variable to be introduced in the left side of their respective regression models. The remaining five studies deal with either the gross value added to the manufacturing industry (Barrell and Holland, 2000), the gross industrial production (Kutan and Yigit, 2009; Sridharan et al., 2009; Fidrmuc and Martin, 2011), or the value added by the industrial sector (Bijsterbosch and Kolasa, 2010) in order to measure macroeconomic growth in their target countries. As for the scale of economic growth, eight studies adopt the level of output volume, seven studies choose the change in output volume, five studies take the level of productivity, and the remaining one by Nath (2009) selects the change in productivity level.

Meanwhile, with regard to the FDI variable, which is to be introduced together with other variables in the right side of the regression models, there is more variation in the types. In fact, according to **Table 1**, the FDI to GDP ratio, which is the most widely used variable type, has been adopted by eight studies. This type is followed by the cumulative investment value (four studies), the annual capital inflow (four studies), and the cumulative investment per capita or worker (three studies). In addition, the FDI to the total value added ratio, the FDI to the gross fixed capital formation ratio, the growth rate, and others are adopted by one of two studies for their empirical analyses.

From these 21 studies, we collected a total of 110 estimates (5.2 per study, on average) in accordance with the coding policy stated in the previous section. As implied in the average precision (*AP*) by study reported in the right column of **Table 1**, they differ substantially. According to our bold classification of the empirical results in these studies, 11 studies report positive and statistically significant macroeconomic impacts of FDI, while Mencinger (2003) takes a pessimistic view of the role of FDI in macroeconomic growth with negative and significant estimates of the FDI variable. The remaining nine studies either detect no significant macroeconomic impact of FDI or reported that the FDI variable is not statistically robust. We conjecture that the above-mentioned differences in empirical methodologies resulted in such mixed results among the relevant studies. In the following sections, we further explore this point by the meta-analysis.

4. Synthesis of Estimates

Figure 1 illustrates a frequency distribution of the PCC and that of the *t* value using 110 estimates collected from the 21 studies listed in **Table 1**. As Panel (a) of this table shows, the PCC draws a normal distribution with the mode of 0.25 (goodness-of-fit test: χ^2=21.176, p=0.218). According to Cohen's (1988) guidelines, 12.7% (14 estimates) find no practical relationship ($|r|<0.1$) between FDI and macroeconomic growth in transition economies, while 50% (55 estimates) and the remaining 37.2% (41 estimates) report a small effect ($0.1\leq|r|\leq0.3$) and a large effect ($0.3<|r|$), respectively. Meanwhile, as seen in Panel (b) of **Figure 1**, the *t* value shows a skewed distribution toward the positive direction longwise with the mode of 2.75 (goodness-of-fit test: χ^2=143.952, p=0.000), and the estimates with respective absolute *t* values that are equal to or exceed 2.0 account for 65.5% (72 estimates) of the total. Therefore, it can be said that the above 21 studies as a whole emphasize the presence of statistically significant and practically meaningful effects of FDI on macroeconomic growth in the CEE and FSU countries.

As shown in **Table 1**, the estimation period of each study varies significantly, and it is possible that this difference might have had a certain influence on the empirical results. In fact, **Figure 2** shows an upward trend in the collected estimates in chronological order. According to the approximate straight lines drawn in this figure, when there is a one-year extension in the average estimation period, the PCC and the *t* value increase by 0.016 and 0.206, respectively. This result may suggest that the more the market mechanism is established in tandem with the progress in the systemic transformation, the more clearly the growth-enhancing effects of FDI tend to be actualized.

Table 2 performs synthesis of the collected estimates. In addition to the overall synthesis results shown on the top line, this table also reports results focusing on the differences in data types and benchmark indices for and types of the macroeconomic variable, as well as the type of FDI variable in light of the discussion in the previous section. As shown in Panel (a) of the table, which reports the synthesis results of the PCC, the homogeneity test rejects the null hypothesis in every case and, thus, the synthesized effect size $\overline{R_r}$ of the random-effects model is adopted as the reference value. Here, the synthesized PCC of all the studies is 0.216 with the statistical significance at the 1% level. The presence of statistically significant positive macroeconomic effects of FDI can be found under all conditions, with the only exception being a study in which the percentage of change in productivity is adopted as a type of macroeconomic variable. However, the magnitude of the synthesized effect size remarkably differs between subjects of comparison. More specifically, studies that conducted a time series data analysis tend to report larger positive effects of FDI on macroeconomic growth than do those performing a panel data analysis. The same applies to the relationship between non-GDP and GDP macroeconomic variables, that between production volume and productivity growth indices, and that between cumulative investment value and other types of FDI variables.

Panel (b) of **Table 2** shows the results of the combination of the *t* value. Here, we can see that the combined *t* value $\overline{T_w}$ that is weighted according to the quality level of the study is not only substantially lower than the unconditionally combined *t* value $\overline{T_u}$, but the combined *t* value $\overline{T_w}$ reported in studies where the percentage change in productivity is adopted as the type of macroeconomic variable and that in studies where the FDI to GDP ratio is adopted as the type of FDI variable is below the 10% level in terms of its statistical significance. These results suggest that there may be a strongly negative correlation between the quality level of the study and the reported *t* value. The fail-safe N (*fsN*) in the right column of **Table 2** shows a sufficiently large value, except for the above two cases. This means that, even taking into consideration the presence of unpublished working papers that have been omitted from our meta-analysis, the overall research implications obtained from the selected studies cannot easily be dismissed.

5. Meta-Regression Analysis of Heterogeneity among Studies

As indicated in **Figure 2** and **Table 2**, the empirical evidence concerning the macroeconomic impact of FDI is largely affected by the estimation period and other conditions. In order to scrutinize this issue more rigidly, we estimated a meta-regression model that takes either the PCC or the *t* value of a collected estimate as the dependent variable. **Table 3** lists the names, definitions, and descriptive statistics of meta-independent variables to be introduced in the right side of the regression model defined in Eq. (8). As this table shows, in our MRA, we examined whether and how empirical evidence from the existing literature is affected by differences in the composition of target countries, the estimation period, the data type, the estimator, the benchmark index/type for the macroeconomic variable, the type of FDI variable, and the degree of freedom as well as the quality level of the study.

Table 4 reports the estimation results. With regard to unbalanced panel regression models [6] and [12], the null hypothesis is not rejected by the Hausman test in both cases, and, hence, we report the random-effects models. At the same time, however, the Breusch-Pagan test accepts the null hypothesis that the variance of the individual effects is zero. Therefore, the estimation results of the random-effects model are rarely different from those of the OLS model. The WLS models are sensitive to the choice of analytical weights. Nevertheless many variables are significantly estimated uniformly. The coefficient of determination (R^2), which indicates the explanatory power of an entire model, ranges from 0.423 (Model [3]) to 0.636 (Model [8]). This is a sufficient level in comparison to similar meta-studies.

Based on **Table 4**, we can confirm the following: First, the composition of target countries does not have a significant influence on the estimates collected from the relevant studies. In other words, the existing literature mainly treats CEE EU countries, but even if non-EU CEE and FSU countries are more frequently covered in empirical analyses from now on, we can predict that the effect size of FDI and its statistical significance will be more likely to match those of the preceding studies.

Second, with regard to the relationship between the observed macroeconomic effect of

FDI and the initial year of the estimation period, the higher the number of years between the collapse of socialism and the start of the estimation, the greater the positive FDI impact that can be verified with higher statistical significance. In fact, every time the initial year of the estimation period is set forward by one year, the PCC and the *t* values increase by more than 0.03 and about 0.50, respectively. At the same time, we can also say that if the initial year of the estimation period is the same, the longer the estimation period, the greater the statistical significance and the stronger the positive FDI effect.

Third, in contrast to the synthesis results of estimates reported in Panel (a) of **Table 2**, the MRA results suggest that the panel data analysis tends to find the positive macroeconomic effects of FDI with greater significance than the time series data analysis. Indeed, on average, estimates of the time series data analysis are lower than those of the panel data analysis by a range of 0.35 to 0.42 in terms of the PCC and by a range of 4.36 to 5.73 in terms of the *t* value. Different estimators also greatly affect the estimation results. Actually, as compared with the estimation results using the OLS estimator, the GLS, SUR, and GMM estimates tend to present a more conservative assessment of the macroeconomic impact of FDI. Meanwhile, we have also confirmed that more positive results concerning the growth-enhancing effect of FDI are found in studies that deal with the simultaneity of macroeconomic growth and FDI using the instrumental variables method, as compared to studies that simply adopt the OLS method and, thus, do not control possible endogeneity between the two elements.

Fourth, the differences in the benchmark indices of the macroeconomic variables do not cause any significant differences in empirical evaluations on the magnitude of the FDI impact, but do largely affect their statistical significance. In fact, according to Panel (b) of **Table 4**, as compared to studies where macroeconomic growth is measured in terms of GDP, studies that adopt non-GDP benchmark indices tend to report estimates in which the *t* value is lower by a range of 2.31 to 2.78 on average. On the other hand, the difference in the macroeconomic variable types does not cause any noteworthy differences among the estimation results in terms of both the PCC and the *t* value.

Fifth, the selection of FDI variable types is an important factor in explaining the differences between the relevant studies. Namely, more significant and positive macroeconomic effects tend to be detected in the estimations in which cumulative investment value, the FDI to the total value added ratio, and the FDI to the gross fixed capital formation ratio are adopted as compared to those in which the FDI to GDP ratio is employed as an independent variable. Meanwhile, as compared to the estimations reported by studies that utilize the FDI to GDP ratio, the estimations reported by studies where the cumulative investment per capita has been adopted are more negative concerning the macroeconomic impact of FDI. These results strongly indicate that the choice of a proxy variable for the foreign investment scale is a critical element in this study area.

In addition to the above findings, **Table 4** also suggests that the degree of freedom and the quality level of the study are influential factors upon empirical evaluations of the macroeconomic impacts of FDI in the existing literature. The square root of the degree of freedom is estimated to be robust and negative both in Panels (a) and (b) of **Table 4**. In other words, when other conditions remain the same, studies with a larger sample size tend to give a lower evaluation both on the magnitude of the FDI effect and its statistical significance. Similar effects have been recognized in terms of the quality level of the study. Therefore, based on these results, we surmise that more precise studies in terms of empirical data or estimation strategies have a strong tendency to draw conservative conclusions concerning the causality between FDI and macroeconomic growth in transition economies.

6. Assessment of Publication Selection Bias

In this section, we examine the possibility of publication selection bias in the literature. First, we looked at a funnel plot of all the estimates' PCCs against the respective inverse of the standard errors in **Figure 3**. This figure hardly shows the expected shape, which can be seen among studies of a given research subject without publication selection. In other words, we cannot see a bilaterally symmetric and triangle-shaped distribution of the collected estimates in the figure, even if either zero or the mean value of the top 10 percent most-precise estimates (0.225) is used as an approximate value of the true effect. This contrasts with the clearly inverted funnel-shaped distribution shown in the funnel plot of Doucouliagos et al. (2010, Figure 1, p. 15), which uses 880 estimates collected from 108 studies on the relationship between FDI and economic growth all over the world. In our case, the insufficient number of studies is considered to be one cause of such an unclear funnel plot.

Moreover, if the true effect exists around zero, then the ratio of the positive versus the negative estimates becomes 86:14, which strongly rejects the null hypothesis that the ratio is 50:50 (z=7.200, p=0.000). Therefore, the type I publication selection bias is strongly suspected to be present in the existing literature. In contrast, if the true effect is close to the mean of the top 10 percent most-precise estimates, the collected estimates are perfectly divided into the ratio of 50:50 with the value of 0.225 being the threshold (z=-0.000, p=1.000). In this case, the possibility of the type I publication selection bias is considered to be low.

Next, looking at the Galbraith plot in **Figure 4**, we can confirm that only 31 out of the 100 estimates show a t value that is within the range of ±1.96 or the two-sided critical values of the 5% significance level. This result strongly rejects the null hypothesis that the rate as a percentage of the total estimations is 95% (z=29.365, p=0.000). Even on the assumption that the mean of the top 10 percent most-precise estimates stands as the true effect, the corresponding result also rejects the null hypothesis that estimates whose statistic

$|(\text{the } k - \text{th estimations} - \text{true effect})/SE_k|$ exceeds the critical value of 1.96 account for 5% of the all estimates (z=17.436, p=0.000). Therefore, the presence of type II publication selection bias is highly likely in this study field.

Finally, in accordance with the methods and procedures described in Section 2, we examined the two types of publication selection bias and the presence of genuine empirical effect through estimating the meta-regression models specially developed for this aim. **Table 5** summarizes the results. As Panels (a) and (b) of the table show, the null hypothesis that the intercept term β_0 in Eqs. (9) and (10) is equal to zero is rejected at the 1% significance level in all cases. Therefore, we assert that there is publication selection bias of both types I and II in the literature. Meanwhile, Panel (c) of **Table 5** shows that the coefficient of the inverse of the standard error β_1 in Eq. (11) is estimated to be positive and significant at the 10% level. This result implies that there may be genuine evidence concerning the growth-promoting effects of FDI in the 21 studies listed in **Table 1**. However, as Panel (a) of **Table 5** indicates, we cannot reject the null hypothesis that the coefficient of the inverse of the standard error β_1 in Eq. (9) is equal to zero and, accordingly, the publication-bias-adjusted effect size obtained from the estimation of Eq. (11) cannot be adopted.

Judging from the above results, we conclude that the empirical results reported in the previous literature that examines the macroeconomic impacts of FDI in transition economies as a whole have not yet provided sufficient empirical evidence to prove a non-zero FDI effect due to the insufficient number of studies and their strong bias in relation to publication selection.

7. Conclusions

In this paper, we conducted a meta-analysis of the literature that empirically examines the causality between FDI and macroeconomic growth in the CEE and FSU countries in the transition period.

After going through a blank period in the 1990s, this study area has made substantial progress in the first 10 years of this new century. A series of empirical results reported in the preceding studies presents positive FDI effects on macroeconomic growth as a whole literature. In fact, the random-effects model indicates that the synthesized PCC is 0.216, and the combined t value weighted by the quality level of the study reaches as high as 4.706. According to the comprehensive meta-analysis by Doucouliagos et al. (2010), which covered all countries and regions in the world, the synthesized PCC of 880 estimations collected from 108 studies is 0.12. If a comparison is allowed, we could say that the CEE and FSU countries have benefited from FDI in terms of macroeconomic growth 1.8 times greater than the world average. This result strongly indicates the high quality of foreign capital invested into the post-communist economies and the excellent absorption capability of local firms and citizens in the former socialist bloc.

Nevertheless, the results of the MRA in this paper have also revealed that empirical evaluations of the effects of FDI on macroeconomic growth strongly depend on the study conditions. We have found that the estimation period, the data type, the estimator, and the type of FDI variable are particularly important factors that explain the heterogeneity in the collected estimates. We have also found that the degree of freedom and the quality level of the study greatly affect the magnitude and statistical significance of the FDI variable. The fact that these two factors are estimated robust and negative implies that evaluations of the macroeconomic impact of FDI may become more conservative in tandem with further improvements in the precision of the empirical analyses.

Furthermore, according to our assessment of the publication selection bias, existing studies have not yet proved the true effects of FDI due to the strong tendency of publication selection in the literature as well as insufficient empirical evidence. Accordingly, it is likely that empirical evaluations on the effects of FDI on macroeconomic growth in the CEE and FSU countries might be revised downward in the future with the further accumulation of highly precise estimates. We hope there will be more development and improvement in this research field so as to capture the true effects of FDI.

Appendix A
Evaluation Method for the Quality Level of the Study

This appendix describes the evaluation method used to determine the quality level of the studies subjected to our meta-analysis.

As for journal articles, we used the ranking of economics journals that had been published as of November 1, 2012, by IDEAS—the largest bibliographic database dedicated to economics and available freely on the Internet (http://ideas.repec.org/)—as the most basic information source for our evaluation of quality level. IDEAS provides the world's most comprehensive ranking of economics journals, and as of November 2012, 1173 academic journals were ranked.

We divided these 1173 journals into 10 clusters by a cluster analysis based on overall evaluation scores, and have assigned each of these journal clusters a score (weight) from 1 (the lowest journal cluster) to 10 (the highest).

The following table shows a list of 12 academic journals that are representative of the study field of transition economies along with their IDEAS economics journal ranking [1], their overall scores [2], and the scores that we assigned in accordance with the above-mentioned procedures [3].

	[1]	[2]	[3]
Journal of Comparative Economics	129	129.98	8
Economics of Transition	138	137.84	8
Emerging Markets Review	162	160.99	7
Economic Systems	230	216.02	7
Economic Change and Restructuring	362	338.54	5
Comparative Economic Studies	397	370.99	5
Emerging Markets Finance and Trade	419	393.71	5
European Journal of Comparative Economics	443	421.53	5
Post-Communist Economies	449	425.82	5
Eastern European Economics	483	456.52	4
Problems of Economic Transition	626	590.06	4
Transition Studies Review	663	625.18	3

As for academic journals that are not ranked by IDEAS, we referred to the Thomson Reuters Impact Factor and other journal rankings and identified the same level of IDEAS ranking-listed journals that correspond to these non-listed journals; and we have assigned each of them the same score as its counterparts.

Meanwhile, with regard to academic books and book chapters, we have assigned a score of 1 in principle, but if at least one of the following conditions is met, each of the relevant books or chapters has uniformly received a score of 4, which is the median value of the scores assigned to the above-mentioned IDEAS ranking-listed economics journals: (1) The academic book or book chapter clearly states that it has gone through the peer review process; (2) its publisher is a leading academic publisher that has external evaluations carried out by experts; or (3) the research level of the study has been evaluated by the authors to be obviously high.

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Table 1. List of selected studies on macroeconomic impacts of FDI in transition economies for meta-analysi

Author (Publication year)	Target country					Estimation period [d]	Data type	Macroeconomic variable		FDI variable type [f]	Number of corrected estimates	Average precision (AP) [g]
	Number of countries	Breakdown by country group										
		CEE EU countries [a]	Other CEEs	FSU [b]	Others [c]			Benchmark index	Variable type [e]			
Barrell and Holland (2000)	3	3				1993-1996	Panel	Gross value added	III	A, E	9	32.619
Campos and Kinoshita (2002)	25	10	3	12		1990-1998	Panel	GDP	II	F	2	2.395
Cernat and Vranceanu (2002)	10	10				1992-1999	Panel	GDP	I	C	2	7.100
Mencinger (2003)	8	8				1994-2001	Panel	GDP	II	C	5	9.370
Lyroudi et al. (2004)	17	4	2	10	1	1995-1998	Panel	GDP	II	C	2	19.645
Neuhaus (2005)	13	10	3			1991-2002	Panel	GDP	II	C	1	140.000
Redek and Sušjan (2005)	24	10	3	11		1995-2002	Panel	GDP	III	C	1	102.300
Eller et al. (2006)	10	9	1			1996-2003	Panel	GDP	III	F, H	11	165.713
Kukeli et al. (2006)	10	7	3			1990-2001	Panel	GDP	II	A, C, F	9	36.063
Tvaronavičienė and Grybaitė (2007)	1	1				2000-2006	Time series	GDP	I	A	1	10.740
Apergis et al. (2008)	27	10	4	12	1	1991-2004	Panel	GDP	I	B	5	17.060
Kutan and Yigit (2009)	8	8				1995-2006	Panel	Gross industrial production	III	C	6	7.398
Nath (2009)	13	10	3			1990-2005	Panel	GDP	IV	C	6	9.375
Pelinescu and Rădulescu (2009)	1	1				2000-2009	Time series	GDP	II	G	1	66.930
Sridharan et al. (2009)	1			1		1994-2007	Time series	Gross industrial production	I	B	2	92.900
Bijsterbosch and Kolasa (2010)	8	8				1995-2005	Panel	Value added by industrial sector	III	D	15	23.947
Sapienza (2010)	12	10	2			1999-2006	Panel	GDP	I	H	3	153.577
Varamini and Kalash (2010)	10	10				1993-2006	Time series	GDP	I	B	10	[h] n/a
Fidrmuc and Martin (2011)	11	10	1			1995-2009	Time series	Gross industrial production	I	A	11	16.282
Kornecki and Raghavan (2011)	5	5				1993-2003	Panel	GDP	II	G	1	48.260
Weber (2011)	8	7		1		1993-2009	Time series	GDP	I	B	7	1.761

Notes:

[a] CEE EU countries denote the 10 Central and Eastern European countries that joined the European Union either in 2004 or 2007.

[b] Excluding the Baltic countries

[c] Mongolia in all cases

[d] Estimation period may differ depending on target country.

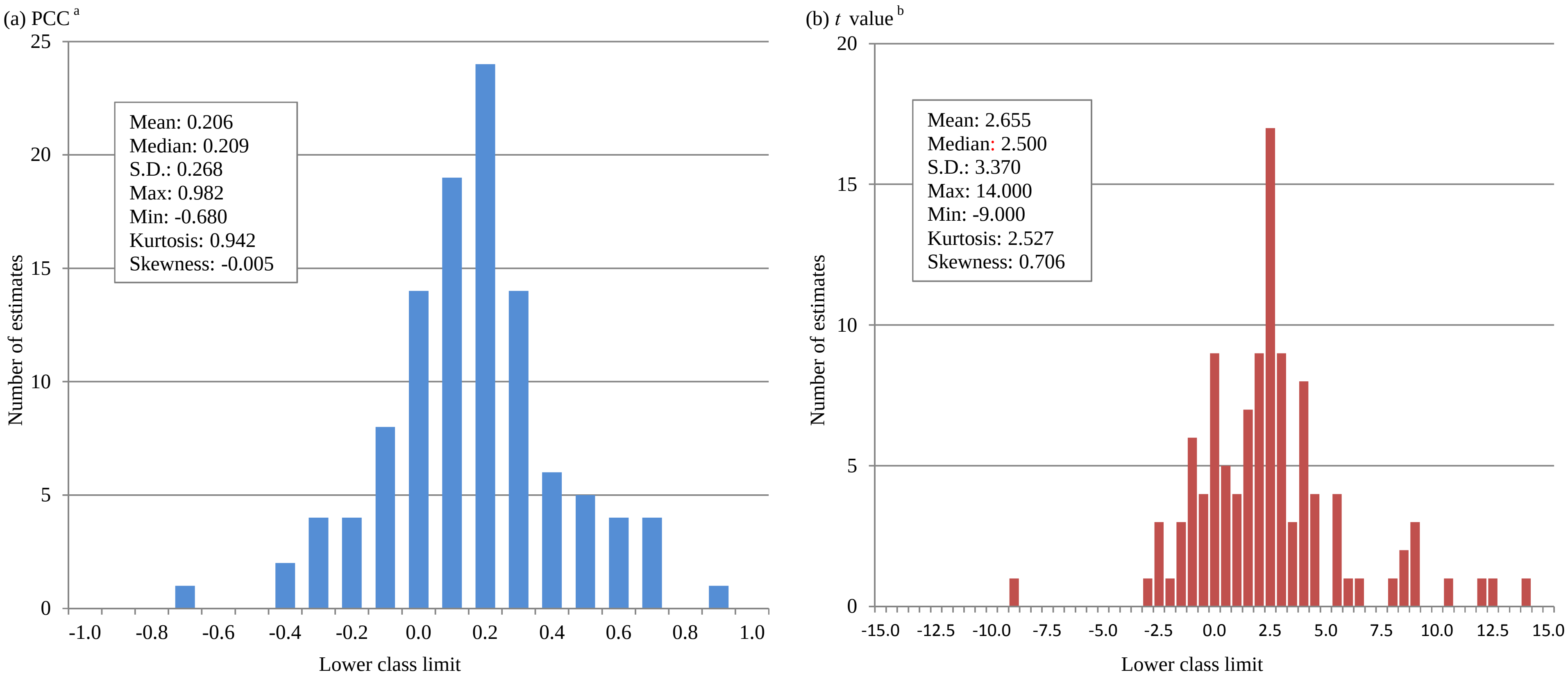
[e] I: Level of output volume; II: Change in output volume; III: Level of productivity; IV: Change in productivity level

[f] A: Cumulative investment value; B: Annual capital inflow; C: FDI to GDP; D: FDI to gross value added; E: FDI to gross fixed capital formation; F: Cumulative FDI per capita (worker); G: Growth rate; H: Others

[g] AP is defined as the mean of the inverse of standard errors of estimates collected from the study.

[h] Varamini and Kalash (2010) report only the t values of their estimation results. Therefore it is impossible to compute the average precision of this study.

Figure 1. Distribution of partial correlation coefficients and t values (K=110)

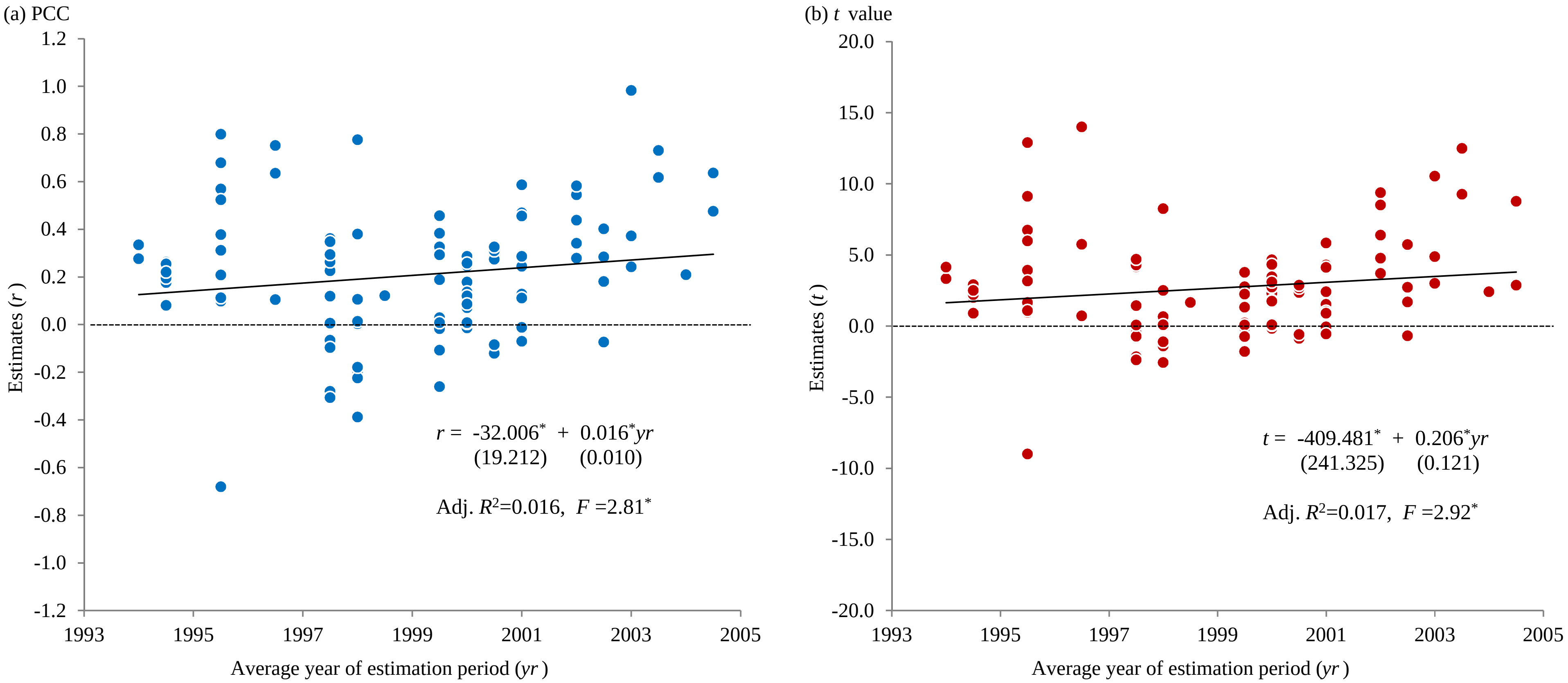


Notes:

[a] Goodness-of-fit test: χ^2=21.176, p=0.218

[b] Goodness-of-fit test: χ^2=143.952, p=0.000

Figure 2. Chronological order of partial correlation coefficients and *t* values (*K* =110)



Note: Figures in parentheses beneath regression coefficients of the approximate straight line are standard errors. * denotes statistical significance at the 10% level.

Table 2. Synthesis of collected estimates

	Number of estimates (K)	(a) Synthesis of PCCs: Fixed-effect model (z value)[a]	(a) Synthesis of PCCs: Random-effects model (z value)[a]	(a) Synthesis of PCCs: Test of homogeneity[b]	(b) Combination of t values: Unweighted combination (p value)	(b) Combination of t values: Weighted combination (p value)	(b) Combination of t values: Median of t values	(b) Combination of t values: Failsafe N (fsN)
All studies	110	0.222 *** (30.40)	0.216 *** (9.00)	1081.695 ***	27.842 *** (0.00)	4.706 *** (0.00)	2.500	31401
(a) Comparison in terms of data type								
Studies that employ panel data	78	0.180 *** (22.28)	0.192 *** (7.62)	676.766 ***	21.215 *** (0.00)	3.379 *** (0.00)	2.540	12895
Studies that employ time series data	32	0.406 *** (23.94)	0.277 *** (5.43)	259.972 ***	18.499 *** (0.00)	3.759 *** (0.00)	2.457	4015
(b) Comparison in terms of the benchmark index of macroeconomic variable								
Studies that use GDP as the benchmark index of macroeconomic variable	67	0.252 *** (20.80)	0.184 *** (4.48)	730.485 ***	16.813 *** (0.00)	3.296 *** (0.00)	1.530	6932
Studies that use a non-GDP index	43	0.205 *** (22.39)	0.254 *** (9.24)	341.503 ***	23.545 *** (0.00)	3.364 *** (0.00)	2.770	8766
(c) Comparison in terms of the type of macroeconomic variable								
Studies that adopt the level of output volume	41	0.357 *** (25.27)	0.266 *** (6.63)	299.719 ***	20.444 *** (0.00)	4.359 *** (0.00)	2.500	6291
Studies that adopt the change in output volume	21	0.361 *** (18.04)	0.248 *** (2.54)	460.911 ***	14.372 *** (0.00)	3.214 *** (0.00)	3.158	1582
Studies that adopt the level of productivity	42	0.138 *** (14.07)	0.160 *** (10.72)	72.189 ***	14.159 *** (0.00)	1.882 ** (0.03)	2.540	3070
Studies that adopt the change in productivity level	6	0.047 (1.38)	0.048 (1.03)	9.464 *	1.423 * (0.08)	0.285 (0.39)	0.072	-2
(e) Comparison in terms of FDI variable								
Studies that use FDI to GDP ratio	24	0.129 *** (6.02)	0.124 *** (2.60)	110.668 ***	5.772 *** (0.00)	1.005 (0.16)	0.900	271
Studies that use cumulative investment value	21	0.455 *** (27.96)	0.411 *** (8.24)	185.645 ***	26.119 *** (0.00)	4.137 *** (0.00)	4.767	5273
Studies that use annual capital inflow	32	0.249 *** (14.81)	0.174 *** (2.94)	361.376 ***	11.720 *** (0.00)	2.725 *** (0.00)	2.033	1592
Studies that use other types of FDI variable	33	0.138 *** (13.35)	0.176 *** (7.33)	132.669 ***	13.533 *** (0.00)	1.926 ** (0.03)	2.710	2200

[a] Null hypothesis: The synthesized effect size is zero.

[b] Null hypothesis: Effect sizes are homogeneous.

***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Name, definition, and descriptive statistics of meta-independent variables

Variable name	Definition	Descriptive statistics		
		Mean	Median	S.D.
Proportion of CEE EU countries	Proportion of CEE EU countries in target countries	0.854	1	0.259
Proportion of other CEEs	Proportion of non-EU CEE countries in target countries	0.075	0	0.133
First year of estimation	First year of estimation period	1994.155	1995	2.495
Length of estimation	Years of estimation period	10.564	11	3.426
Time series data	1 = if time series data is employed for empirical analysis, 0 = otherwise	0.291	0	0.456
GLS	1 = if generalized least squares estimator is used for estimation, 0 = otherwise	0.100	0	0.301
SUR	1 = if seemingly unrelated regression estimator is used for estimation, 0 = otherwise	0.036	0	0.188
FE	1 = if fixed-effects panel estimator is used for estimation, 0 = otherwise	0.282	0	0.452
GMM	1 = if generalized method of moments estimator is used for estimation, 0 = otherwise	0.055	0	0.228
AR/VAR	1 = if auto regression model is used for estimation, 0 = otherwise	0.073	0	0.261
IV	1 = if instrumental variable method is used for estimation, 0 = otherwise	0.018	0	0.134
Non-GDP index	1 = if non-GDP index is used as macroeconomic variable, 0 = otherwise	0.391	0	0.490
Changes (Level)	1 = if macroeconomic variable is expressed in change rate, 0 = otherwise	0.245	0	0.432
Productivity (Output)	1 = if macroeconomic variable is measured in productivity, 0 = otherwise	0.436	0	0.498
Cumulative investment value	1 = if cumulative investment value is used as the type of FDI variable, 0 = otherwise	0.191	0	0.395
Annual capital inflow	1 = if annual capital inflow is used as the type of FDI variable, 0 = otherwise	0.291	0	0.456
FDI to gross value added	1 = if FDI to gross value added ratio is used as the type of FDI variable, 0 = otherwise	0.136	0	0.345
FDI to gross fixed capital formation	1 = if FDI to gross fixed capital formation ratio is used as the type of FDI variable, 0 = otherwise	0.009	0	0.095
Cumulative FDI per capita	1 = if cumulative FDI per capita (or worker) is used as the type of FDI variable, 0 = otherwise	0.073	0	0.261
Growth rate	1 = if growth rate is used as the type of FDI variable, 0 = otherwise	0.018	0	0.134
Other FDI variables	1 = if other FDI variable is used, 0 = otherwise	0.064	0	0.245
$\sqrt{\ }$Degree of freedom	Root of degree of freedom of the estimated model	10.979	9.670	5.625
Quality level	Ten-point scale of the quality level of the study [b]	5.418	7	2.386

Notes:

[a] CEE EU countries denote the 10 Central and Eastern European countries that joined the European Union either in 2004 or 2007.

[b] See Appendix A for more details.

Table 4. Meta-regression analysis of heterogeneity among studies

(a) Dependent variable — PCC

Estimator (Analytical weight in parentheses)	Cluster-robust OLS	Cluster-robust WLS [Quality level]	Cluster-robust WLS [N]	Cluster-robust WLS [1/SE]	Multilevel mixed effects RML	Random-effects panel GLS
Meta-independent variable (Default) / Model	[1]	[2]	[3]	[4] [a]	[5]	[6] [b]
Composition of target countries (FSU)						
Proportion of CEE EU countries	-0.009	-0.072	0.105	0.149	-0.009	-0.009
	(0.10)	(0.10)	(0.10)	(0.20)	(0.09)	(0.10)
Proportion of other CEEs	0.113	0.034	0.232 *	0.247	0.113	0.113
	(0.13)	(0.10)	(0.11)	(0.24)	(0.11)	(0.13)
Estimation period						
First year of estimation	0.035 **	0.038 **	0.032 ***	0.028	0.035 ***	0.035 ***
	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)
Length of estimation	0.047 ***	0.052 ***	0.036 ***	0.038 *	0.047 ***	0.047 ***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
Data type (Panel data)						
Time series data	-0.420 ***	-0.347 ***	-0.404 ***	-0.228	-0.420 ***	-0.420 ***
	(0.08)	(0.08)	(0.07)	(0.27)	(0.07)	(0.08)
Estimator (OLS)						
GLS	-0.191 *	0.006	-0.178 **	-0.352 *	-0.191 **	-0.191 *
	(0.10)	(0.07)	(0.08)	(0.19)	(0.09)	(0.10)
SUR	-0.251 **	-0.122 **	-0.130 ***	-0.260 ***	-0.251 ***	-0.251 **
	(0.10)	(0.06)	(0.04)	(0.08)	(0.09)	(0.10)
FE	0.065	0.226 ***	-0.009	-0.040	0.065	0.065
	(0.07)	(0.08)	(0.03)	(0.12)	(0.06)	(0.07)
GMM	-0.085 *	0.004	-0.083 ***	-0.151 *	-0.085 **	-0.085 *
	(0.04)	(0.05)	(0.01)	(0.08)	(0.04)	(0.04)
AR/VAR	0.273 *	0.028	0.399 ***	-0.178	0.273 **	0.273 *
	(0.15)	(0.05)	(0.12)	(0.27)	(0.13)	(0.15)
IV	0.628 ***	0.406 ***	0.644 ***	0.400	0.628 ***	0.628 ***
	(0.19)	(0.12)	(0.16)	(0.34)	(0.17)	(0.19)
Benchmark index of macroeconomic variable (GDP)						
Non-GDP index	-0.186	-0.192	-0.008	-0.183	-0.186 *	-0.186
	(0.13)	(0.15)	(0.08)	(0.17)	(0.11)	(0.13)
Type of macroeconomic variable						
Changes (Level)	-0.166 *	-0.129	-0.151	0.025	-0.166 **	-0.166 *
	(0.10)	(0.10)	(0.09)	(0.18)	(0.08)	(0.10)
Productivity (Output)	0.042	-0.025	0.032	0.062	0.042	0.042
	(0.09)	(0.05)	(0.08)	(0.14)	(0.08)	(0.09)
Type of FDI variable (FDI to GDP)						
Cumulative investment value	0.622 ***	0.729 ***	0.418 ***	0.540 ***	0.622 ***	0.622 ***
	(0.14)	(0.15)	(0.07)	(0.14)	(0.13)	(0.14)
Annual capital inflow	-0.090	0.148	-0.084	0.029	-0.090	-0.090
	(0.08)	(0.10)	(0.07)	(0.16)	(0.07)	(0.08)
FDI to gross value added	0.518 ***	0.450 ***	0.233 ***	0.522 ***	0.518 ***	0.518 ***
	(0.17)	(0.15)	(0.07)	(0.16)	(0.15)	(0.17)
FDI to gross fixed capital formation	0.608 ***	0.721 ***	0.395 ***	0.540 ***	0.608 ***	0.608 ***
	(0.15)	(0.15)	(0.08)	(0.14)	(0.13)	(0.15)
Cumulative FDI per capita	-0.227 **	-0.278 **	-0.116	-0.147	-0.227 **	-0.227 **
	(0.11)	(0.12)	(0.08)	(0.11)	(0.10)	(0.11)
Growth rate	0.444	0.681 ***	0.491	0.487 *	0.444 *	0.444 *
	(0.26)	(0.13)	(0.29)	(0.26)	(0.23)	(0.26)
Other FDI variables	-0.030	-0.010	-0.005	0.146	-0.030	-0.030
	(0.14)	(0.14)	(0.17)	(0.13)	(0.12)	(0.14)
Degree of freedom and research quality						
$\sqrt{\text{Degree of freedom}}$	-0.022 **	-0.018 ***	-0.011 ***	-0.017 ***	-0.022 ***	-0.022 **
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Quality level	-0.057 *	-	-0.070 ***	-0.034	-0.057 **	-0.057 *
	(0.03)	(-)	(0.02)	(0.05)	(0.03)	(0.03)
Constant	-69.248 **	-76.937 **	-63.721 ***	-56.570	-69.248 ***	-69.248 ***
	(26.02)	(29.36)	(20.91)	(53.79)	(23.11)	(26.02)
K	110	110	110	100	110	110
R^2	0.465	0.588	0.515	0.423	-	0.465

(continued)

(b) Dependent variable — t value

Estimator (Analytical weight in parentheses)	Cluster-robust OLS	Cluster-robust WLS [Research quality]	Cluster-robust WLS [N]	Cluster-robust WLS [1/SE]	Multilevel mixed effects RML	Random-effects panel GLS
Meta-independent variable (Default) / Model	[7]	[8]	[9]	[10] [a]	[11]	[12] [c]
Composition of target countries (FSU)						
Proportion of CEE EU countries	-0.289	-0.565	1.211	-0.389	-0.289	-0.289
	(0.87)	(0.97)	(1.04)	(1.60)	(0.77)	(0.87)
Proportion of other CEEs	1.206	1.375	3.066 **	0.672	1.206	1.206
	(1.09)	(1.00)	(1.24)	(2.01)	(0.97)	(1.09)
Estimation period						
First year of estimation	0.485 ***	0.515 ***	0.555 ***	0.554 *	0.485 ***	0.485 ***
	(0.13)	(0.15)	(0.12)	(0.28)	(0.11)	(0.13)
Length of estimation	0.667 ***	0.679 ***	0.589 ***	0.743 ***	0.667 ***	0.667 ***
	(0.10)	(0.09)	(0.10)	(0.20)	(0.09)	(0.10)
Data type (Panel data)						
Time series data	-5.171 ***	-4.359 ***	-5.732 ***	-5.097 *	-5.171 ***	-5.171 ***
	(0.69)	(0.74)	(0.83)	(2.45)	(0.61)	(0.69)
Estimator (OLS)						
GLS	-2.527 ***	-0.754	-3.380 ***	-3.955 **	-2.527 ***	-2.527 ***
	(0.88)	(0.69)	(0.75)	(1.48)	(0.78)	(0.88)
SUR	-3.359 ***	-2.070 ***	-2.677 ***	-3.668 ***	-3.359 ***	-3.359 ***
	(0.88)	(0.56)	(0.45)	(0.61)	(0.78)	(0.88)
FE	0.727	1.953 **	-0.768	0.405	0.727	0.727
	(0.58)	(0.91)	(0.62)	(0.84)	(0.52)	(0.58)
GMM	-1.456 ***	-0.718	-1.796 ***	-1.798 ***	-1.456 ***	-1.456 ***
	(0.37)	(0.53)	(0.16)	(0.50)	(0.33)	(0.37)
AR/VAR	1.302	-1.048 *	3.314 **	-2.602	1.302	1.302
	(1.51)	(0.53)	(1.47)	(2.79)	(1.34)	(1.51)
IV	6.187 ***	3.887 ***	7.254 ***	3.869	6.187 ***	6.187 ***
	(1.77)	(1.07)	(1.75)	(3.11)	(1.57)	(1.77)
Benchmark index of macroeconomic variable (GDP)						
Non-GDP index	-2.780 ***	-2.306 *	-1.527	-2.677 *	-2.780 ***	-2.780 ***
	(0.96)	(1.24)	(1.13)	(1.47)	(0.85)	(0.96)
Type of macroeconomic variable						
Changes (Level)	-1.303	-0.952	-1.266	1.178	-1.303 *	-1.303
	(0.80)	(0.99)	(0.90)	(1.66)	(0.71)	(0.80)
Productivity (Output)	-0.102	-0.858	0.304	-0.386	-0.102	-0.102
	(0.76)	(0.50)	(0.78)	(1.22)	(0.68)	(0.76)
Type of FDI variable (FDI to GDP)						
	8.914 ***	9.090 ***	7.234 ***	9.946 ***	8.914 ***	8.914 ***
Cumulative investment value	(1.07)	(1.46)	(1.32)	(1.09)	(0.95)	(1.07)
	-0.334	1.994 *	-0.673	0.730	-0.334	-0.334
Annual capital inflow	(0.78)	(1.01)	(0.80)	(1.37)	(0.70)	(0.78)
	7.456 ***	6.131 ***	5.125 ***	8.496 ***	7.456 ***	7.456 ***
FDI to gross value added	(1.42)	(1.43)	(1.35)	(1.28)	(1.26)	(1.42)
	8.672 ***	8.944 ***	6.861 ***	9.971 ***	8.672 ***	8.672 ***
FDI to gross fixed capital formation	(1.16)	(1.53)	(1.46)	(1.15)	(1.03)	(1.16)
	-2.127 **	-2.335 **	-1.234	-1.082	-2.127 **	-2.127 **
Cumulative FDI per capita	(0.95)	(1.04)	(0.89)	(0.86)	(0.84)	(0.95)
	3.925	6.236 ***	3.896	4.201	3.925	3.925
Growth rate	(2.79)	(1.47)	(3.57)	(2.56)	(2.48)	(2.79)
	-0.564	-0.288	-0.476	1.238	-0.564	-0.564
Other FDI variables	(1.17)	(1.27)	(1.59)	(1.00)	(1.03)	(1.17)
Degree of freedom and research quality						
$\sqrt{\text{Degree of freedom}}$	-0.178 **	-0.130 **	-0.085 **	-0.169 ***	-0.178 ***	-0.178 **
	(0.07)	(0.06)	(0.04)	(0.04)	(0.07)	(0.07)
Quality level	-0.569 **	-	-0.878 ***	-0.336	-0.569 **	-0.569 **
	(0.27)	(-)	(0.26)	(0.45)	(0.24)	(0.27)
Constant	-965.358 ***	-1031.280 ***	-1104.430 ***	-1106.090 *	-965.358 ***	-965.358 ***
	(256.51)	(291.62)	(248.68)	(568.03)	(227.85)	(256.51)
K	110	110	110	100	110	110
R^2	0.530	0.636	0.539	0.527	-	0.530

Notes:

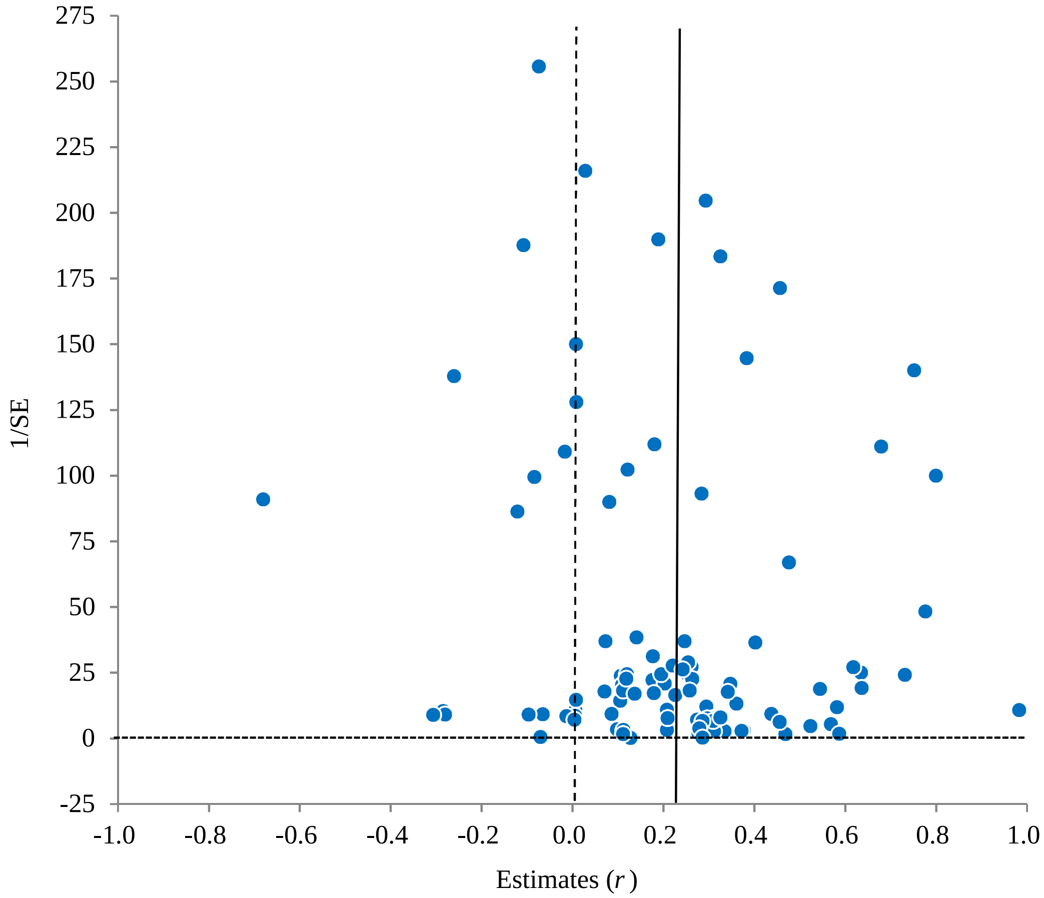
[a] Excluding 10 estimates collected from Varamini and Kalash (2010) that report only t values of their estimation results.

[b] Breusch-Pagan test: χ^2=0.00, p=1.000; Hausman test: χ^2=4.08, p=0.990

[c] Breusch-Pagan test: χ^2=0.00, p=1.000; Hausman test: χ^2=8.21, p=0.830

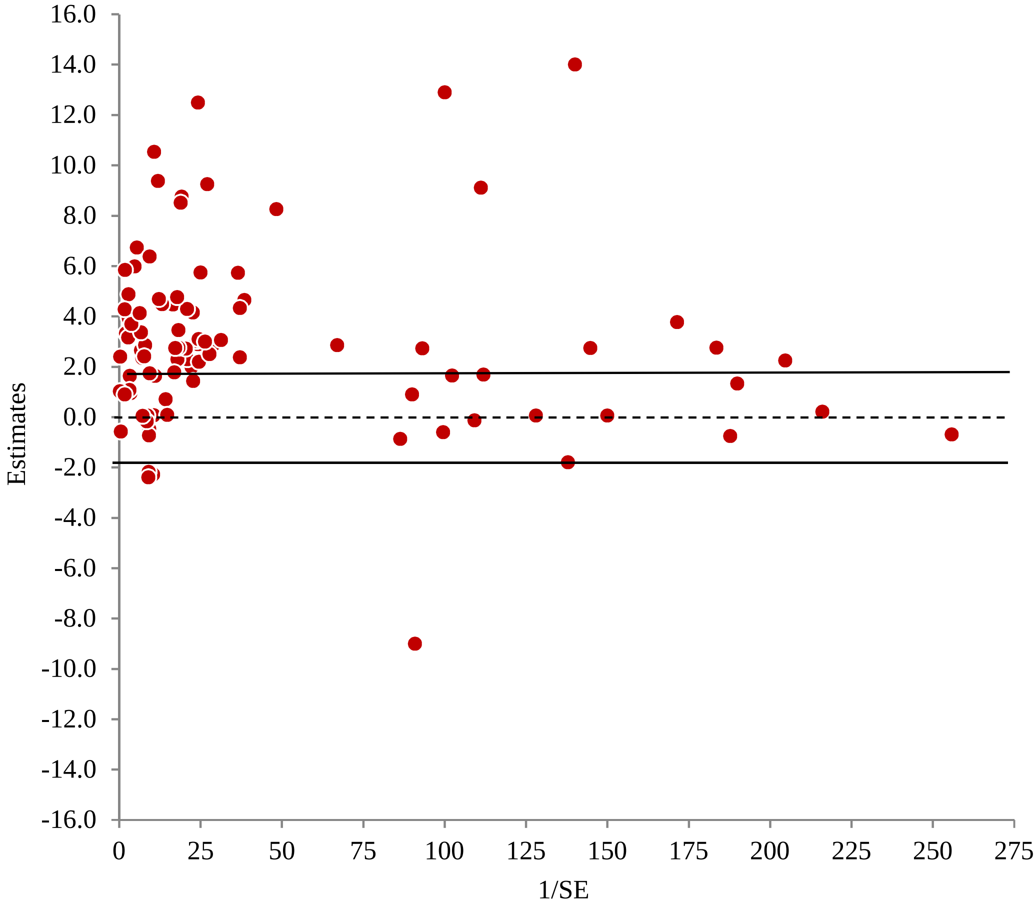
Figures in parentheses beneath regression coefficients are robust standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Figure 3. Funnel plot of patial correlation coefficients (*K* =100)



Note: Solid line indicates the mean of top 10 percent most-precise estimates 0.225.

Figure 4. Galbraith plot of *t* values (*K* =100)



Note: Solid lines indicate the thresholds of two-sided critical values at the 5% significance level ±1.96.

Table 5. Meta-regression analysis of publication selection

(a) FAT (Type I PSB)-PET test (Equation: $t=\beta_0+\beta_1(1/SE)+v$)

Estimator	OLS	Cluster-robust OLS	Random-effects panel GLS
Model	[1]	[2]	[3] [a]
Constant (FAT: H_0: β_0=0)	3.246 ***	3.246 ***	3.123 ***
	(0.35)	(0.73)	(0.70)
1/SE (PET: H_0: β_1=0)	-0.007	-0.007	0.005
	(0.01)	(0.01)	(0.01)
K	100	100	100
R^2	0.015	0.015	0.015

(b) Test of type II PSB (Equation: $|t|=\beta_0+\beta_1(1/SE)+v$)

Estimator	OLS	Cluster-robust OLS	Random-effects panel GLS
Model	[4]	[5]	[6] [b]
Constant (H_0: β_0=0)	3.533 ***	3.533 ***	2.847 ***
	(0.31)	(0.64)	(0.82)
1/SE	-0.003	-0.003	0.021
	(0.01)	(0.01)	(0.02)
K	100	100	100
R^2	0.005	0.005	0.005

(c) PEESE approach (Equation: $t=\beta_0 SE+\beta_1(1/SE)+v$)

Estimator	OLS	Cluster-robust OLS	Random-effects panel ML
Model	[7]	[8]	[9]
SE	1.049 **	1.049 *	-0.488
	(0.46)	(0.58)	(0.59)
1/SE (H_0: β_1=0)	0.020 ***	0.020 *	0.017 *
	(0.01)	(0.01)	(0.01)
K	100	100	100
R^2	0.124	0.124	-

Notes:

[a] Breusch-Pagan test: χ^2=23.63, p=0.000; Hausman test: χ^2=0.07, p=0.786

[b] Breusch-Pagan test: χ^2=29.99, p=0.000; Hausman test: χ^2=1.90, p=0.168

Figures in parentheses beneath regression coefficients are standard errors. Except for Model [9], robust standard errors are estimated. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.