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Meta Regression Application for Detecting Publication Bias and Variation of Results in Economic Research

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Abstract. This paper briefly aims to introduce the meta regression application or better known as the Meta Regression Analysis (MRA). This tool is widely used to detect publication bias in the publication of scientific articles, including in the field of economics. Publication bias occurs because researchers tend to publish their research results that support certain hypotheses (significant). Research results that are not significant have a relatively small probability of being published. Publication bias can be detected by means of a relatively simple regression test. A set of quantitative studies on the same topic is tabulated and analyzed using meta regression. Meta regression is not only used to detect publication bias. This analysis tool can also explain the source of variations in the results of several studies due to differences in location, research year, methods, gender and measurement methods used by researchers. This paper uses meta-regression to examine the variation in outcomes in an intergenerational transfer study. The results showed that location differences had a significant effect on transfers. Meanwhile, the research period and the variation of methods used in the previous study did not have a significant impact.

INTRODUCTION

Meta-analysis is determined as a statistical analysis of the various results of the analysis with the aim of finding more integrated results [1]. More than just narrative, meta-analysis uses statistics to look for more appropriate conclusions about methodological variations in influencing the results of studies. In addition, meta-analysis can also be used to test the effect of other factors (moderating variables) that can explain differences in research results in the same domain of study; such as gender bias, study period, research location and differences in the research options used in the study [2]. One example of research with a meta-analysis approach is carried out to measure bank efficiency [3]. Several moderating variables are used in this study, including: estimation technique (parametric or non-parametric), form of variable (logarithmic or linear), type of data, type of bank and measurement used to identify efficiency. The moderating variable approach is also used in research on international trade [4]. In socioeconomic research, the use of dummy variables is very commonly used to define qualitative variables.

One of the advantages of meta-analysis is that it can be used to detect bias in scientific publications [5]. As it is understood that the number of scientific publications is one measure of the performance of lecturers and researchers. The structure of academic incentives based on credit scores, more or less affects the desire of lecturers to publish as much of their work as possible. On the other hand, publishers of scientific articles tend to only choose research works that, say, provide significant test results. The researchers also have the same tendency to only send results of research that "has" been significant. The same case can be found in the practice of writing scientific papers such as theses and theses that often adjust the results of research in order to obtain the desired results (to be significant or support certain theories).

The results of studies that are often cited are meta analyzes of price and income elasticities of water demand [6]. The basic theory shows that the price elasticity for demand for goods is negative. From about 110 elasticity figures obtained in previous empirical studies, the average price elasticity was -0.38 and only three empirical studies showed positive price elasticity. Illustratively using funnel graphs show that study results pile up around negative quadrants. Quantitative meta regression confirms that publication bias can be proven in research on this water

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demand [7]. How a simple illustration of the meta regression for testing publication bias and its application for economic studies will be explained in the following section. Furthermore, it also discusses the use of this method for analyzing variations in results in economic research.

META REGRESSION: BASIC CONCEPT

The basic regression model [8] in a study is usually defined as follows:

$$Y = \beta_0 + \beta_1 X + \varepsilon \tag{1}$$

In this case, Y is the dependent variable, X is the independent variable, β_0 is the intercept coefficient, β_1 is the regression slope coefficients were analyzed and ε is the error term. The error term is assumed to be random and normally distributed. In each study, one estimator value for β_1, say, b will be obtained. The basic concept of meta regression [9] is to collect so many studies on the relationship of Y to X such that an estimator for β_1 is obtained, and it regresses with several moderator variables as follows:

$$b_j = \alpha + \gamma_1 Z_{1j} + \gamma_2 Z_{2j} + \gamma_3 Z_{3j} + e_j \tag{2}$$

In equation (2), b_j is the dependent variable which is a collection of regression coefficients from several single studies. Meanwhile, Z_1, Z_2 and Z_3 respectively are moderator variables which explain the variation of the b_j coefficient from the previous study, e_j is an error element which is assumed normally distributed. Meta regression analysis can accommodate several explanatory variables which are referred to as moderator variables.

Some moderator variable candidates commonly used are:

a. Model specifications used in the base model
b. Characteristics of researchers such as gender, origin of researchers and so on
c. Data characteristics

To examine the existence of publication bias, the basic meta regression model (2) is expanded with the following specifications:

$$b_j = \alpha + \gamma_1 Z_{1j} + \gamma_2 Z_{2j} + \gamma_3 Z_{3j} + \partial SE_j + e_j \tag{3}$$

Equation (3) is basically the same as equation (2) with the addition of a measure of precision that is represented by the variable Standard Error (SE) of each single study. The coefficient of the standard error variable, ∂, can be used as an indicator of publication bias. If there is no publication bias, the estimated parameters of the study results will vary randomly around the population value. Publication bias arises because researchers with small data tend to tamper with the specifications in such a way as to obtain significant estimates. Otherwise, the results of the study will not be statistically significant and are less likely to be published. Conversely, studies with large samples tend to easily obtain significance so as not to reduce the interest of researchers to find alternative specifications [10].

Likewise, researchers who have a small sample size will seek to find additional data such that a significant effect will be obtained. Researchers with large samples will always find reasons to classify some data as outliers. In essence, publication bias will be detected if the estimated parameters obtained are proportional to the standard error. In this case if the coefficient ∂ in equation (3) is zero (not significant), then there is no publication bias. This kind of testing is known as the Funnel Asymmetry Test [11].

Given the potential for heteroscedasticity, equation (3) is rarely estimated directly with Ordinary Least Square (OLS). To correct heteroscedasticity, equation (3) is estimated by Weighted Least Squares (WLS) using standard

error as the weights for both side of the equation. Technically, to eliminate the effect of heteroscedasticity, the left and right sides of equation (3) are multiplied by 1 / SE. Thus, it will be obtained:

$$b_j(\frac{1}{SE}) = \alpha(\frac{1}{SE}) + \gamma_1 Z_{1j}(\frac{1}{SE}) + \gamma_2 Z_{2j}(\frac{1}{SE}) + \gamma_3 Z_{3j}(\frac{1}{SE}) + \partial + e_j \quad (4)$$

Equation (4) is basically equation (3) which is extended. Each side of equation (3) is divided by the element of standard error (SE) for each observation. The test for the existence of publication bias is determined from the significance of the intercept coefficient, ∂, in equation (4).

GRAPHIC ILLUSTRATION OF PUBLICATION BIAS

To clarify the understanding of publication bias tests [9], this section will briefly review one of the results of a meta-analysis study of price elasticities for water demand [6]. As mentioned in the previous section that price elasticity is theoretically negative so that the negative and significant coefficient results are what is more "desirable" in empirical testing. Of the 110 empirical test results, only three cases "missed". To test for a systematic relationship between price elasticity estimation (PE) and standard error (publication bias test), first consider the plot of the two variables as follows:

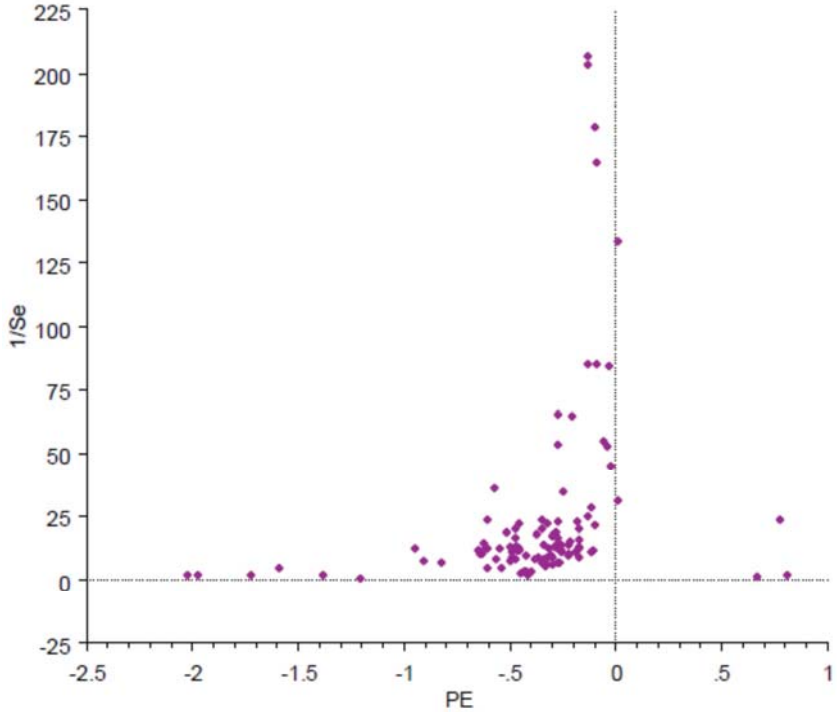

FIGURE 1. Funnel Graph for price elasticity

Based on Figure 1, the plot results between the estimated price elasticity coefficients and the standard error (exactly 1/SE) show that a systematic relationship between the two can be detected. Thus, the hypothesis of publication bias cannot be rejected. Alleged publication bias can be rejected if the funnel graph plot does not form a kind of chimney (funnel) but spread randomly. The estimated meta regression for this case using equation (4) in the simplest version can be reported as follows (equation 5). In this case, the dependent variable is price elasticity (PE).

Meanwhile, the independent variable is the model specification (SPEC), the researcher is the density (DENS) and the data is cross-section data (CROS).

$$\begin{array}{l} PE= 0{,}68^{**} + 0{,}04\ SPEC + 0{,}35^{**}\ DENS + 0{,}08\ CROS \\ \quad (2{,}60) \quad (0{,}45) \qquad (2{,}06) \qquad (0{,}84) \\ R^2 = 0{,}81 \quad n = 124 \end{array} \tag{5}$$

Equation (5) is the OLS regression result from equation (4) using empirical variables. The value in parentheses in equation (5) is the t statistic of each regression coefficient. The t-table value for the corresponding degrees of freedom on 5 percent level of significance is 1.96, therefore, the intercept coefficient and density are significant at the 5 percent level. This reinforces the notion that the publication bias in this case cannot be denied.

APPLICATION: INTER GENERATIONAL TRANSFER REVIEW

Meta regression is not only used to detect publication bias. This tool can also be used in literature studies that are usually done in writing scientific papers [12]. During this time the literature review of previous research more often uses a narrative approach. With meta regression will be obtained more accurate information about the determinants of variations in research results. To further clarify the use of meta regression, the following will be illustrated the application of meta regression in intergenerational transfer studies.

Inter-generational transfers are transfers given by parents to children or vice versa. The study of intergenerational transfers is important to be carried out considering the role of the family as an institution in many ways turns out to have an effect that is no less important than the market or the country. The important question that researchers want to answer about intergenerational transfers is what motivates the background of transfers. This is important to do because it is suspected that inter-generational transfers (private transfers) have a substitutive effect on transfers by the government (public transfers). If this happens, government policies to improve the distribution of income will be ineffective.

The main hypothesis put forward is that intergenerational transfers arise from altruistic motives. Parents make transfers to their children due to their relatively low-income level (and vice versa). This means that the lower the level of recipient income (receipt), the higher the amount of transfers from the donor (donor). The point is that the relationship between the level of the recipient's income and the amount of the transfer is negative. The results showed that this relationship was not always negative (in some cases it was significantly positive). Faced with this reality, experts began to propose alternative hypotheses such as exchange motivation. Parents provide transfers because they previously received assistance from their parents, while children provide transfers because they hope to get an inheritance.

TABLE 1. Factors Affecting Household Transfers

	Macro Level (household)	Micro Level (individual)
Structural Factors	Demographic structure, employment structure, income and wealth distribution	Household composition, educational status and employment of children and parents, income and wealth status
Institutional Factors	Rules regarding parental care, tax grants, social security policies	Marital status, division of household work
Cultural Factors	Religious traditions, family values, heredity and age	Parent-child norms, beliefs, attitudes and habits

The variation in results in intergenerational transfer studies has intrigued researchers to look at the most fundamental factors influencing transfer behavior. Some experts state that for developed countries, altruism motives

are more appropriate while exchange motives are more suitable for developing countries that do not have a social security system. Based on theory, the determinants of intergenerational transfer can be classified into three factors, namely structural factors, institutional factors and cultural factors [13]. Each factor is further divided according to the level of aggregation whether at the macro level or the micro level. Each division of the determinants of intergenerational transfer can be presented schematically in Table 1.

To find out more specifically the determinants of variations in the results of intergenerational transfer studies, this article presents the results of a meta-regression study of 130 studies on intergenerational transfers in various countries, various approaches, several research periods and status of countries (developed or developing). Of the 30 cases, 16 of them fit the altruism hypothesis while the rest match the exchange case. The study was conducted in various countries such as America, France, Germany, South Korea, Malaysia, Indonesia, Nepal and several other developing countries. While the approach taken is OLS, Non-Linear, Tobit, 2SLS and the threshold regression approach. The research period spread from 1985 to 2010. The data used were mostly micro data at the household level. A brief description of the operational definition can be presented as follows:

TABLE 2. Operational Definitions of Research Variables

No.	Variables	Description	Role
1	Altruism	1if dT/dYr negative 0 if positive	Dependent Variables
2	USA	1 if USA Case 0 if other	Region Characteristic
3	Developing	1 Developing Countries 0 if other	Region Characteristic
4	OLS	1 if using OLS 0 if other	Model Spesification
5	Period	1 if in 2000 or above 0 if other	Data Characteristic

Source: author

Using the basic meta regression model as in equation (2), the estimated results of the meta regression coefficient are presented as follows:

$$\begin{array}{l} \text{Altruism} = 0{,}041 + 0{,}562^{**}\ \text{USA} + 0{,}124\ \text{Developing} + 0{,}185\ \text{OLS} + 0{,}112\ \text{Period} \\ \qquad\qquad (0{,}279)\quad (2{,}643) \qquad\quad (0{,}635) \qquad\quad (0{,}767) \qquad (0{,}876) \end{array}$$

$$R^2 = 0{,}76 \qquad n = 130 \tag{6}$$

Equation (6) is the OLS regression result from equation (2) using variables in Table 2. The value in parentheses in equation (6) is the t-statistic of each regression coefficient. The t-table value for the corresponding degrees of freedom on 5 percent level of significance is 1.96. The calculation results show that variations in the results of studies regarding intergenerational transfers so far have not been determined by the approach used or the study period. Variation in results (altruism or exchange motives) is precisely determined by the research case whether in the United States or not. Calculations show that statistically Americans are more altruistic compared to people in other countries. These results also partly confirm the results of research that found statistical evidence that Americans tend to be more altruistic than Japanese [14]. Differences in preferences that reflect variations in cultural backgrounds, habits and institutions that affect the relationship between variables can be captured through the meta regression approach.

To test the robustness of OLS estimation results in (6), several estimation alternatives are also performed such as logit and probit using robust standard error as well as finding the coefficient of marginal effect for each approach. The result remains the same i.e. only the USA coefficient is significant [12]. Apart from the controversy over the results and methodology, this section shows that the use of meta regression can be done to strengthen the literature study which so far has been mostly done narratively. As has been shown, the operational meta regression is not much different from the basic principles of OLS so that its application is relatively easy to do with standard statistical data processing software. Development of meta regression is certainly still ongoing.

CONCLUSION

Based on the results of studies on meta-analysis, several things can be concluded as follows. First, meta-analysis mixes apples and oranges. The purpose of the literature review is indeed to generalize to the differences in results in primary studies. Second, meta-analysis tends to ignore quality differences between studies. In fact, the meta-analysis does not ignore but does the coding and includes the quality difference explicitly as a moderating variable. Third, meta-analysis is a garbage-in, garbage-out (GIGO) procedure. This criticism is pretty basic. However, detecting bad meta-analysis is easier than detecting bad narrative analysis. Fourth, meta-analysis cannot produce valid conclusions because only significant results are published. It is precisely here that the challenge of meta-analysis (which is good) is to also gather insignificant research results. Fifth, meta-analysis is said to be related only to the main effect. In practice, the use of moderator interactions can enrich the analysis.

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