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Bank Productivity: A Meta-Regression Analysis

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ABSTRACT
Purpose: This study aims at examining studies employing the Malmquist Productivity Index (MPI) in calculating banks' productivity. It also seeks to determine the factors affecting the total factor productivity change of banks through meta-regression analysis.
Methodology: On December, 2023, relevant works were systematically reviewed using Web of Science (WoS), Scopus, and Google Scholar. The literature review employed a comprehensive search involving all files with the keywords such as ''productivity" and "bank''. The research process adhered to the PRISMA guidelines.
Findings: Key features of the 35 studies incorporated in the analysis are presented. The samples of 65.71% of the studies are Asian countries. The bank productivity of 45.71% was calculated through the DEA-MPI method. The studies under consideration were sourced from diverse populations. These studies share key similarities in terms of subject and methodology. Random Effects Model was used to test heterogeneity across studies. The common effect size is 19.361 (z= 4.23, 95% CI: [10.384, 28.338]). Inter-study heterogeneity was determined through Cochran Q test and I^2 index (I^2= % 100, df=32.000, Q=141163533.762, p<0.001).
Originality: No meta analysis of studies calculating productivity with the Malmquist Productivity Index (MPI) has been found in the relevant literature. This study provides robust, valid and reliable parameter estimates for future studies that will use the Malmquist Productivity Index in evaluating banks' productivity.
Keywords: Bank, Productivity, Malmquist Productivity Index, Meta-Regression Analysis.
JEL Codes: C0, D24, M10.

Banka Verimliliği: Bir Meta-Regresyon Analizi

ÖZET
Amaç: Bu çalışmanın amacı, bankalarda verimliliğin hesaplanmasında Malmquist Verimlilik Indeksi (MPI) kullanan çalışmaları incelemektir. Bankaların Toplam faktör verimlilik değişimini etkileyen faktörleri meta-regresyon analizi ile belirlemektir.
Yöntem: Aralık 2023'te "verimlilik" ve "banka" anahtar kelimelerinin yer aldığı tüm çalışmaları kapsayan bir arama Web of Science (WoS), Scopus ve Google Akademik' te yapılmıştır. Araştırma sürecinde PRISMA yönergelerine bağlı kalınmıştır.
***Bulgular**:* Analize 35 çalışma dahil edilmiştir. Çalışmaların %65,71' inin örneklemi Asya ülkeleridir. Banka verimliliğinin %45,71'i DEA-MPI yöntemiyle hesaplanmıştır. Söz konusu çalışmalar farklı popülasyonlardan alınmıştır. Bu çalışmalar konu ve metodoloji açısından temel benzerlikleri paylaşmaktadır. Çalışmalar arasındaki heterojenliği test etmek için Rastgele Etkiler Modeli kullanılmıştır. Ortak etki büyüklüğü 19,361'dir (z= 4,23, %95 GA: [10,384, 28,338]). Çalışmalar arası heterojenlik Cochran Q testi ve I^2 indeksi ile belirlenmiştir. (I^2= % 100, df=32.000, Q=141163533.762, p<0.001).
Özgünlük: Yazında verimliliği Malmquist Productivity Index ile hesaplayan çalışmaların meta analizine rastlanmamıştır**.** Çalışma banka verimliliğinin hesaplanmasında Malmquist Verimlilik İndeksini kullanacak çalışmalar için etkili, geçerli ve güvenilir parametre tahminleri sunmaktadır.
Anahtar Kelimeler: Banka, Verimlilik, Malmquist Verimlilik İndeksi, Meta-Regresyon Analizi.
JEL Kodları: C0, D24, M10.

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1. INTRODUCTION

Banks play a significant role in fostering the development of a country's economy by injecting funds into the financial sector, facilitating the transfer of resources from units with surplus to those with deficits, and providing a variety of innovative services (Uddin et al., 2022). Evaluating bank productivity analyses, financing their investments, ensuring effective fund allocation to firms, and enhancing their capacity to transform inputs like savings and deposits into outputs such as loans are pivotal for depositors, businesses, and the country's economy (Pasiouras and Sifodaskalakis, 2010).

Productivity serves as a key metric for gauging performance. Performance stands out as one of the crucial indicators of competitiveness across companies (Pitaloka et al., 2018; Sukmaningrum et. al., 2023). The elevation of productivity occurs concomitantly with an increase in output variables while maintaining constancy in input variables (Tarwaka, 2005; Sukmaningrum et. al., 2023). Firms express a willingness to identify variables affecting their productivity. Productivity increase boosts the performance and service quality of firms. Productivity ensures the determination of competitive pricing and accurate resource allocation within a business context (Koutsomanoli-Filippaki et. al., 2009; Sukmaningrum et. al., 2023). The Malmquist Productivity Index (MPI) is one of the most commonly employed techniques for measuring the productivity of businesses.

Bank effectiveness and productivity have a significant place in the economic development of countries. In the relevant literature, bank productivity is measured through integrating MPI (Baral and Patnaik, 2023; De, 2021; Otaviya and Rani, 2020), cost-MPI (Walheer, 2018a; Walheer, 2018b; Thanassoulis et al., 2015; Maniadakis and Thanassoulis, 2004), metafrontier cost -MPI (Huang et al., 2015; Cho and Chen, 2021), global cost MPI (Tohidi et al., 2012), global Malmquist-Luenberger productivity index (Zhao et al., 2023; Wu and Fan, 2023; Zhong et al., 2022), global dynamic MPI (Fang et al., 2023; Yang and Soltani, 2021), metafrontier biennial cost-MPI (Du et al., 2023), biennial MPI (Li et al., 2021; Wang et al. , 2020; Zhao and Lin, 2019); DEA-MPI (Majid et al., 2022; Zhu et al., 2021; Defung, 2020), DEA, MPI and regression analysis (Wu et al., 2023; Shair et al., 2021; Rashid et al., 2020).

While studies calculating bank productivity with the MPI exist in the literature, no meta analysis of these studies has been conducted previously. This study delves into the assessment of banks' productivity changes over specified years through the MPI. It specifically focuses on studies that employ MPI for measuring the productivity of banks. Moreover, the study seeks to determine the factors affecting total factor productivity changes used in banks' productivity measurement through meta-regression analysis. The effects on total factor productivity change are determined by synthesizing data from various studies. The risk of bias and limitation inherent in a single study calculating the productivity of banks using MPI is eliminated. By making the literature more accessible, this study provides robust, valid and reliable parameter estimates for future studies that will use the Malmquist Productivity Index in evaluating banks' productivity.

The manuscript is divided into four sections. The first section provides a general overview of the subject. The second section outlines the study's methodology. In the third section, the findings are discussed. The final section presents the results and evaluations.

2. METHOD

On December, 2023, relevant works were systematically reviewed using Web of Science (WoS), Scopus, and Google Scholar. The literature review employed a comprehensive search involving all files with the keywords such as ‘‘productivity” and “bank’’. PRISMA is a set of guidelines designed to help researchers report systematic reviews and meta analyses transparently (Sarkis-Onofre et al., 2021). The research process adhered to the PRISMA guidelines (Moher et al., 2009; Kaya and Algın, 2022).

This study reviewed all studies published between 1931-2023 identifying 170691 studies in the initial scan by the author. The author scrutinized the titles, abstracts, keywords, text, and references of all manuscripts to mitigate selection bias and determine whether eligibility criteria were met. Exclusions from the scope encompassed duplicate downloads, papers, books and book chapters, together with studies having low quality scores, no full-text versions, and those that are irrelevant to the subject. Figure 1 displays the selection process of studies.

Studies from diverse types of publications such as papers, books, book chapters, and articles not written in English, along with duplicate studies, those employing different methods, focusing on profitability, having samples from more than one country, and those with a low-quality score were excluded from the scope. Each selected study underwent a meticulous data collection process, encompassing information such as publication year, sample size, the country of origin for the sample, data collection year, input and output variables, total factor productivity change scores, the software employed, and quality score data. Figure 1 shows the selection process of studies.

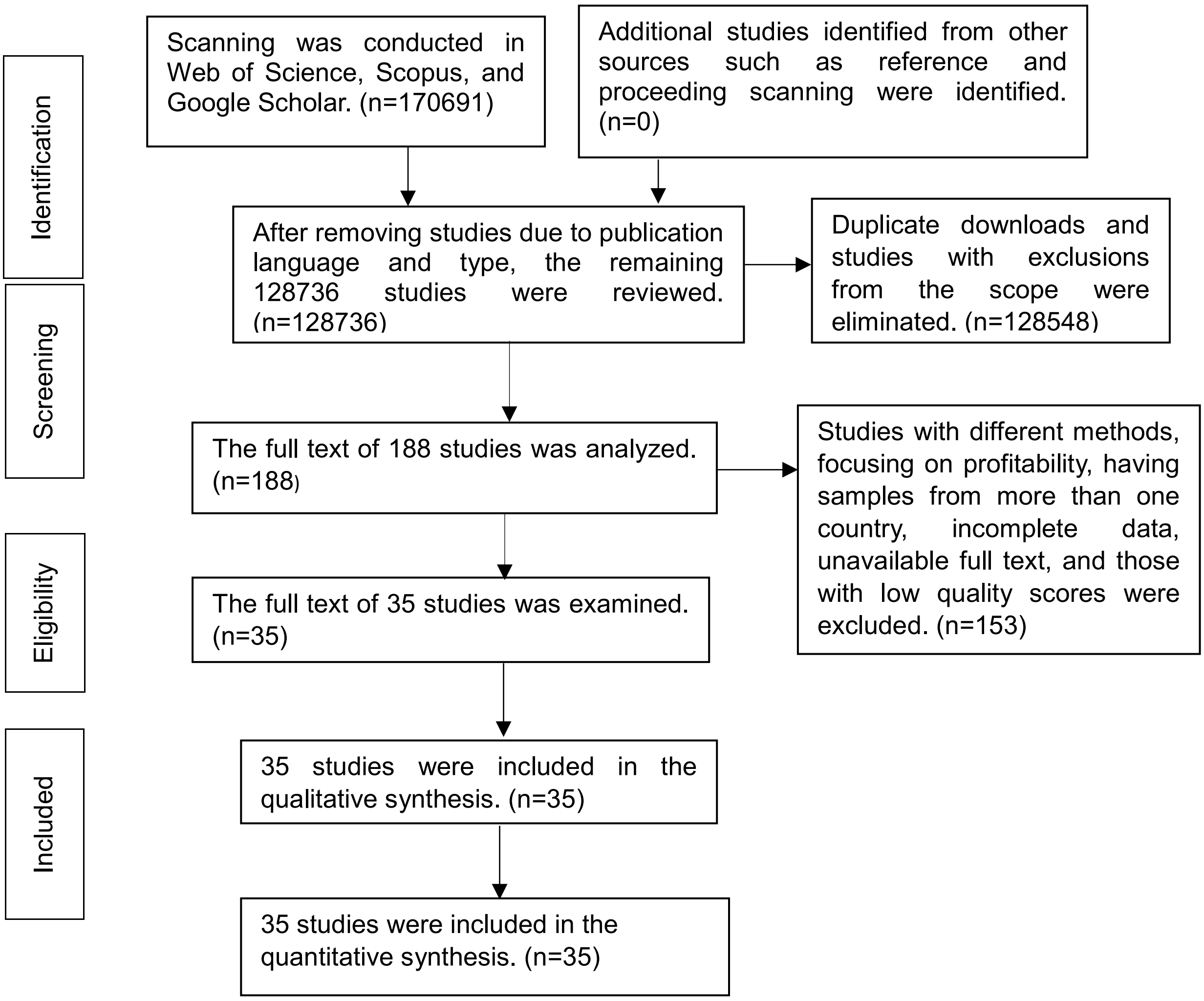

Figure 1. Flow diagram of the study (Moher et al., 2009; Kaya and Algın, 2022)

A 14- question quality checklist covering reporting, external validity, bias and power was employed for calculating the quality score of the studies (Downs and Black, 1998; Varabyova and Müller, 2016). Each question in the checklist received a quality score, with 1 point for meeting the criteria and 0 points for not meeting it (Table 1). Each question in the checklist is numbered in Table 2. The studies were scored based on these questions. The overall quality score for the study was calculated by adding up the scores. Those with a general quality score of 8 and above were included in the analysis (Table 2). The average quality score was found to be 66.4%. A total of 35 studies were selected for further analysis.

3. FINDINGS

Key features of the 35 studies incorporated in the analysis are presented (Table 3). 31.42% of the studies employing the MPI to gauge bank productivity focus on countries classified as high income. Countries in the high-income group exhibit higher bank productivity. Saudi Arabia stands out with the highest TFPCH. Togo, categorized as a low-income country, demonstrates high bank productivity. The samples of 65.71% of the studies are Asian countries. The bank productivity of 45.71% was calculated through the DEA-MPI method.

Table1. Quality checklist of studies

Item	*Scoring*
Reporting	
1. Is the hypothesis/objective of the study clearly described?	35/35
2. Is the underlying economic theory of production/cost properly described? For example, is the reason for selecting input- vs. output orientation (economic justification) given?	34/35
3. Are the input and output variables clearly defined? Is the reason for choosing these variables stated?	35/35
4. Are the findings of the study clearly presented with reference to study objectives?	35/35
5. Are the study limitations discussed (e.g., omitted variables)?	15/35
External Validity	
6. Is the sample inclusive enough (appropriate benchmark)?	35/35
7. Is the assumption of a common technology addressed/tested (e.g., developing and developed countries analyzed together)?	35/35
Bias	
8. Does the analysis result (quantitative/qualitative data) align with the purpose?	35/35
9. Is the method (parametric/non-parametric) appropriate to the subject?	35/35
10. Has the dataset been examined for the presence of outliers?	5/35
11. Is the problem of convergence (σ, β) due to dimensionality properly addressed?	1/35
12. If the second-stage analysis is undertaken, are any statistical problems accounted for?	0/35 N/A=6
Power	
13. Have the sensitivity analyses been conducted?	3/35
14. Are the confidence intervals for productivity estimates generated?	24/35

Note: Yes (1), No/Unclear (0), Not Applicable (N/A)
Source: Downs and Black (1998), Varabyova and Müller (2016).

The studies under consideration were sourced from diverse populations. These studies share key similarities in terms of subject and methodology. Random Effects Model was used to test heterogeneity across studies (Table 4). Prediction was made through maximum likelihood (ML) and 2 out of the 35 studies were excluded due to the inability to calculate Cohen's d value. The common effect size is 19.361 (z= 4.23, 95% CI: [10.384, 28.338]. Inter-study heterogeneity was determined through Cochran Q test and I^2 index (I^2 = % 100 df=32.000 Q=141163533.762 p<0.001). Heterogeneity is high.

The study deployed Egger's Regression test and funnel plot to detect potential publication bias (Figure 2). The results indicated the presence of publication bias (Egger's test = -1.130, p=0.230). Most of the studies were not distributed symmetrically based on the common effect size. The statistical power of the study was calculated with a hypothetical effect size and sample size, resulting in a value of 0.795 (δ=0.5, α=0.05). The statistical power of the study was shown by the p-curve (Figure 3). The analysis, including the calculation of effect size, assessment of heterogeneity, detection of publication bias, and determination of statistical power, was conducted using Jamovi software.

Table2. Quality assessment results

		Reporting					*External Validity*		*Bias*					*Power*		
No	*Author(s)*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*Total Score*
1	Wu et al. (2023)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14 =0,71
2	Majid et al. (2022)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14 =0,64
3	Zhu et al. (2021)	1	1	1	1	1	1	1	1	1	0	0	0	0	0	9/14=0,64
4	Shair et al. (2021)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14 =0,71
5	De et al. (2021)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14=0,57
6	Otaviya et al. (2020)	1	1	1	1	0	1	1	1	1	1	0	0	0	1	10/14=0,71
7	Defung (2020)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14 =0,64
8	Rashid et al. (2020)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14=0,71
9	Zhou et al. (2018)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14=0,57
10	Kasman and Mekenbayeva (2016)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14=0,64
11	George (2015)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14 =0,57
12	Alhassan and Biekpe (2016)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14 =0,64
13	Alhassan and Asare (2016)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14 =0,71
14	Sharma and Sharma (2015)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14=0,71
15	Daştan and Çalmaşur (2015)	1	1	1	1	1	1	1	1	1	1	1	0	0	0	11/14=0,78
16	Sufian and Kamarudin (2014)	1	1	1	1	1	1	1	1	1	0	0	0	1	1	11/14=0,78
17	Sufian and Habibullah (2014)	1	1	1	1	0	1	1	1	1	1	0	0	1	1	11/14=0,78
18	Keskin Benli and Degirmen (2013)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14=0,57
19	Sufian (2012)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14 =0,71
20	Kasman and Kasman (2011)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14=0,71
21	Arjomandi et al. (2011)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14=0,64
22	Pasiouras and Sifodaskalakis (2010)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14=0,57
23	Akhtar (2010a)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14=0,57
24	Akhtar (2010b)	1	1	1	1	1	1	1	1	1	0	0	0	0	0	9/14=0,64
25	Sufian (2009)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14=0,71
26	Chortareas et al. (2009)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14=0,64
27	Tortosa-Ausina et al. (2008)	1	1	1	1	0	1	1	1	1	1	0	0	1	1	11/14=0,78
28	Guzman and Reverte (2008)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14=0,64
29	Omar et al. (2007)	1	1	1	1	0	1	1	1	1	0	0	0	0	0	8/14=0,57
30	Rezitis (2006)	1	1	1	1	1	1	1	1	1	0	0	0	0	1	10/14=0,71
31	Isik and Hassan (2003).	1	1	1	1	0	1	1	1	1	1	0	0	0	1	10/14=0,71
32	Alam (2001)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14=0,64
33	Mukherjee et al. (2001)	1	1	1	1	0	1	1	1	1	0	0	0	0	1	9/14=0,64
34	Chen and Yeh (2000)	1	0	1	1	1	1	1	1	1	0	0	0	0	1	9/14=0,64
35	Noulas (1997)	1	1	1	1	1	1	1	1	1	0	0	0	0	0	9/14=0,64

Table3. Studies examined in meta-regression analysis

Author(s)	*Country*	*Method*	*Sample Period*	*Tfpch*
Wu et al. (2023)	China	DEA, MPI, Regression Analysis	2011-2019	0,995
Majid et al. (2022)	Indonesia	DEA, MPI	2015-2020	1,097
Zhu et al. (2021)	Pakistan	DEA, MPI	2006–2017	0,981
Shair et al. (2021)	Pakistan	DEA, MPI, GMM	2007–2017	1,010
De et al. (2021)	India	MPI	2001-2010	1,037
Otaviya and Rani (2020)	Indonesia	MPI	2011-2018	1,053
Defung (2020)	Indonesia	DEA, MPI	1993-1994/ 2010-2011	1,009
Rashid et al. (2020)	Bangladesh	DEA, MPI, Regression Analysis	2013-2017	1,034
Zhou et al. (2018)	Togo	DEA, MPI	2000–2008	1,315
Kasman and Mekenbayeva (2016)	Kazakh	DEA, MPI	2000-2013	1,021
George, (2015)	Greece	DEA, MPI	2013-2014	1,173
Alhassan and Biekpe (2016)	Ghana	MPI	2003-2004/ 2010-2011	1,018
Alhassan and Asare (2016)	Ghana	MPI	2003-2004/ 2010-2011	1,069
Sharma and Sharma (2015)	India	DEA, MPI, Panel Regression Analysis	2000–2010	1,069
Daştan and Çalmaşur (2015)	Türkiye	DEA, MPI	2003-2004 / 2013-2014	1,052
Sufian and Kamarudin (2014)	Malaysia	MPI	1998-2008	1,097
Sufian and Habibullah (2014)	Malaysia	MPI, Panel Regression Analysis	1998-2007	0,994
Keskin Benli and Degirmen (2013)	Türkiye	DEA, MPI	2004-2009	1,050
Sufian (2012)	China	MPI	2000-2001/2004-2005	1,029
Kasman and Kasman (2011)	Türkiye	DEA, MPI	1998-1999/ 2007-2008	1,001
Arjomandi et al. (2011)	Iran	DEA, MPI	2003-2004/ 2007-2008	1,052
Pasiouras and Sifodaskalakis (2010)	Greece	MPI	2000-2005	1,018
Akhtar (2010a)	Saudi	DEA, MPI	2001-2006	1,270
Akhtar (2010b)	Saudi	DEA, MPI	2001-2006	1,330
Sufian (2009)	Malaysia	MPI	2001–2002/ 2003-2004	0,983
Chortareas et al. (2009)	Greece	DEA, MPI	1998–1999/2002-2003	1,147
Tortosa-Ausina et al. (2008)	Spanish	MPI	1992-1993/1997-1998	1,206
Guzman and Reverte (2008)	Spanish	DEA, MPI	2000–2001/2003–2004	1,022
Omar et al. (2007)	Indonesia	DEA, MPI	2002-2003/2003-2004	1,141
Rezitis (2006)	Greece	DEA, MPI, Tobit Regression Analysis	1982-1983/1996-1997	1,028
Isik and Hassan (2003)	Türkiye	MPI	1992-1996	0,972
Alam (2001)	US	MPI	1980-1981/1988-1989	0,999
Mukherjee and Miller (2001)	US	MPI	1984-1985/ 1989-1990	1,045
Chen and Yeh (2000)	Taiwan	DEA, MPI	1993-1994	1,013
Noulas (1997)	Greece	MPI	1991-1992	1,080

Table 4. Heterogeneities of studies

Author(s)	*Effect Size*	*95 % CI [Lower Bound, Upper Bound]*
Zhu et al. (2021)	9.96	[9.91, 10.0]
Shair et al. (2021)	7.61	[7.56, 7.66]
De et al. (2021)	16.84	[16.82, 16.87]
Otaviya and Rani (2020)	2.91	[2.69, 3.14]
Defung (2020)	9.57	[9.55, 9.59]
Rashid et al. (2020)	15.02	[15.01, 15.04]
Zhou et al. (2018)	4.99	[4.86, 5.11]
Kasman and Mekenbayeva (2016)	10.58	[10.56, 10.61]
George (2015)	118.26	[118.21, 118.32]
Alhassan and Biekpe (2016)	8.08	[8.02, 8.13]
Alhassan and Asare (2016)	6.25	[6.17, 6.33]
Sharma and Sharma (2015)	5.06	[5.01, 5.11]
Daştan and Çalmaşur (2015)	8.21	[8.19, 8.23]
Sufian and Kamarudin (2014)	19.74	[19.71, 19.76]
Sufian and Habibullah (2014)	10.36	[10.32, 10.40]
Keskin Benli and Degirmen (2013)	13.73	[13.66, 13.80]
Sufian (2012)	39.51	[39.50, 39.52]
Kasman and Kasman (2011)	30.82	[30.80, 30.84]
Arjomandi et al. (2011)	6.50	[6.42, 6.57]
Pasiouras and Sifodaskalakis (2010)	14.85	[14.84, 14.87]
Akhtar (2010a)	3.09	[2.85, 3.34]
Akhtar (2010b)	1.95	[1.55, 2.35]
Sufian (2009)	12.26	[12.21, 12.32]
Chortareas et al. (2009)	7.92	[7.84, 8.00]
Tortosa-Ausina et al. (2008)	104.341	[104.21, 104.46]
Guzman and Reverte (2008)	34.81	[34.79, 34.82]
Omar et al. (2007)	1.75	[1.55, 1.94]
Rezitis (2006)	53.27	[53.27, 53,28]
Isik and Hassan (2003)	12.12	[12.08, 12.16]
Alam (2001)	18.39	[18.38, 18.40]
Mukherjee et al. (2001)	13.49	[13.48, 13.50]
Chen and Yeh (2000)	9.86	[9.66, 10.06]
Noulas (1997)	6.79	[6.58, 7.00]

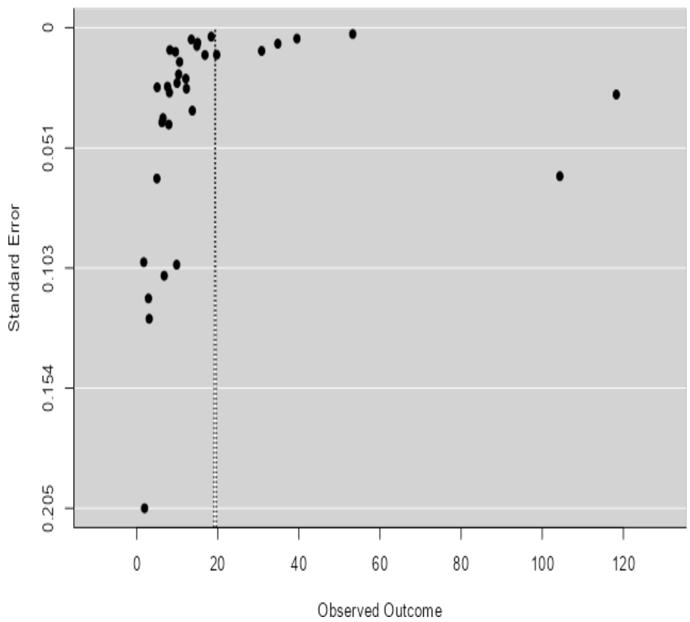

Figure 2. Publication bias of the studies

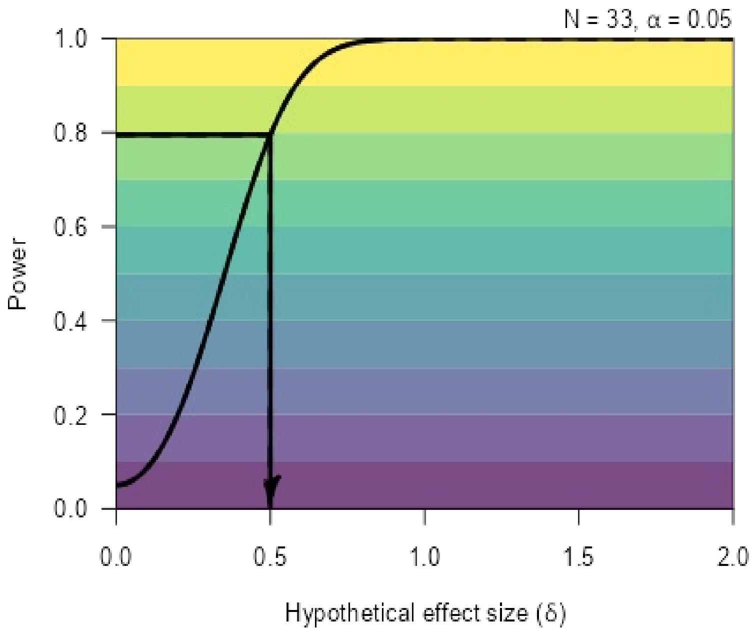

Figure 3. Statistical power of the studies

A meta-regression analysis was conducted to evaluate the estimated average technical efficiencies derived from the collected data (Table 6). The dependent variable in the Tobit model was the total factor productivity change. Based on the literature and model features, the explanatory variables included the number of observations, number of variables, and the number of years of data collection. Additionally, dummy variables were introduced for the income group of the country in the sample, the continent where the country is located, the method(s) employed in the studies, and the year of publication (Table 5). It was assumed that the productivity change of banks may be explained by the characteristics of the studies such as the number of samples, the method of the study, and the group of the country from which the sample was drawn (Kaya and Algın, 2022).

Table 5. Variables used in analysis

Variable Type	*Definition*
Dependent Variable	
$TFPCH$	Total factor productivity change
Independent Variables	
O	Number of observations
V	Number of Variable
DC	Year of Data Collection
Dummy Variables	
P	Year of Publication
IG	Income Group
C	Continent
M	Methodology

Total factor productivity chance is estimated by the following models (Equation 1-3).

Model 1: $TFPCH_i = \alpha_0 + \beta_1 O_i + \beta_2 V_i + \varepsilon_i$ (1)

Model 2: $TFPCH_i = \alpha_0 + \beta_1 O_i + \beta_2 V_i + \beta_3 M_i + \varepsilon_i$ (2)

Model 3: $TFPCH_i = \alpha_0 + \beta_1 O_i + \beta_2 V_i + \beta_3 M_i + \beta_4 IG_i + \beta_5 C_i + \beta_6 DC_i + \beta_7 P_i + \varepsilon_i$ (3)

Tobit method was used to estimate banks' productivity. Considering the methodology and data used in the analysis, Tobit is deemed the most methodologically appropriate. The number of observations and the number of variables were incorporated into Model 1. Besides, the number of observations, number of variables and method were included in Model 2. Furthermore, Model 3 considered the effects of all variables. The number of observations, the method and variables related to the country's income group are effective on the estimation of total factor productivity change within the models (p = 0.05). The number of variables in Model 1, the number of variables in Model 2, the number of variables, the variables continent, publication year, and data collection year in Model 3 were not statistically significant. The number of variables was not statistically significant across all models. The number of observations held statistical significance in all four models. The dummy variable consisting of the methods used to calculate bank productivity was statistically significant in both Model 1 and Model 2. The results of these models are consistent with the data detailed in Table 3.

Table 6. Tobit Analysis results for TFPCH

	Model 1		*Model 2*		*Model 3*	
Variables	*Tobit (S.E)*	*p*	*Tobit (S.E)*	*p*	*Tobit (S.E)*	*p*
Constant	0.000575 (0.00290)	0.0000***	0.000558 (0.00277)	0.0000***	0.000645 (0.00521)	0.0000***
O	-0.00989 (0.00404)	0.0144*	-0.000112 (0.00367)	0.0023**	-0.000109 (0.00316)	0.0005***
V	-0.000418 (0.010371)	0.9678	0.011887 (0.011087)	0.2837	0.007891 (0.011223)	0.4820
M			-0.00471 (0.00199)	0.0177*	-0.000498 (0.000158)	0.0016**
IG					-0.00692 (0.00224)	0.0020**
C					0.00109 (0.00182)	0.5505
DC					-0.003496 (0.008210)	0.6703
P					-0.00415 (0.00303)	0.1707
Loglikelihood	293.8977		296.2409		301.9648	
Regression S.E	0.00475		0.00478		0.00474	

Note: ***p<0.001 **p<0.010 *p<0.05

4. CONCLUSION

Malmquist Productivity Index (MPI) is frequently used in bank productivity studies due to its easy understandability and applicability. The full text of 35 empirical articles published between 1931 and 2023 was reviewed. In this regard, the variables affecting total factor productivity change were determined through meta-regression analysis. This study aims at establishing the connection between this study and those on bank productivity using the meta-analysis method. All studies related to the subject were scanned in the present study. The samples of most of the studies using MPI on bank productivity consist of high-income and Asian countries. Total factor productivity change scores are negatively and significantly related to the number of observations, method and income group of the country where the sample is selected.

The study has certain limitations. One limitation is the potential presence of language bias. Besides, a notable limitation is the lack of consideration for bank ownership (private, public and foreign) in most of the studies. Moreover, variables related to the financial system and sector reforms of the countries were not taken into account. These limitations in the literature also affect the results of the study.

The reliability of meta-regression analysis results depends on the quality of the studies under examination, the variables used and the steps followed in the analysis process. In this study, meta-regression analysis systematically provided valuable insights into the effects of methodological assumptions on the productivity of banks, consolidating empirical findings from various sources. By making the literature more accessible, this study serves as a resource for researchers aiming to utilize the Malmquist Productivity Index (MPI) in gauging bank productivity.

This study is expected to guide managers in enhancing bank productivity, taking national requirements into account, formulating and implementing legal regulations, and determining policies. Future studies may carry out a meta analysis of studies calculating the productivity of different sectors using MPI to contribute to the literature and the sector.

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