Twenty years of efficiency research in Czech and Slovak banking – A bibliometric analysis

Martin Boďa[1], Emília Zimková[2], Anton Karaka[3]

[1] *Jan Evangelista Purkyně University in Ústí nad Labem, Faculty of Social and Economic Studies, Department of Finance and Accounting, Czech Republic, ORCID: 0000-0002-7503-6898, martin.boda@outlook.com;*
[2] *Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Finance and Accounting, Slovakia, ORCID: 0000-0003-1648-8103, emilia.zimkova@umb.sk;*
[3] *Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Finance and Accounting, Slovakia, karaka-anton@gmail.com.*

Abstract: *The article is a survey of 44 empirical studies that applied frontier techniques in analyzing efficiency of Czech and Slovak commercial banks in a hope to summarize the state of the art of efficiency research in Czech and Slovak banking. A sample of 44 journal articles was extracted from the Web of Science™ database, and a bibliometric analysis was conducted to identify the most active authors and most influential works to establish mutual relationships between them and to sketch the main research trajectories. The paper contributes to the extant literature by providing guidance for new researchers and identifying for efficiency research on Czech and Slovak banking: (i) the most productive authors as well as the works with the most impact; (ii) the network structure amongst the authors and works; and (iii) main paths of knowledge diffusion across the surveyed works. The findings indicate that efficiency research of Czech and Slovak banks grew out of global banking efficiency research and is thus its integral part. Lotka's law applied to Czecho-Slovak banking efficiency research does not suggest that its productivity patterns are altogether different from its global counterpart. The first identifiable wave of research was represented by foreign authors who examined issues of economic transition and its impact on the performance of banks. This wave of research endured until about 2013, when the torch passed into the hands of authors of domestic provenience. The findings are useful in bridging the gap between the accumulated knowledge in the field and the new research directions.*

Keywords: *Banking efficiency, Czech banks, Slovak banks, research trajectory, bibliometric analysis.*

JEL Classification: *G21, L25.*

APA Style Citation: Boďa, M., Zimková, E., & Karaka, A. (2025). Twenty years of efficiency research in Czech and Slovak banking – A bibliometric analysis. *E&M Economics and Management, 28*(1), 135–151. https://doi.org/10.15240/tul/001/2025-1-009

Introduction

The upsurge of banking efficiency as a central topic of analytical and empirical literature in the past four decades (Berger & Humprey, 1997; de Abreu et al., 2019; Duygun-Fethi & Pasiouras, 2010) has four major reasons. A first reason is the fact that the concept of efficiency builds on microeconomic foundations, and understanding it only requires taking an elementary course in economics. A second reason is that efficiency is a concept that puts an activity or unit (such as a bank) into a direct confrontation with an optimal situation. A third reason is that the concept of efficiency is easily usable even in complex situations when several performance factors (such as inputs, outputs, and operating variables) must be considered simultaneously. Finally, a fourth reason is that econometrics and operations research have provided efficiency measurement with

fully fledged and sound tools that are adjustable to particular situations.

The contemporary Czech and Slovak banking sectors have been operating in market conditions since the early 1990s, and in the first decade of their renewed market existence, they had to struggle with extensive banking reforms aimed at securing their survival and stability after the damage caused by both the initial undercapitalization and the absence of prudential regulation. Having been solidified with the turn of the new millennium, the early 2000s became the landmark when more serious academic research sprang out to investigate the issues of performance, competitiveness, stability, liquidity and capital adequacy of Czech and Slovak commercial banks. The first academic studies took form of international comparisons and were originated by foreign authors that explored the legacies of economic transition and the effects of ownership upon performance of Czech and Slovak banks in confrontation to banks in other transition economies or to western banks. Only in their wake came domestic authors with a focus specialized mostly upon Czech and/or Slovak commercial banks or possibly their branches. A body of empirical literature has arisen in which efficiency has become synonymous with performance, partly understood in a multitude of forms. Efficiency as a major object in banking academic research has presently stepped down in favour of a more diversified portfolio of research interests such as macroprudential regulation and financial stability, and the initial efficiency-related research front has become saturated.

Based upon a selection of 44 journal articles extracted from Web of Science™ that are thematically devoted to efficiency measurement in Czech and Slovak banking, this paper performs a bibliometric analysis of the main works that have shaped and advanced knowledge on the efficiency of Czech and Slovak banks. The exploration relies entirely on articles published in journals with a peer-review process, and excludes conference papers that are generally known to be of lesser quality, although their presentation before a wider audience was effective in the diffusion and dissemination of knowledge amongst Czech and Slovak researchers who took up the initiative in the last decade. The exploration covers articles published in the past two decades between 2002 and 2022, and the paper contributes to the extant literature by identifying for banking research on Czech and Slovak banking: (i) the main research fronts followed by the authors; (ii) the most productive authors as well as the works with the most impact; (iii) the network structure amongst the authors and works, and main paths of knowledge diffusion across the surveyed works. These interests facilitate a general view of the research field on Czecho-Slovak banking efficiency, and their coverage ranges from performance analysis (ii) to science mapping (i, iii). Being two basal methodologies in bibliometrics, performance analysis measures the position of the field in terms of scientific outputs, science mapping outlines the relationship between authors, citations and the flow of information amongst the authors (Öztürk et al., 2024). Inter alia, bibliometric analysis can be instrumental in identifying research gaps (Fergnani, 2019), and this is also anticipated of the current bibliometric survey: to wit, to identify underexplored elements of efficiency research.

With a geographical focus upon two post-Socialist and post-transition economies, the operating space is admittedly much narrower than that available for studies with a global focus (e.g., Berger & Humphrey, 1997; de Abreu et al., 2019; Duygun-Fethi & Pasiouras, 2010). Nonetheless, the outcomes of the study are not only suited to researchers interested in Czech and Slovak banks alone. More importantly, they also provide first guidance to those scholars who wish to study the effects of transitional and consolidation reforms in a particular set-up of post-Socialist countries that lived in a multinational federation and split up peacefully to follow a path of European integration after a decade. Albeit it was not sort of uncommon for multi-national states in the Eastern Block to dissolve (Bunce, 1999), this is a rare case when the process of disintegration was not violent, and was later crowned by joining a project of a higher economic integration. Hence, that this paper considers Czech and Slovak banking simultaneously is but natural given the fact that both banking sectors shared their history until the end of 1992, and after the split in 1993 they had to undergo a series of similar reforms. Whereas roughly the first decade of the surveyed portfolio of articles is concerned with the transition experience, the second decade is more engaged in monitoring the effects of European integration.

Aside from their shared political and socio-economic history until 1993, Czechia and Slovakia represent an interesting case study in and of themselves. As also echoes amongst the analytical outcomes of the present study, both banking sectors experienced in the 1990s a painstaking transformation process, and extensive changes were undertaken in multiple areas. They aimed at the consolidation in order to remove classified loans from balance sheets of commercial banks and strengthen capital adequacy, and they also aspired to improve the ownership structure through privatization and inviting the entry of foreign capital in the hope of acquiring new know-how from foreign investors (Medveď et al., 2012). Given the small size of both banking sectors, both banking sectors were constructed as small nets of universal banks that would provide a range of services to their customers without a particular emphasis on specialization (Šestáková & Ferenčíková, 2015). A consequence is that both banking sectors share a similar banking structure (Cienski, 2011) that remain relatively highly concentrated, with 5-bank concentration ratios remaining across 1993 to 2021 at an average 75% for Czechia and 90% for Slovakia (World Bank, 2022). Nonetheless, they are both underbanked compared with western Europe, which is then reflected in their relatively low deposit-to-gross-domestic-product and loans-to-gross-domestic-product ratios (World Bank, 2022). Czech and Slovak banks tilt towards conservative models with an emphasis upon the domestic retail and corporate segments, which is also the reason that they were never seriously hit by the Global Financial Crisis as they had not participated in innovative products (Cienski, 2011). The abstinence of highly risky business engagements was a natural consequence of their enjoyably high level of liquidity that has remained to date (European Commission, 2024; Palečková & Klepková Vodová, 2021). Although the banking sectors of Czechia and Slovakia have many striking similarities, and both countries joined the European Union in the same year, their economies have, in fact, taken different reform paths with differently timed measures. In this respect, Slovakia is evaluated as extraordinarily pro-reformist and the implemented reforms attracted capital inflows and helped the re-orientation of Slovakia to western markets, which was also aided partly by the euro adoption in 2009 (Horská & Prega, 2023). For these reasons, comparisons of efficiency of Czech and Slovak banks are likely to remain perennial challenges also in the future research.

The field has progressed considerably since the last survey on banking efficiency in Central or Eastern European (CEE) countries by Banerjee (2012). With a greater and updated selection of articles, the present paper may be envisioned to ignite this sort of interest specialized to a territorial selection of countries where specific topics such as those linked with economic transition or bank competition are of paramount importance in addition to otherwise standard performance assessment of banks.

The remainder of the paper is organized into three more sections. Section 2 gives details on the compilation of the surveyed papers. The results of the bibliometric analysis are presented in Section 3. The last Section 4 discusses and concludes.

1. Data

For economics fields, there are three basic sources to identify relevant publications for state-of-the-art surveys and bibliometric analyses: Web of Science™ (currently maintained by Clarivate PLC, Pennsylvania, USA), Scopus® (provided by Elsevier B. V., the Netherlands) or Google Scholar (operated by Google LLC, California, USA). Of these, the first two are citation databases provided as a paid service and are fully recognized in the academic community; whereas the last one is a freely accessible web search engine that emulates the functions of full-text and citation databases and has only a complementary status. Albeit none of them can be claimed to have full coverage and different strategies were implemented to identify relevant documents to review and analyse (e.g., Banerjee, 2012; Fall et al., 2018; Kaffash et al., 2020; Kumar & Gulati, 2014; Liu et al., 2013), Web of Science is certainly most comprehensive and is chosen here as the main source.

With reliance upon Web of Science, a two-stage procedure was applied at the end of February 2022 to select the set of 44 journal articles. The list of the selected articles is reported at the end of the concluding section. Only journal articles that presented (solely or predominantly) applied research in bank efficiency in Czechia or Slovakia using a frontier method were

qualified for this survey. Five approaches have been counted amongst frontier methods as they have profiled themselves over the years in banking efficiency literature (Banerjee, 2012; Berger & Humphrey, 1997; Kumar & Gulati, 2014): stochastic frontier analysis (SFA), the distribution-free approach (DFA) and the thick frontier approach (TFA), data envelopment analysis (DEA), and free-disposal hull (FDH).

In the first stage, a search in the Web of Science Core Collection was conducted in the abstracts, keywords and titles of documents for search words filtering the output related to: (i) banking; (ii) efficiency; (iii) Czechia or Slovakia. Different combinations were successively employed; to wit: efficiency Slovak banks/banking, efficiency Czech banks/banking, bank/banking efficiency Slovakia/Czechia, bank/banking efficiency Slovak/Czech Republic. The search targeted only journal articles (either published or in the early access stage) and data papers. Conference papers were not included in the search inasmuch as only rigorously peer-reviewed scientific output was intended for the survey. Conference proceedings typically organize research output with preliminary results and are notorious for their varying quality. Subject to exclusion was also other publication output such as working papers, research reports, monographs or chapters in edited monographs, dissertations. Such an exclusion of minor research output is in tune with best practices in state-of-the-art and bibliometric surveys (e.g., Banerjee, 2012; Duygun-Fethi & Pasiouras, 2010; Kaffash et al., 2020). The initial search returned a list of 324 candidate articles, which were screened by examining their titles and abstracts and reviewing their contents for compliance with the qualifying criteria. This narrowed the initial list to 44 articles (the full list is provided at the end of the concluding section). The qualifying criterion of applied research turned out to be crucial in distinguishing purely methodological developments (reposing in this case on DEA) illustrated on Czech or Slovak banks or bank branches from papers that contribute to understanding efficiency in Czech and Slovak banking. Nonetheless, the stipulation that an article be included in Web of Science caused that some articles slipped the survey (e.g., Stavárek, 2005b), which may pose some limitations on the scope of the survey.

The analysis in this paper is based not only on individual papers, but also on their full bibliographic records available and downloaded from Clarivate's Web of Science (especially citations and journal citation metrics). This bibliometric analysis ensues in the next section. Some summaries of the bibliographic data extend purely quantitative information on authors and their published output by additional qualitative information on the journals that published the surveyed efficiency research on Czech and Slovak banks. Specifically, the quality of journals is represented by two journal metrics extracted from Clarivate's Journal Citation Reports™ for 2021, which is the latest available year in the time of writing this survey. Insomuch as for a good many journals their journal impact factors were not available, two less known, if more refined, journal metrics are utilized instead; to wit, the Article Influence Score™ (AIS) as well as the normalized Eigenfactor™ Score (nEF). Both metrics are intended to capture the prestige of a journal in the scientific community and are an improvement upon the journal impact factor (Bergstrom et al., 2008). Whilst they are constructed in such a way that an average journal has an AIS of 1.00 and/or an nEF of 1.00, a rough difference between them lies in that that the former gauges the importance per article, and the latter the importance of all articles published in the journal. Their advantage, amongst others, is in their review time frame since they monitor and aggregate citation impact for a five-year period.

2. Bibliometric analysis

The present analysis of scholarly literature on efficiency of Czech and Slovak banks serves a three-fold purpose. First, it seeks to establish productivity and citation patterns detectable in the surveyed empirical literature. Second, it strives to outline and determine relationships amongst the authors and articles. Finally, it aspires to highlight main flows of knowledge diffusion amongst the articles.

The survey comprises a total of 44 articles, authored or co-authored by 63 researchers who produced an average 1.508 ± 1.311 articles on banking efficiency spotlighting at least marginally Czech or Slovak banks. Whereas every article was written by one to five authors, most of these articles were originated by a single author or by a pair of authors, which were 17 articles in either case. Subsequently, 6, 3, and 1 published articles were written by three, four and five authors. Only three researchers

published each article of theirs alone, and as many as 5 articles arose in this self-reliant fashion (i.e., Palečková, 2017, 2019; Stavárek, 2005a, 2006; Svitálková, 2014). Despite the fact that the language was not a selection criterion, almost all the surveyed articles were written in English, and only 6 articles were published in a different language. Specifically, 4 articles were published in Slovak (Baruník & Soták, 2010; Boďa, 2019; Kočišová, 2012, 2014b), and there were per one case of an article written in Czech (Stavárek, 2005a) and French (Weill, 2006).

The articles included in the survey were published in 27 different scholarly journals and their distribution points to an extremely low level of concentration in these journals. Tab. 1 reports 13 academic journals that published more than one paper and their catalogue comprises 6 periodicals that are operated by publishers located in the CEE area. It is but understandable that unless an article is shaped as an extensive comparative study across a range of countries, its international reach is rather limited, and its authors are likely to face troubles with finding an appropriate outlet for their research. It is then easy to surmise that the reach to an international audience and knowledge diffusion may be notably restricted. This unfortunate bias is also attested by the fact that top-quality journals are not particularly listed. For instance, only two journals are tagged in Tab. 1 with an above-average AIS or an average nEF. For the 27 target journals of Czecho-Slovak banking efficiency research, these averages for 2020 were

Tab. 1: Target journals with at least two published articles

# articles	Journals
4	Ekonomický časopis, Comparative Economic Studies, Journal of Banking & Finance†/‡
2	Acta Oeconomica, Acta Polytechnica Hungarica, E&M Economics and Management, Eastern European Economics, Economic Change and Restructuring, Economics of Transition†, Finance a úvěr – Czech Journal of Economics and Finance, Politická ekonomie

Notes: The symbols † and ‡ in superscripts denote journals whose AIS or normalized eigenfactor score, respectively, is above average amongst the 29 journals that provided publication outlets of efficiency research in Czech and Slovak banking.

Source: own

0.371 and 0.540, respectively. The distribution of journal metrics for the 27 target journals is extremely right-skewed.

Unlike other similar recent surveys (e.g., Bhukya et al., 2022; de Abreu et al., 2019; Kaffash et al., 2020), this analysis handles productivity and citations of individual authors not only in the sense of gross counts, but also in the sense of their co-authorship shares. These concepts coincide with what Perianes-Rodriguez et al. (2016) call full and fractional counting, respectively, albeit their terminology arises in construction of bibliometric networks. If an article emerged from a collaborative effort of n authors and has received k citations, with full counting each author is assigned for the given article a count of 1 and a full number of k citations. In contrast, under fractional counting each author is attributed only a $1/n$-th of an article with k/n citations. Certainly, it would be ideal to allocate the count and citations amongst the authors in proportions in which they contributed to the writing of the article, but this information is not normally available.

The most prolific authors are reported in Tab. 2 and their report is restricted to the authors whose number of published works for full and fractional counting is above average. For most authors, going from full counting to fractional counting does not affect much their relative position in the ranking. In terms of the quantity of published articles, the most prolific authors are those of Czecho-Slovak provenance (K. Kočišová, M. Boďa, E. Zimková, I. Palečková, D. Stavárek) plus an author of French provenience (L. Weill).

Tabs. 3–4 give a list of the most cited articles and the most cited authors. For articles, two aggregate citations metrics are displayed;

Tab. 2: Ranking of the prolific authors

Full counting			Fractional counting		
Rank	**Name**	**Count**	**Rank**	**Name**	**Count**
1–2	K. Kočišová	7.00	**1–2**	K. Kočišová	5.33
	L. Weill			L. Weill	
3	M. Boďa	6.00	**3**	M. Boďa	4.00
4	E. Zimková	3.00	**4–5**	I. Palečková	2.00
5–14	A. M. Andrieș	2.00		D. Stavárek	
	J. P. Bonin		**6–8**	A. M. Andrieș	1.50
	I. Hasan			A. Kasman	
	A. Kasman			E. Zimková	
	J. Lešanovská		**9–10**	J. Podpiera	1.00
	I. Palečková			Z. Svitálková	
	J. Podpiera		**11–12**	J. Lešanovská	0.83
	A. Pruteanu-Podpiera			A. Pruteanu-Podpiera	
	D. Stavárek				
	P. Wachtel				

Source: own

to wit, total citations and citations per year. Citations per year follow from dividing total citations by the number of years that have elapsed since official publication determined by the formula max {2022 − publication year, 1}, where the maximum makes amends for Moudud-Ul-Huq et al. (2022). For authors, citations are considered in measurements arising from full and fractional counting. Tab. 3 exhibits the top 10 most cited surveyed articles in total or per year. Apparently, citations per year is a better metric of impact for fresher publications that have not had an opportunity to attract sufficient attention as yet than older articles. Moving from total citations to citations per year only induces a slight permutation in the position of the eight first articles and updates the articles at positions 9 and 10. Useful information is that an article in the survey during its life generated on average 45.591 ± 94.351 citations altogether and 3.464 ± 5.807 citations per year, which demonstrates a good scientific impact of the articles reported in Tab. 3, leastwise in comparative terms. Simultaneously, the high standard deviations attest to high heterogeneity in citations amongst the authors. The most cited positions are occupied by cross-country studies whose research agenda focused upon banking efficiency in transition economies. These studies were first to explore the effects of transition reforms (Fries & Taci, 2005), ownership (Bonin et al., 2005a; Fries & Taci, 2005; Weill, 2003), privatization (Bonin et al., 2005b) or to perform extensive comparisons of banking efficiency whilst identifying drivers of efficiency (Grigorian & Manole, 2006; Kasman & Yildirim, 2006). Exceptions are Podpiera and Weill (2008) who sought connections between banking efficiency and non-performing loans with a focus on Czech banks only, and Balcerzak et al. (2017) who assessed the efficiency of 28 European Union banking sectors. Tab. 4 resembles Tab. 3 and comes almost as its transposition by listing the 11 most cited authors identified by full as well as fractional citation counts. The average number of citations per author amongst the surveyed works was 82.105 ± 157.765 citations under full counting and 35.193 ± 64.140 citations under fractional counting, so Tab. 4 contains safely above-average cited researchers. A notable aspect behind the lists in Tab. 4 is that their positions are occupied by pioneers on the topic of banking efficiency in transition countries, to Czecho-Slovak conditions foreign authors who made an early contribution to this fledgling

research area. Their publication at the inception of this research front in applied economics in journals of good standing ensured them accelerated citations, albeit some of them have had only one shared research output (S. Fries, A. Taci, C. Yildirim, V. Manole, D. A. Grigorian) or two shared publication outputs (J. P. Bonin, I. Hasan, P. Wachtel, A. Kasman, J. Podpiera).

Tab. 3: Ranking of the most cited articles

Total citations			Citations per year		
Rank	**Article**	**# citations**	**Rank**	**Article**	**# citations**
1	Bonin et al. (2005a)	472	**1**	Bonin et al. (2005a)	27.765
2	Fries and Taci (2005)	385	**2**	Fries and Taci (2005)	22.647
3	Bonin et al. (2005b)	172	**3**	Balcerzak et al. (2017)	16.000
4	Weill (2003)	141	**4**	Bonin et al. (2005b)	10.118
5	Kasman and Yildirim (2006)	112	**5**	Podpiera and Weill (2008)	7.643
6	Podpiera and Weill (2008)	107	**6**	Weill (2003)	7.421
7	Grigorian and Manole (2006)	105	**7**	Kasman and Yildirim (2006)	7.000
8	Balcerzak et al. (2017)	80	**8**	Grigorian and Manole (2006)	6.563
9	Pruteanu-Podpiera et al. (2008)	63	**9**	Matoušek et al. (2015)	5.000
10	Andrieș (2011)	37	**10**	Havránek et al. (2016)	4.833

Notes: Only citations in the Web of Science Core Collection are taken into account. Nonetheless, calculating with citations in all Web of Science databases will not affect the reported ranking.

Source: own

Tab. 4: Ranking of the most cited authors

Full counting			Fractional counting		
Rank	**Authors**	**# citations**	**Rank**	**Authors**	**# citations**
1–3	J. P. Bonin	644	**1**	L. Weill	250.000
	I. Hasan	644	**2–4**	J. P. Bonin	214.667
	P. Wachtel	644		I. Hasan	214.667
4–5	S. Fries	385		P. Wachtel	214.667
	A. Taci	385	**5–6**	S. Fries	192.500
6	L. Weill	346		A. Taci	192.500
7	A. Kasman	126	**7**	A. Kasman	70.000
8	J. Podpiera	116	**8**	J. Podpiera	58.000
9	C. Yildirim	112	**9**	C. Yildirim	56.000
10–11	D. A. Grigorian	105	**10–11**	D. A. Grigorian	52.500
	V. Manole	105		V. Manole	52.500

Notes: Only citations in the Web of Science Core Collection are taken into account. Nonetheless, calculating with citations in all Web of Science databases will not affect the reported ranking.

Source: own

In this respect it is only L. Weill that sticks out by having produced 9 surveyed articles, out of them five in collaboration.

Needless to say, the tabular presentation in Tab. 2 and Tab. 4 gives a list of leading authors in the field who cannot be ignored when preparing a research study on the efficiency of Czech and Slovak banking. Likewise, Tab. 3 provides a catalogue of canonical works that introduced methodological standards into the field.

In order to summarize aptly the productivity of efficiency research on Czech and Slovak banking, Lotka's constant is estimated and confronted with the values that are typical for finance literature. Lotka's law is an empirical regularity formulated first by Lotka (1926) and later generalized (Chung & Cox, 1990) that has been employed to describe the frequency of publication output in any subject area. It fits remarkably well across different scientific fields (e.g., Nicholls, 1986) and posits the following relationship for the number of authors who have published the same number of papers in the given area: $n^c \cdot a_n = a_1$. It states that the number of authors, a_n, who have produced n papers is n^c-proportional to the number of authors, a_1, who have published just one paper, and this equation is just a restatement of a power-law pattern whose intensity is governed by the constant c. Rearranging the generalized Lotka's equation yields a regression model $\log(a_n/a_1) = -c \cdot \log(n) + \varepsilon$, where: ε is a random error. The regression output presented in Tab. 5 declares an excellent fit and shows the estimated value of Lotka's constant at 1.977, which is not different from values ranging from 1.95 to 3.26 for general finance research reported by Chung and Cox (1990) or from an average value of 1.872 for accounting research estimated by Chung et al. (1992). In a similar vein, this number is comparable to the value of Lotka's constant estimated for banking efficiency research by de Abreu et al. (2019) at 2.304. Unfortunately, de Abreu et al. (2019) have in their reported Tab. 7 a glaring mistake, indicating a value of 4.846 for c. In contrast, the original data in Tab. 6 point to a value of 2.304. Hence, in spite of its narrow geographical focus, research on efficiency of Czech and Slovak banks in terms of productivity is not found altogether different from general or global finance research. The estimated coefficient c matches the original value 2 suggested by Lotka (1926) and proves that this subject area has been dominated by a few researchers. Indeed, the publication output is concentrated amongst

Tab. 5: Regression of the generalized Lotka's law

Estimate of c	Standard error	*T*-statistic	*P*-value	R^2	# observations
2.055	0.166	12.361	<0.001	0.921	5

Notes: The reported R^2 is computed by a formula recommended for a regression model without intercept (e.g., Kozak & Kozak, 1995). The conventional 95% confidence interval for the productivity constant c is [1.594, 2.517].

Source: own

a handful of researchers who found the topics related to Czech and Slovak banking efficiency attractive and worth of pursuit.

After this initial bibliometric assessment oriented on publication and citation productivity, attention is turned to detecting and describing relationships between the authors and articles through bibliographic coupling and co-citation networks. Both these concepts are intended to capture likeness or interconnections between published papers and scholars. Whereas bibliographic coupling refers to the number of references shared by two documents, co-citation represents the frequency with which two documents are cited together. Two documents that cite the same reference are likely to be similar (bibliographic coupling); and this reasoning also applies to a converse situation: two documents that are both cited by a third document are likely to be similar (co-citation). Zupic and Čater (2015) discuss the advantages and disadvantages of both bibliographic mapping methods in detail. Perianes-Rodriguez et al. (2016) recommend accounting for co-authorship of publications in co-citation and other bibliometric analyses by stating that fractional counting is expected to provide more trustworthy results. Two bibliographic coupling networks and two co-citations networks are produced here for the surveyed

articles with the use of the VOSviewer software, version 1.6.17 (van Eck et al., 2010; van Eck & Waltman, 2010), by following fractional counting, when applicable. Fig. 1 displays bibliographic coupling networks for articles and for authors, and Fig. 2 does this for co-citation networks for references and authors. Circle size embodies relative importance and link size represents interconnection strength.

It is not directly visible in the bibliographic coupling network for articles in Fig. 1, but there are four main clusters of articles citing similar research. That said, the cluster formed of Bonin et al. (2005a,b) as well as Fries and Taci (2005) is clearly detectable and populated by studies with similar references. This is the strand of literature occupied with disentangling effects of transition reforms and ownership restructuring from banking efficiency. The other three clusters are around Weill (2003), around Balcerzak et al. (2017), and around Andrieș (2011), respectively. The bibliographic coupling network for authors in Fig. 1 is more a co-authorship network with authors who typically publish in collaboration. There are five clusters of authors whose references overlap with other authors. Articles authored or co-authored by K. Kočišová, M. Boďa, L. Weill cite similar research works. Amongst the four clusters, one cluster consists of K. Kočišová, A. M. Andrieș, I. Palečková, a second cluster is made up of J. Bonin, I. Hasan and P. Wachtel, and a third cluster is formed by M. Boďa and E. Zimková.

Perhaps more revealing is the study of the co-citation networks in Fig. 2 that present references and authors that are cited most frequently. Amongst the cited references are seminal masterpieces of the founding fathers of DEA, M. J. Farrell, A. Charnes, R. D. Banker, or W. W. Cooper; the pivotal paper on SFA by D. J. Aigner, C. A. K. Lovell and P. Schmidt; canonical studies on theory of banking production by C. W. Sealey and J. T. Lindley, A. N. Berger and L. Mester, or P. W. Bauer; first applications of DEA in the banking industry by H. D. Sherman and F. Gold, or J. M. Pastor, and the first authoritative survey on efficiency measurement in banking by A. N. Berger and D. B. Humphrey. The network also contains Bonin et al. (2005a) and Fries and Taci (2005), two early studies on banking efficiency in transition economies that are part of this survey as well. This graph is dominated chiefly by methodological DEA and SFA papers and SFA banking applications. Likewise, concerning the co-citation network for authors, amongst the cited authors are two clusters, which are perhaps not ideally separated. One cluster is DEA-related, whereas the other is SFA-related. The DEA-related block is primarily populated by key figures in DEA methodology R. D. Banker, A. Charnes, W. W. Cooper, R. Färe, and K. Tone, but also contains C. W. Sealey

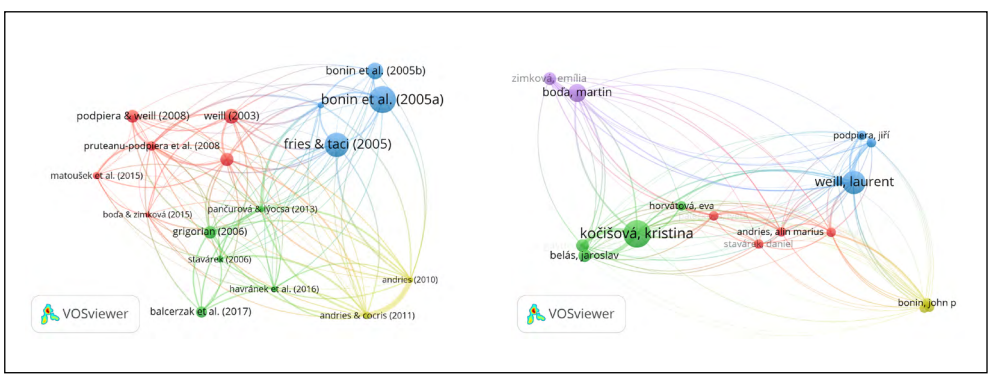

Fig. 1: Bibliographic coupling network for articles and authors

Note: In constructing the network for articles, a threshold of 18 citations at least for an article was applied, which reduced the number of articles to 17. Similarly, for an author at least 2 articles were required, which reduced the number of authors to 16. Fractional counting of Perianes-Rodriguez et al. (2016) was applied in either case.

Source: own

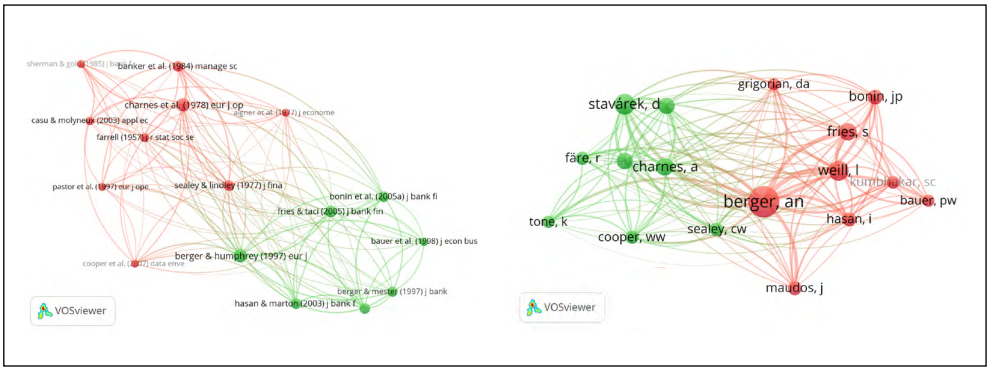

Fig. 2: Co-citation network for references and authors

Note: In constructing the network for references, a minimum of 8 citations for a cited reference was set, which produced a network of 16 references. Likewise, for an author at least 12 citations were required, which reduced the number of authors to 12. Fractional counting of Perianes-Rodriguez et al. (2016) was applied in either case.

Source: own

alongside two empirical economists B. Casu and D. Stavárek. These last two co-cited authors feature for their DEA analyses. In contrast, the SFA-related block is formed of applied researchers included in the survey, J. P. Bonin, S. Fries, I. Hasan, L. Weill (of the seven articles authored or co-authored in the survey, as many as six are based on SFA or DFA), SFA theorist S. C. Kumbhakar and applied stochastic frontier econometrist J. Maudós. Nonetheless, the SFA-related block encompasses also theorists of banking production A. N. Berger and P. W. Bauer (who are closer to SFA than to DEA).

Ultimately, as the preceding analyses have failed to identify the trajectories by which new ideas developed, methodological advances were communicated and knowledge spread across the surveyed articles, main path analysis is conducted in order to uncover these otherwise missed trajectories of historical knowledge diffusion in efficiency research on Czech and Slovak banks. The foundations of main path analysis were laid by Hummon and Doreian (1989), and the method was later refined by Batagelj (2003) and Liu and Lu (2012). Hummon and Doreian (1989) developed first search algorithms applicable to citation networks, Batagelj (2003) proposed an enhanced metric to measure the significance of knowledge dissemination between articles, so-called search path count (SPC), and Liu and Lu (2012) improved on algorithms to search for most significant paths by introducing global and key-route searches. The central idea is to transform a binary citation network into a weighted citation network in which the importance of links between articles is represented by traversal counts measuring how often knowledge passed from first to recent works on the topic whilst traversing through referred and citing articles. When all such possible paths are counted between two articles, their link's SPC is obtained. Global search simply selects a trajectory through articles in the network that maximizes the sum of traversal counts, perhaps subject to the requirement that links with high traversal counts are represented. These are called key routes. Liu and Lu (2012) or Liu et al. (2013) give a full description of these building blocks.

Fig. 3 exhibits the global main path that was selected by including four main key routes. The Pajek software, version 5.14, was employed to identify the global main path and make the graph (de Nooy et al., 2018). The main path is made up of 10 articles, and is initialized with the oldest two papers included in the survey by Weill (2002, 2003). At Weill (2003) the trajectory splits into two different streams: through Kasman (2005) to Kasman and Yildirim (2006), and through Fries and Taci (2005) to Grigorian and Manole (2006). The division implies that Weill (2003) did inspire both lines of research, but these proceeded

without mutual dissemination and unknowingly. Both lines combine in Pančurová and Lýocsa (2013). The chief research agenda of the first works Weill (2002, 2003), Kasman (2005), Fries and Taci (2005) was the effect of restructuring, ownerships on banking efficiency in transition economies, but gradually this emphasis attenuated with Kasman and Yildirim (2006) as well as Grigorian and Manole (2006) paying more attention to comparative assessment of efficiency and identification of its determinants in a panel of transition or CEE countries. Beginning with Grigorian and Manole (2006) the methodology of articles on the main path was DEA or DEA-based. Interestingly, there was a gap of seven years until Pančurová and Lýocsa (2013), who are the last study on the main path that explored banking efficiency for a broad cross-section of countries in order to establish drivers of efficiency. With Pančurová and Lýocsa (2013), the main path was started to be led by Czecho-Slovak authors. Palečková (2017) investigated chiefly the effect of financial conglomeration on banking efficiency for a small panel of Visegrád Group countries, but studied also productivity change. Focused only on Slovak commercial banks, productivity change is the leitmotif of Boďa (2019), but Boďa and Piklová (2021) investigated the effect of diverse input-output specifications on efficiency scores. It should also be noted that the main path displayed in Fig. 3 constructed with global search with four main key routes is fairly robust to a change in parameters, and resembles the main paths produced by standard global search or forward local search.

The identified main path sheds light upon the prevailing research agenda and timeline in efficiency research of Czech and Slovak banks. First, between 2002 and 2005, the central topic was the effect of transition reforms and ownership upon banking efficiency. In the sparse period from 2006 to 2013, the research question was to find general factors

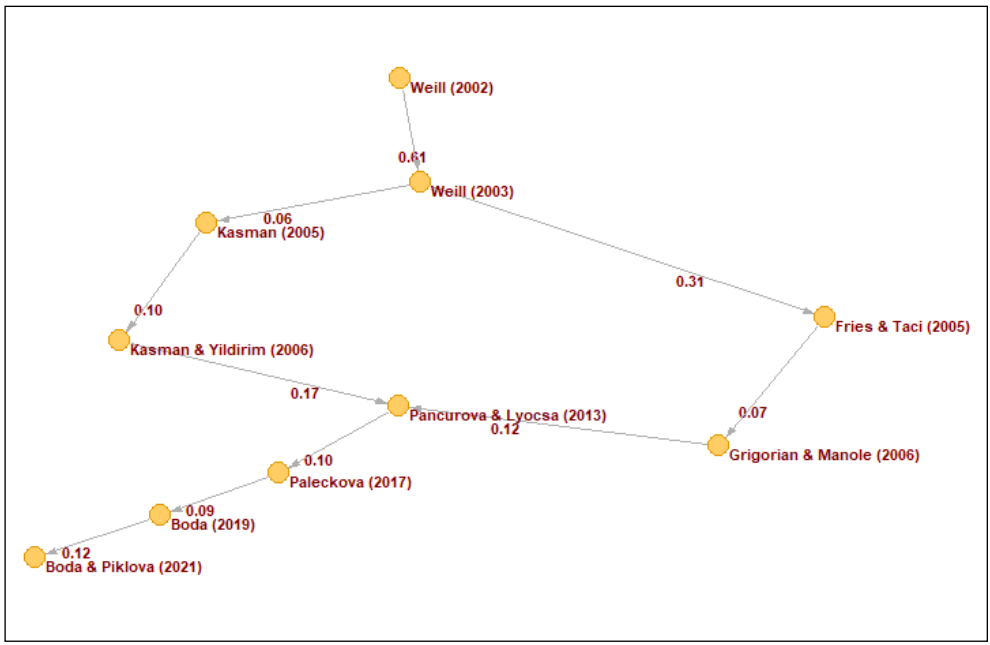

Fig. 3: Global main path

Note: The SPC (search path count) algorithm is used to determine traversal counts, and the graph reflects citation weights in the network. Main key routes are shown.

Source: own

of efficiency and in this period DEA became a leading methodology for efficiency exploration. Since 2013, the main say in efficiency research has been assumed by domestic authors with diversified topics of research including DEA-based productivity change.

Conclusions and insights

With a view of sketching historical trajectories and identifying the state of the art, this paper reviewed 44 journal articles listed in the Web of Science™ database whose substantial application focus was efficiency research of Czech and Slovak banks by frontier techniques. The reviewed items ranged from the pioneering study by Weill (2002) to the article by Moudud-Ul-Huq et al. (2022). Albeit this review is predated by Banerjee (2012), this paper is not just an update or a mere continuation of this prior review.

By dint of standard tools of science mapping, the paper sought to reveal the intellectual structure of efficiency research in Czecho-Slovak banking, and to describe the evolutionary development of its research agenda. Whereas the choice of the countries might have been more liberal and possibly include the other two Visegrád Group countries, this might not be desirable since Czech and Slovak banking provide a unique case study of banking sectors that came to existence after a rarely peaceful dismemberment of a multinational federation, here with a Socialist past, and that both soon became involved in the project of European integration. Furthermore, there is an aspect of comparability since there are only small differences in the legislative framework of both countries, and large Czech and Slovak banks commercial banks are operated by the same banking groups and run under similar, if not identical, principles. Both transition issues and manifold aspects of operations were represented in the research agenda and transformed into distinct research waves.

The first identifiable wave of research was represented by foreign authors who examined issues of economic transition and its impact on performance of banks. The first generation of authors such as L. Weill, A. Kasman, P. Wachtel, J. P. Bonin, I. Hasan, A. Taci and S. Fries typically contributed literally by a few published studies that have been heavily cited and are comparative in nature. The central topics of these first studies were effects of privatization, foreign ownership and complementarily also those of bank size upon efficiency. This wave of research endured until about 2013 when the baton passed into the hands of authors of Czecho-Slovak provenience. The lesson of transition research is the stylized fact that foreign ownership is generally beneficial to efficiency and that bank size is an advantage that bigger banks may typically exploit to outperform smaller banks at least in some form of efficiency. Historically, with the accession of the Czech and Slovak Republics to the European Union, most Czech and Slovak banks were already financed by foreign capital that had assumed strategic influence, which is the apparent reason why productivity change studies could conclude safely an improvement of banking productivity in the two decades following the transition in the mid-1990s. Hence, efficiency-based productivity change research is another coherent research front that occupied Czecho-Slovak authors such as I. Palečková, K. Kočišová, M. Boďa, E. Zimková intensively between 2017 and 2019. Whilst the studies varied in the attribution of banking productivity dynamics to driving factors of change, they agreed in outlining rise in productivity of both Czech and Slovak banks. Meanwhile, in addition to these two most prominent topics, there were secondary streams that attracted more or less repetitive research interest such as the relation between bank efficiency and failure (which was an ad hoc topic culminating in 2008), the effect of efficiency on bank competition, the effects of European integration or the Global Financial Crisis on efficiency. For instance, European Union membership and euro adoption were generally assessed as positive and the Global Financial Crisis was unanimously found to exert detrimental effects in spite of strong resilience of banks.

The historical development of research interests suggests some research gaps implied by an otherwise suddenly discontinued research agenda. Whereas the transition impact upon Czech and Slovak banks was assessed on several occasions, it is not clear whether long decades after the transition the Czech and Slovak banking sectors are now comparable in efficiency with developed (bank-based) banking sector that did not have to sustain a painstaking transition. There are still unresolved issues of the relationship between banking efficiency and competition almost two decades after the Global Financial Crisis or the impact of the COVID-19 pandemic upon banking productivity.

Admittedly, Czech and Slovak conditions alone are not normally in the forefront of global banking efficiency research except when it comes to conducting an extensive comparative study, so the field upon which the present survey centres is partly bound to develop in isolation. Nonetheless, the co-citation analysis confirmed that efficiency research of Czech and Slovak banks grew out of the canonical works of frontier efficiency research and is an integral part of global banking efficiency research. Furthermore, productivity patterns evaluated through the lens of Lotka's law do not divorce Czecho-Slovak banking efficiency research from its global counterpart. Yet, this is not to say that authors focusing on Czech and Slovak banks are not struggling to publish their output in journals with a wider reach. On the contrary, typical outlets of these authors are journals maintained by academic institutions in CEE countries. The most prominent journals published results of this research field in the first decade of the past 20 years when the transition-related topics culminated. The repetitive authors with at least 2 published articles can be roughly sorted into two generations. The first generation laid foundations in the first decade, say between 2002 and 2012, and is represented by 10 economists, namely L. Weill, J. P. Bonin, P. Wachtel, I. Hasan, A. Kasman, D. Stavárek, J. Lešanovská, J. Podpiera, A. Pruteanu-Podpiera, and A. M. Andrieș. The second generation was active in the second decade, starting after about 2012, and is represented by 7 authors, K. Kočišová, M. Boďa, E. Zimková, I. Palečková. All these are of Czech or Slovak provenience. Whereas the first generation of scholars would set research trends in the first decade, the second generation prescribes the research interests now, and it is where a new researcher should stop to acquaint oneself with the state of the art.

An obvious limitation of the present survey is that it only sources journal articles listed in Web of Science™ and ignores Scopus®, which necessarily implies skipping relevant studies in the field. That being said, there are guidelines on merging searches from both databases for the purpose of a bibliometric analysis (e.g., Echchakoui, 2020).

The following 44 articles were incorporated in the survey and are listed fully with bibliographic details amongst the references: Andrieș (2011), Andrieș and Cocriș (2010), Azorfa et al. (2013), Balcerzak et al. (2017), Baruník and Soták (2010), Belás et al. (2019), Boďa (2018), Boďa (2019), Boďa and Piklová (2021), Boďa and Zimková (2015), Boďa and Zimková (2017), Boďa and Zimková (2019), Bonin et al. (2005a), Bonin et al. (2005b), Černohorská et al. (2017), Čupić and Širaňová (2018), Dráb and Kočišová (2018), Fries and Taci (2005), Grigorian and Manole (2006), Havránek et al. (2016), Kasman (2005), Kasman and Yildrim (2006), Kočišová (2012), Kočišová (2014a), Kočišová (2014b), Kočišová (2015), Kočišová and Šugerek (2021), Lešanovská and Weill (2016), Matoušek et al. (2015), Moudud-Ul-Huq et al. (2022), Palečková (2017), Palečková (2019), Pančurová and Lýocsa (2013), Poghosyan and Poghosyan (2010), Pruteanu-Podpiera and Podpiera (2008), Podpiera and Weill (2008), Pruteanu-Podpiera et al. (2008) Stavárek (2005a), Stavárek (2006), Svitálková (2014), Weill (2002), Weill (2003), Weill (2006), Weill (2007).

Acknowledgments: *This research arose in partial fulfilment of project grants VEGA # 1/0442/22 and VEGA # 1/0346/25.*

References

Andries, A. M. (2011). The determinants of bank efficiency and productivity growth in the Central and Eastern European banking systems. *Eastern European Economics*, *49*(6), 38–59. https://doi.org/10.2753/eee0012-8775490603

Andrieș, A. M., & Cocriș, V. (2010). A comparative analysis of the efficiency of Romanian banks. *Romanian Journal of Economic Forecasting*, *13*(4), 54–75.

Azorfa, S. S., Saiz, M. C., Olmo, B. T., & Gutiérrez, C. L. (2013). Financial crises, concentration and efficiency: Effects on performance and risk of banks. *Finance a úvěr*, *63*(6), 537–558.

Balcerzak, A., Klieštik, T., Sterimikiene, D., & Smrčka, L. (2017). Non-parametric approach to measuring the efficiency of banking sectors in European Union countries. *Acta Polytechnica Hungarica*, *14*(7), 51–70.

Banerjee, B. (2012). Banking sector efficiency in new EU member states. *Eastern European Economics*, *50*(6), 81–115. https://doi.org/10.2753/eee0012-8775500604

Baruník, J., & Soták, B. (2010). Influence of different ownership forms on efficiency of Czech and Slovak banks: Stochastic frontier

approach. *Politická Ekonomie*, *58*(2), 207–224. https://doi.org/10.18267/j.polek.727

Batagelj, V. (2003). *Efficient algorithms for citation network analysis* [ArXiv preprint cs/0309023 No. 41]. University of Ljubljana, Institute of Mathematics, Physics and Mechanics, Department of Theoretical Computer Science.

Belás, J., Kočišová, K., & Gavurová, B. (2019). Determinants of cost efficiency: Evidence from banking sectors in EU countries. *Acta Polytechnica Hungarica*, *16*(5), 101–123.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research*, *98*(2), 175–212. https://doi.org/10.1016/s0377-2217(96)00342-6

Bergstrom, C. T., West, J. D., & Wiseman, M. A. (2008). The Eigenfactor™ metrics. *The Journal of Neuroscience*, *28*(45), 11433–11434. https://doi.org/10.1523/jneurosci.0003-08.2008

Bhukya, R., Paul, J., Kastanakis, M., & Robinson, S. (2022). Forty years of European Management Journal: A bibliometric overview. *European Management Journal*, *40*(1), 10–28. https://doi.org/10.1016/j.emj.2021.04.001

Boďa, M. (2018). Market power and efficiency as the source of performance in banking: A case study of the Slovak banking sector. *International Review of Applied Economics*, *32*(5), 589–619. https://doi.org/10.1080/02692171.2017.1360845

Boďa, M. (2019). Productivity change in multi-year periods: The Hicks-Moorsteen index, its decomposition and bank application. *Politická ekonomie*, *67*(2), 157–180. https://doi.org/10.18267/j.polek.1235

Boďa, M., & Piklová, Z. (2021). Impact of an input-output specification on efficiency scores in data envelopment analysis: A banking case study. *RAIRO – Operations Research*, *55*, 1551–1583. https://doi.org/10.1051/ro/2020040

Boďa, M., & Zimková, E. (2015). Efficiency in the Slovak banking industry: A comparison of three approaches. *Prague Economic Papers*, *24*(4), 434–451. https://doi.org/10.18267/j.pep.546

Boďa, M., & Zimková, E. (2017). Malmquist index analysis of the recent development of the Slovak banking sector from two different angles. *Economic Change and Restructuring*, *50*(2), 95–131. https://doi.org/10.1007/s10644-016-9183-0

Boďa, M., & Zimková, E. (2019). Spatial aspect in bank branch performance management. *Engineering Economics*, *30*(2), 128–139. https://doi.org/10.5755/j01.ee.30.2.19210

Bonin, J. P., Hasan, I., & Wachtel, P. (2005a). Bank performance, efficiency and ownership in transition countries. *Journal of Banking & Finance*, *29*(1), 31–53. https://doi.org/10.1016/j.jbankfin.2004.06.015

Bonin, J. P., Hasan, I., & Wachtel, P. (2005b). Privatization matters: Bank efficiency in transition countries. *Journal of Banking & Finance*, *29*(8–9), 2155–2178. https://doi.org/10.1016/j.jbankfin.2005.03.012

Bunce, V. (1999). Peaceful versus violent state dismemberment: A comparison of the Soviet Union, Yugoslavia, and Czechoslovakia. *Politics & Society*, *27*(2), 217–237. https://doi.org/10.1177/0032329299027002003

Černohorská, L., Pilyavskyy, A., & Aaronson, W. (2017). Comparative performance of the Visegrad group banks for the period 2009–2013. *E&M Economics and Management*, *20*(2), 175–187. https://doi.org/10.15240/tul/001/2017-2-013

Chung, K. H., & Cox, R. A. K. (1990). Patterns of productivity in the finance literature: A study of the bibliometric distributions. *The Journal of Finance*, *45*(1), 301–309. https://doi.org/10.1111/j.1540-6261.1990.tb05095.x

Chung, K. H., Pak, S. H., & Cox, R. A. K. (1992). Patterns of research output in the accounting literature: A study of the bibliometric distributions. *Abacus*, *28*(2), 168–185. https://doi.org/10.1111/j.1467-6281.1992.tb00278.x

Cienski, J. (2011). *The Czech Republic and Slovakia tread similar banking paths*. The Banker. https://www.thebanker.com/The-Czech-Republic-and-Slovakia-tread-similar-banking-paths-1304496125

Čupić, M., & Širaňová, M. (2018). Banking sector in the process of European integration: How did EU accession and euro adoption affect cost efficiency of Slovak banking sector? *Ekonomický časopis*, *66*(2), 115–138.

De Abreu, E. S., Kimura, H., & Sobreiro, V. A. (2019). What is going on with studies on banking efficiency? *Research in International Business and Finance*, *47*, 195–219. https://doi.org/10.1016/j.ribaf.2018.07.010

De Nooy, W., Mrvar, A., & Batagelj, V. (2018). *Exploratory social network analysis with Pajek: Revised and expanded edition for updated software*. Cambridge University Press.

Dráb, R., & Kočišová, K. (2018). Efficiency of the banks: The case of the Visegrad countries. *Economic Annals-XXI*, *174*(11–12), 34–42. https://doi.org/10.21003/ea.v174-06

Duygun-Fethi, M., & Pasiouras, F. (2010). Assessing bank efficiency and performance with operational research and artificial intelligence techniques: A survey. *European Journal of Operational Research*, *204*(2), 189–198. https://doi.org/10.1016/j.ejor.2009.08.003

Echchakoui, S. (2020). Why and how to merge Scopus and Web of Science during bibliometric analysis: The case of sales force literature from 1912 to 2019. *Journal of Marketing Analytics*, *8*(3), 165–184. https://doi.org/10.1057/s41270-020-00081-9

Emrouznejad, A., & Yang, G. (2018). A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016. *Socio-Economic Planning Sciences*, *61*, 4–8. https://doi.org/10.1016/j.seps.2017.01.008

European Commission. (2024). *In-depth review 2024: Slovakia* [European Economy Institutional Paper No. 276]. European Commission: Directorate-General for Economic and Financial Affairs. https://doi.org/10.2765/642448

Fall, F., Akim, A., & Wassongma, H. (2018). DEA and SFA research on the efficiency of microfinance institutions: A meta-analysis. *World Development*, *107*, 176–188. https://doi.org/10.1016/j.worlddev.2018.02.032

Fergnani, A. (2018). Mapping futures studies scholarship from 1968 to present: A bibliometric review of thematic clusters, research trends, and research gaps. *Futures*, *105*, 104–103. https://doi.org/10.1016/j.futures.2018.09.007

Fries, S., & Taci, A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. *Journal of Banking & Finance*, *29*(1), 55–81. https://doi.org/10.1016/j.jbankfin.2004.06.016

Grigorian, D. A., & Manole, V. (2006). Determinants of commercial bank performance in transition: An application of data envelopment analysis. *Comparative Economic Studies*, *48*(3), 497–522. https://doi.org/10.1057/palgrave.ces.8100129

Havránek, T., Iršová, Z., & Lešanovská, J. (2016). Bank efficiency and interest rate pass-through: Evidence from Czech loan products. *Economic Modelling*, *54*, 153–169. https://doi.org/10.1016/j.econmod.2016.01.004

Horská, H., & Prega, R. (2023). *30 years of independence: Which country is more successful – The Czech Republic or Slovakia?* Raiffeisen Bank International. https://www.rbinternational.com/en/raiffeisen/blog/market-trends/30-years-of-independence.html

Hummon, N. P., & Doreian, P. (1989). Connectivity in a citation network: The development of DNA theory. *Social Networks*, *11*(1), 39–63. https://doi.org/10.1016/0378-8733(89)90017-8

Kaffash, S., Azizi, R., Huang, Y., & Zhu, J. (2020). A survey of data envelopment analysis applications in the insurance industry 1993–2018. *European Journal of Operational Research*, *284*(3), 801–813. https://doi.org/10.1016/j.ejor.2019.07.034

Kasman, A. (2005). Efficiency and scale economies in transition economies – Evidence from Poland and the Czech Republic. *Emerging Markets Finance and Trade*, *41*(2), 60–81. https://doi.org/10.1080/1540496x.2005.11052605

Kasman, A., & Yildirim, C. (2006). Cost and profit efficiencies in transition banking: The case of new EU members. *Applied Economics*, *38*(9), 1079–1090. https://doi.org/10.1080/00036840600639022

Kočišová, K. (2012). Application of DEA models at the analysis of bank branches technical efficiency. *Ekonomický časopis*, *60*(2), 169–186.

Kočišová, K. (2014a). Application of data envelopment analysis to measure cost, revenue and profit efficiency. *Statistika*, *94*(3), 47–57.

Kočišová, K. (2014b). The use of credit cards and bank efficiency. *E&M Economics and Management*, *17*(1), 121–139. https://doi.org/10.15240/tul/001/2014-1-010

Kočišová, K. (2015). Loan efficiency in the Visegrad countries. *Acta Oeconomica*, *65*(s1), 161–181. https://doi.org/10.1556/032.65.2015.s1.10

Kočišová, K., & Šugerek, P. (2021). Revenue efficiency in the Czech Republic and Slovakia. *AD ALTA: Journal of Interdisciplinary Research*, *11*(1), 130–137. https://doi.org/10.33543/1101

Kozak, A., & Kozak, R. A. (1995). Note on regression through the origin. *The Forestry Chronicle*, *17*(3), 326–330.

Kumar, S., & Gulati, R. (2014). A survey of empirical literature on bank efficiency. In *Deregulation and efficiency of Indian banks*. Springer.

Lešanovská, J., & Weill, L. (2016). Does greater capital hamper the cost efficiency of banks? A bi-causal analysis. *Comparative Economic Studies*, *58*(3), 409–429. https://doi.org/10.1057/s41294-016-0002-4

Liu, J. S., & Lu, L. Y. Y. (2012). An integrated approach for main path analysis: Development of the Hirsch index as an example. *Journal of the American Society for Information Science and Technology*, *63*(3), 528–542. https://doi.org/10.1002/asi.21692

Liu, J. S., Lu, L. Y. Y., Lu, W.-M., & Lin, B. J. Y. (2013). A survey of DEA applications. *Omega*, *41*(5), 893–902. https://doi.org/10.1016/j.omega.2012.11.004

Lotka, A. J. (1926). The frequency distribution of scientific productivity. *Journal of the Washington Academy of Sciences*, *16*(12), 317–324.

Matoušek, R., Rughoo, A., Sarantis, N., & Assaf, A. G. (2015). Bank performance and convergence during the financial crisis: Evidence from the "old" European Union and Eurozone. *Journal of Banking & Finance*, *52*, 208–216. https://doi.org/10.1016/j.jbankfin.2014.08.012

Medveď, J., Sobek, O., Sipko, J., Dufala, V., Demjan, V., Košík, O., Malcová, Z., & Vargová, V. (2012). *Banky* [Banks]. Sprint.

Moudud-Ul-Huq, S., Mateev, M., Abbas, F., Hossain, M., & Sohail, H. M. (2024). How does diversification affect efficiency? Insights of the Central Europe. *Global Business Review*, *25*(6), 1603–1618. https://doi.org/10.1177/09721509211026823

Nicholls, P. T. (1986). Empirical validation of Lotka's law. *Information Processing & Management*, *22*(5), 417–419. https://doi.org/10.1016/0306-4573(86)90076-2

Öztürk, O., Kocaman, R., & Kanbach, D. K. (2024). How to design bibliometric research: An overview and a framework proposal. *Review of Managerial Science*, *18*(11), 3333–3361. https://doi.org/10.1007/s11846-024-00738-0

Palečková, I. (2017). Efficiency change of banking sectors and banks in the financial conglomerates in Visegrad group countries. *Ekonomický časopis*, *65*(1), 79–92.

Palečková, I. (2019). Cost efficiency measurement using two-stage data envelopment analysis in the Czech and Slovak banking sectors. *Acta Oeconomica*, *69*(3), 445–466. https://doi.org/10.1556/032.2019.69.3.6

Palečková, I., & Klepková Vodová, P. (2021). Assessment of selected aspects of financial stability of the Czech banks. *International Journal of Monetary Economics and Finance*, *14*(1), 23–34. https://doi.org/10.1504/ijmef.2021.113311

Pančurová, D., & Lýocsa, Š. (2013). Determinants of commercial banks efficiency: Evidence from 11 CEE countries. *Finance a úvěr*, *63*(2), 152–179.

Paradi, J. C., & Zhu, H. (2013). A survey on bank branch efficiency and performance research with data envelopment analysis. *Omega*, *41*(1), 61–79. https://doi.org/10.1016/j.omega.2011.08.010

Perianes-Rodriguez, A., Waltman, L., & van Eck, N. J. (2016). Constructing bibliometric networks: A comparison between full and fractional counting. *Journal of Informetrics*, *10*(4), 1178–1195. https://doi.org/10.1016/j.joi.2016.10.006

Podpiera, J., & Weill, L. (2008). Bad luck or bad management? Emerging banking market experience. *Journal of Financial Stability*, *4*(2), 135–148. https://doi.org/10.1016/j.jfs.2008.01.005

Poghosyan, T., & Poghosyan, A. (2010). Foreign bank entry, bank efficiency and market power in Central and Eastern European countries. *Economics of Transition*, *18*(3), 571–598. https://doi.org/10.1111/j.1468-0351.2009.00378.x

Pruteanu-Podpiera, A., & Podpiera, J. (2008). The Czech transition banking sector instability: The role of operational cost management. *Economic Change and Restructuring*, *41*(3), 209–219. https://doi.org/10.1007/s10644-008-9049-1

Pruteanu-Podpiera, A., Weill, L., & Schobert, F. (2008). Banking competition and efficiency: A micro-data analysis on the Czech banking industry. *Comparative Economic Studies*, *50*(2), 253–273. https://doi.org/10.1057/palgrave.ces.8100248

Šestáková, M., & Ferenčíková, S. (2015). Restructuring of the banking sector in Slovakia over the last two decades. *Ekonomické rozhľady*, *44*(2), 168–172.

Stavárek, D. (2005a). Estimation of factors influencing efficiency of banks in new member states before joining the European Union. *Ekonomický časopis*, *53*(6), 593–610.

Stavárek, D. (2005b). Zprostředkovatelská činnost bank ve střední Evropě: Část I. – Mezinárodní analýza efektivnosti [Bank intermediation in Central Europe: Part I – International. *E&M Economics and Management*, *8*(1), 33–53.

Stavárek, D. (2006). Banking efficiency in the context of European integration. *Eastern European Economics*, *44*(4), 5–31. https://doi.org/10.2753/eee0012-8775440401

Svitálková, Z. (2014). Comparison and evaluation of bank efficiency in Austria and the Czech Republic. *Journal of Competitiveness*, *6*(2), 15–29. https://doi.org/10.7441/joc.2014.02.02

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

Van Eck, N. J., Waltman, L., Dekker, R., & van den Berg, J. (2010). A comparison of two techniques for bibliometric mapping: Multidimensional scaling and VOS. *Journal of the American Society for Information Science & Technology*, *61*(12), 2405–2416. https://doi.org/10.1002/asi.21421

Weill, L. (2002). Does restructuring improve banking efficiency in a transition economy? *Applied Economics Letters*, *9*(5), 279–281. https://doi.org/10.1080/13504850110068125

Weill, L. (2003). Banking efficiency in transition economies: The role of foreign ownership. *Economics of Transition*, *11*(3), 569–592. https://doi.org/10.1111/1468-0351.00155

Weill, L. (2006). Foreign ownership and technical efficiency in banking in transition countries: A DEA analysis. *Revue Economique*, *57*(5), 1093–1108.

Weill, L. (2007). Is there a gap in bank efficiency between CEE and Western European countries? *Comparative Economic Studies*, *49*(1), 101–127. https://doi.org/10.1057/palgrave.ces.8100183

World Bank. (2022). *Global financial development database*. https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*(3), 429–472. https://doi.org/10.1177/1094428114562629