Original scientific paper

EXPLORING THE EFFICIENCY OF PLATFORM ECONOMY: A PRISMA COMPLIANT SYSTEMATIC REVIEW OF DATA ENVELOPMENT ANALYSIS APPLICATIONS

Katerina Fotova Čiković[1]
Damira Keček
Mirko Smoljić

Abstract

This paper reports on a systematic literature review of 14 empirical studies which address various aspects of platform economy with the application of the non-parametric DEA methodology.

This review aimed to present the different aspects of efficiency evaluation of platform economy-based businesses with the applications of DEA. A secondary aim was to present recommendations or areas for future research in this area.

A systematic search of the online Scopus scientific database has been conducted, with no restrictions to language, date of publication or study design. The methodology draws from the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). The results of the 14 surveyed studies are presented in a narrative synthesis.

Despite increasing academic and public interest in the platform economy, research on platform economy-based business has not been examined in a systematic study. Moreover, the applications of DEA methodology in this area of research have not been explored. This review examines the current state of knowledge about what platform economy is, the different aspects researched, the DEA models and extensions used and the future research potentials. The findings are discussed in detail. Moreover, specific literature gaps are identified, and suggestions and implications for further research are provided.

Keywords: platform economy, DEA, data envelopment analysis, PRISMA, literature review.

JEL classification: C14, C69, L14, L19, L81, L82.

INTRODUCTION

Nowadays, the Internet holds immense power over both people's private and professional lives. People from all generations are keener on using internet applications, search engines, and social media networks for satisfying different needs. Moreover, this has opened up vast possibilities for entrepreneurs to sell their products and/or services online, and this is where the platform-based business model kicks in. Namely, the easy combination of supply and demand and the act of intermediation have set the online platforms as "access points to the market and consumers". Online platforms "create

[1] **Katerina Fotova Čiković,** Ph.D., lecturer; **Damira Keček,** Ph.D., Assistant Professor; **Mirko Smoljić,** Ph.D., Assistant Professor, University North, Croatia.

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

markets, because they represent the place where supply and demand meet, which goes beyond the existing legal framework of contract law" (Akrap et al., 2020).

However, when diving into the performance and the main characteristics of a business model, efficiency is the first feature that is assessed. One of the most popular and leading non-parametric methodologies nowadays for efficiency evaluation is the Data Envelopment Analysis (DEA hereafter). Although DEA has been increasingly popular in many industries and research areas, its applicability in platform-based business models is still very low.

The main goal of this study is to identify, survey and present the different aspects of efficiency evaluation of platform economy-based businesses with the applications of DEA. A secondary aim was to tackle the platform-based business model and to present recommendations or areas for future research in this area. Accordingly, a systematic literature review of the Scopus scientific database has been conducted, with no restrictions to the date of publication or study design, with the implementation of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The results of the 6 surveyed studies are presented in a narrative synthesis. Another goal is to motivate scholars and practitioners globally to try and apply different DEA models to the assessment of the efficiency of different platform-based businesses.

This paper is organized into five sections. After the introduction, theoretical background on the platform economy and the Data Envelopment Analysis (DEA) are given. In Section 3, the research approach, i.e. the SLR (systematic literature review) methodology together with the PRISMA guidelines are presented, whereas the fourth Section reveals the research results, i.e. the applications of DEA in platform economy efficiency evaluation. The last, fifth section opens a discussion regarding the findings of the six selected relevant papers and concludes the paper.

1. THEORETICAL BACKGROUND
a. Platform Economy

In the mid-1990s to 2010, the emergence and development of the Internet, the digitalization of production processes and the fast-technological advances "connected billions of people from all over the globe, enabling them to communicate with each other, coordinate activities, conduct commerce, socialize, and cooperate to solve problems in novel ways—in ways that one could only have dreamt of only a few years earlier". More importantly, these digital benefits also "enabled firms to build resources and use them to generate, deliver, and monetize benefits to customers in novel ways—that is, enabled them to produce business model innovations" (Afuah, 2019). These occurrences have impacted many media industries and "have directly influenced radical changes in the management strategies of the media industry" (Lozić, 2020b). Moreover, the changes in users' preferences and the emergence of the Generation Z as major portion of the technology user base has affected the increased „technological presence in everyday life" (Lozić, 2021).

Even though the platform-based business model was not entirely novel before the
success of the Airbnb and Uber platforms, they are still considered the stepping stones
for the further growth, expansion and success of the platform-based business models.

The platform economy, in general, includes media industries, which have "changed
dramatically under the influence of post-industrial society and changed the ways of
operating and generating income". With the development of smartphones, MP3 devices,
sound reproduction devices, tablets, laptops and other tech devices, users' access to
media content is easier and simpler. Therefore, the platform economy model is often
used by corporations that develop their own software applications, however, they cannot
be classified in the software (IT) industry. The zero marginal cost model is the main
characteristic of the platform economy business model, and it is applied to organizations
that distribute a product of their own production as digital content (Lozić, 2020c).

Economic platforms create and enable systems that, with proper design, could bring
benefits and a win-win situation for both content creators and content users. The
technology today „enables unprecedented physical and geographic uses and impacts".
Thus, the development and success of economic platforms that are secure, open and
flexible depend solely on trust, i.e. the „belief in the common prosperity and
opportunities for inclusive growth". Furthermore, the economic platforms cannot be
considered sole businesses, since they represent the collective eyes, ears and
opportunities for growth and expansion (Mićković et al., 2018).

There are many different definitions of the platform economy. The term "sharing
economy" can often be found in the literature. Akrap et al. (2020) define online platforms
as „a source of data-driven innovations that enable businesses to be online, as well as
provide citizens with easier access to information, offer social and creative content, affect
the increase of consumer choice, improve the efficiency and competition of businesses
as well as they can strengthen civic participation in society".

Platforms are "an increasingly salient topic" in Science and Technology Studies,
management, communication, entrepreneurship and media studies, with the term
'platform' itself becoming "a broad signifier employed across disciplines to read and
make sense of social, cultural, and economic formations" (Lusoli, 2020).

However, the public's understanding of these platforms "is still in its infancy", since
the emergence of the online outsourcing platforms elevating from the Internet has been
incorporated into the organization of work itself. Namely, in 2016 the European
Commission published the Communication on the European Agenda for the
Collaborative Economy and thus referred to online platforms as "collaborative
economies", as a term to explain "the role of online platforms in facilitating temporary
access to goods and services, including labour outsourcing". Moreover, they added
another definition of the collaborative economy as "business models where activities are
facilitated by online platforms that create an open marketplace for the temporary use of
goods or services often provided by private individuals" (Drahokoupil & Fabo, 2016).

According to Afuah (2019), there are six digital/sharing economy core concepts, as
follows network effects, multisided platforms, crowd-sourcing, disruptive innovation,
long tails, and complementary assets. Moreover, he amplifies the importance of

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

understanding what platforms are and that their understanding is "critical to thriving in today's economy".

In the digital market with no geographical boundaries whatsoever, "significant market power is concentrated on a smaller number of online platforms, which have a large number of users", which is the reason why the success of small businesses is increasingly dependent on collaboration with these leading online platforms. This highlights the strong bargaining power of online platforms and therefore, the increasing addiction of businesses with low bargaining power to online platforms (Akrap et al., 2020). The strength of the platform economy can be found in the new business model that uses modern technologies to connect people, organizations and resources into an interactive ecosystem in which fascinatingly large amounts are created and exchanged (Lozić, 2019).

The decisive role of digital/ online platforms "in creating value to stakeholders in the digital platform economy by redefining the way to do business and contributing to developing new products and services" has become an even greater imperative for entrepreneurs. Thus, digital platforms "have accumulated significant power", which raises many concerns and issues in policy circles (Lafuente et al., 2022). The growing importance of the platform economy is apparent and undeniable. Interestingly, the popularity and investment in platforms "has not been limited to equity investors", since many traditional companies have also invested in platforms that may undermine their business models (Drahokoupil & Fabo, 2016). Their further growth and development are yet to be discovered.

b. Data Envelopment Analysis (DEA)

The Data Envelopment Analysis (DEA hereafter) was first introduced in 1978 in the seminal paper of Charnes, Cooper & Rhodes (1978), and it was developed on the basis of Farrell (1957)'s work. It is a non-parametric optimization method and its basic principle is „a generalization of the normal efficiency evaluation by means of the relationship from an output to an input into the general case of a multi-output, multi-input system without any given conversion rates or same units for all factors" (Koch, 2009). Nonparametric methodologies include Data Envelopment Analyses (DEA) and the Free Disposal Hull (FDH) and they are normally used to "measure technical (technological) efficiency, which means to minimise inputs at a given level of outputs or maximise outputs at a given level of inputs" (Vincova, 2005).

It represents a linear programming technique that provides relative efficiency measures in samples constituting Decision-Making Units (DMUs). It is widely accepted in many different industries and research areas, for use in "evaluating the performances of many different kinds of entities engaged in many different activities in many different contexts in many different countries" (Cooper et al., 2007) but it is mostly applied to "agriculture, banking, transportation, supply chain and public policy" (Emrouznejad & Yang, 2018). The reason behind the large empirical application of DEA is mirrored in its numerous advantages over parametric methodologies, the main advantage being "the

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

possibility to include more than one output, and to simultaneously analyse input and output variables; and to not set assumptions for the production function" (Fotova Čiković et al., 2022b).

DEA is a frontier methodology. That said, the frontier or envelope "contains the foundation for the whole concept of DEA, i.e. the efficiency frontier defines a standard of best performance based on observed data" (El-Mahgary & Lahdelma, 1995). However, it should be taken into consideration that the benchmarking and comparison are only between the units in the sample, and therefore, the efficiency is a relative and not an absolute measure. The efficiency frontier is presented in Figure 1.
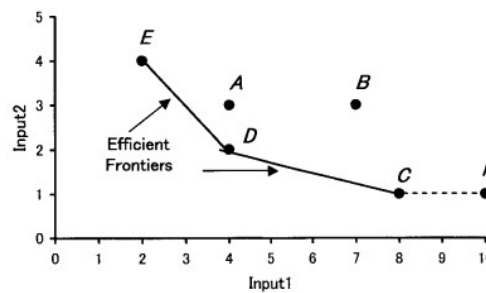

Figure 1. The efficiency frontier.
Source: Cooper et al. (2007)

The two basic DEA models are the CCR and the BCC DEA models. Namely, both the CCR and BCC models were named after their founders (Charnes, Cooper and Rhodes – CCR and Banker, Charnes and Cooper for the BCC model). The main distinction between these two models is the scale assumption (whether DEA is carried with the constant variable returns to scale – CRS or the variable returns to scale – VRS). The VRS approach "produces technical efficiency scores which are greater than or equal to those obtained using CRS and is considered the more flexible frontier" (Jacobs, 2001). The constant return to scale (CRS) implies that "a proportional increase in all inputs results in the same proportional increase in outputs" (Borozan & Borozan, 2018), whereas the variable (either increasing or decreasing) returns to scale (VRS) assumes „assumes that an increase in the input variables does not result in a proportional change in the output variables" (Fotova Čiković et al., 2022a). Moreover, the DEA model can be either input- or output-oriented, as shown in Figure 2.
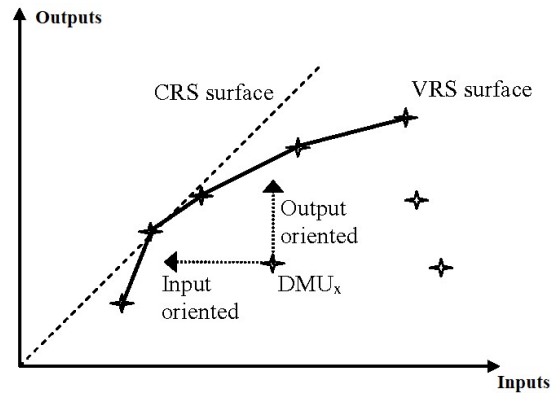
Figure 2. Envelopment surfaces and orientation.
Source: Cooper et al. (2007)

2. RESEARCH APPROACH

The research approach to the conducted systematic literature review revealed a very low
number of published papers applying the DEA methodology in the research field of
platform economy. The PRISMA guidelines that were introduced in 2009 (and later
upgraded in 2020) have been applied to the research approach. Namely, the four-phase
process started with the selection of the scientific database that would be subject to
exploration and survey. In this case, the Scopus scientific database has been selected. In
the first phase of the study (also known as the identification phase), the key phrases
„DATA ENVELOPMENT ANALYSIS" and „PLATFORM ECONOMY" were entered
in the "Title, Abstract, and Keywords" section of papers in the Scopus database. In this
first phase, this resulted in only 14 published papers. In the second phase of the research
(the screening phase), the abstract screening occurred, where the authors screened the
author keywords, the title and the abstract text to determine whether the identified paper
is relevant to this systematic literature review, i.e. to select only those studies that meet
both the inclusion and exclusion criteria. Therefore, the papers that did not report the
application of Data Envelopment Analysis in the platform economy were eliminated
from the further phases. This step eliminated 3 published papers. The third phase (the so-
called eligibility phase) included a secondary abstract and full-text screening manually
by the authors. In this step, one paper has been eliminated. Ultimately, only six papers
were left for the last, inclusion phase, where quantitative and qualitative analysis of these
six papers occurred. The whole research process and approach are shown in Figure 1
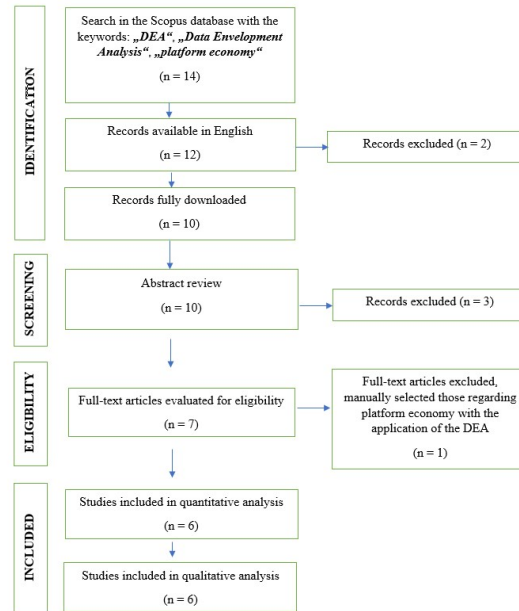below.

241

Figure 3. The PRISMA-compliant research approach to systematic literature review (SLR)

3. RESULTS: APPLICATIONS OF DEA IN PLATFORM ECONOMY

This systematic literature review (SLR) has been performed to review all the relevant scientific studies that employ the DEA methodology and revolve around the research area of the platform economy and thus summarize past findings in this research field. For this purpose, the Scopus scientific database has been explored with the keywords/key phrases: "DATA ENVELOPMENT ANALYSIS" and "PLATFORM ECONOMY". As shown in Section 3, the initial number of papers and studies found with the PRISMA guidelines was only 14, which once again highlights the need to encourage other scholars and practitioners as well as business analysts to employ the DEA methodology in the assessment of efficiency of the platform economy on a more common basis. Notwithstanding, after the screening and eligibility phases, the total number of relevant papers was 6, as shown in Figure 3.

In Table 1, the authors and the title of the relevant papers are presented, and a more comprehensive analysis of the results is laid out thereafter.

Table 1. Authors and the title of the relevant papers

Author/s and year of publication	Title of the paper
Lafuente, Ács & Szerb (2022)	Analysis of the digital platform economy around the world: A network DEA model for identifying policy priorities
Zekan, Önder & Gunter (2019)	Benchmarking of Airbnb listings: How competitive is the sharing economy sector of European cities?
Xu, Hu & Guan (2018)	Evaluation of the efficiency of Chinese makerspace operation based on double-creation background
Gao, Yu & Shiue (2018)	The performance of the P2P finance industry in China
Shao, Lin & Tsai (2017)	An Empirical Study of the Telecommunications Service Industries Using Productivity Decomposition
Koch (2009)	Exploring the effects of SourceForge.net coordination and communication tools on the efficiency of open source projects using data envelopment analysis

Lafuente, Ács & Szerb (2022) explore the quality of the digital platform economy globally by employing a network DEA model on a sample of 116 countries for the year 2019. They found that the configuration of countries' platform economy is "very heterogeneous", which suggests that "an informed, tailor-made approach to policy might produce more effective outcomes". Their study contributes greatly not only to scientific and scholarly literature but also to digital platform developers and practitioners since it proposes a model that is "in accordance with the geographic diversity (country heterogeneity) and the multi-layered structure characterizing the interactions between system participants: governments, digital platforms, platform-dependent firms, and end users". Their model introduces the digital ecosystem as a two-stage process.

Zekan, Önder & Gunter (2019) have assessed the efficiency of the world's most popular accommodation-sharing platform, Airbnb. However, in this study, the efficiency of Airbnb listings in European cities is inspected. Their study is considered the first comprehensive benchmarking attempt in the platform (sharing) economy. They have employed the output-oriented BCC radial DEA model with four inputs (Number of properties, Maximum number of guests, Minimum number of nights, and Number of photos) and four outputs (Annual revenue, Occupancy rate, Number of bookings, and Overall rating) on a sample of 29 DMUs (i.e. accommodations in the 29 European cities). Their findings reveal efficiency scores range from 71.62% to 106.50%. Airbnb listings of Barcelona are the most inefficient DMU in the sample and four benchmarking partners have been identified for this DMU: the listings of Amsterdam, Hamburg, Reykjavik, and

243

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

Stockholm. Obtained results also show that "listings of only seven cities are inefficient in terms of the chosen indicators; whilst of the remaining 22 are efficient". They also include guidelines for future research on the efficiency of sharing platforms.

Xu, Hu & Guan (2018) employ the Data Envelopment Analysis methodology to explore the efficiency of the "makerspace operation in 30 provinces and cities of China in 2016 from four aspects of technical efficiency, pure technical efficiency, scale efficiency and projection analysis". Namely, the makerspace is considered "a new generation of incubator platform". Their findings reveal that "the technical efficiency of 30 provinces and cities in China is 0.847, the overall level is good, but not DEA effective accounted for the total area of 63.33%, of which scale efficiency is the main cause of technical efficiency".

Gao, Yu & Shiue (2018) investigate the business performance of the P2P finance industry in China and their study is original in the sense that it is the first empirical study to examine P2P lending activities with the application of the DEA methodology. Moreover, they tackle the definition of the "sharing economy", which includes "temporary transfer of property rights between strangers and often involves a new economic model for online transactions". They have employed a "modified slacks-based measure under a two-dimensional growth and operating efficiency paradigm", i.e. the SBM DEA model on a sample of 19 online P2P lending platforms operating in China. They selected a total of 8 variables as follows: time of operation, online investors, employees, and total operating expenses as input variables and balance of P2P loans, accumulated borrowers, net operating income, and overdue rate as output variables for the DEA model. The results regarding the overall efficiency reveal that only two out of 19 platforms are operating relative efficiently, whereas 17 platforms are inefficient. Furthermore, they have revealed that "listed companies, platforms with venture capital investment, and platforms funded by state-owned capital exhibit higher growth efficiency, while platforms with financial group involvement and diversified ownership show increased operating efficiency". Interestingly, they claim that "management incentives and the relative economic level of the platform location have whatsoever no significant impact on efficiency". However, their study showed "significant contradictions between the growth and operating efficiency of the P2P finance industry".

Shao, Lin & Tsai (2017) have explored the efficiency of the telecommunications sector, considered „a platform technology for innovation over the past several decades". In their study, they investigate the output performance of telecommunications service industries in 13 Organization of Economic Cooperation and Development countries in the period 2000 - 2011 using the Malmquist total factor productivity index (MTFPI) as a performance metric and data envelopment analysis as the measurement approach.

Koch (2009) explored the "possible benefits of communication and coordination tools in free and open source projects using an efficiency score derived from data envelopment analysis (DEA) as dependent variable". Moreover, Koch focuses on the impact of the usage of communication and coordination tools on efficiency with the application of the DEA methodology. The DMUs in this study are open and free-source projects that are part of a hosting platform economy. They employ two data sets, the first

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

containing 30 successful projects, whereas the second one 100 randomly selected projects. The findings reveal that "the variance in efficiency scores is much smaller within the first data set of successful projects".

4. DISCUSSION AND CONCLUSION

The growing importance of the platform economy as well as the literature published in this research area are apparent and undeniable. However, the evaluation of the efficiency of platform-based businesses and industries is not commonly studied. Nevertheless, the application of the leading non-parametric DEA methodology in platform-based research is very modest and still in its infancy.

The main goal of this study is to identify, survey and present the different aspects of efficiency evaluation of platform economy-based businesses with the applications of DEA. A secondary aim was to tackle the platform-based business model and to present recommendations or areas for future research in this area. Accordingly, a systematic literature review of the Scopus scientific database has been conducted, with no restrictions to the date of publication or study design, with the implementation of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The results of the research include a quantitative and qualitative analysis of 6 relevant papers published in peer-indexed journals in Scopus. Most of these 6 papers are published after 2017 (i.e. 5). Only one paper (Koch, 2009) has been published in 2009. This, once more, reveals the novelty of the concept of the platform economy and highlights the contemporaneity of this research area. This study reveals all the different DEA models and approaches, as well as industries and types of businesses to which DEA can be applied in researching the platform economy. In Table 2, the main concepts, the used DEA models and the findings of the surveyed papers are presented.

Moreover, considering that the DEA methodology has been introduced almost 45 years ago, it can be, without doubt, concluded that this methodology has been neglected by scholars and researchers from this area, as can be seen in the small amount of relevant surveyed papers. This work can represent an incentive for other scholars to implement the DEA methodology on a more common basis.

Table 2. The main concepts, used DEA models and findings of the surveyed papers.

Authors and paper titles	Main concepts, DEA models and findings
Lafuente, Ács & Szerb (2022): Analysis of the digital platform economy around the world: A network DEA model for identifying policy priorities	• digital platform economy • a network DEA model on a sample of 116 countries in 2019 • the configuration of countries' platform economy is "very heterogeneous", which suggests that "an informed, tailor-made approach to policy might produce more effective outcomes"

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

Zekan, Önder & Gunter (2019): Benchmarking of Airbnb listings: How competitive is the sharing economy sector of European cities?	• Assessment of the efficiency of the world's most popular accommodation-sharing platform, Airbnb • Airbnb listings of European cities • output-oriented BCC radial DEA model with four inputs (Number of properties, Maximum number of guests, Minimum number of nights, and Number of photos) and four outputs (Annual revenue, Occupancy rate, Number of bookings, and Overall rating) on a sample of 29 DMUs
Xu, Hu & Guan (2018): Evaluation of the efficiency of Chinese makerspace operation based on double-creation background	• exploring the efficiency of the "makerspace operation in 30 provinces and cities of China in 2016 from four aspects of technical efficiency, pure technical efficiency, scale efficiency and projection analysis"
Gao, Yu & Shiue (2018): The performance of the P2P finance industry in China	• the business performance of the P2P finance industry in China • an SBM DEA model on a sample of 19 online P2P lending platforms • "management incentives and the relative economic level of the platform location have whatsoever no significant impact on efficiency"
Shao, Lin & Tsai (2017): An Empirical Study of the Telecommunications Service Industries Using Productivity Decomposition	• efficiency of the telecommunications sector • sample of 13 Organization of Economic Cooperation and Development countries in the period 2000 – 2011 • use of the Malmquist total factor productivity index (MTFPI) as a performance metric and data envelopment analysis as the measurement approach
Koch (2009): Exploring the effects of SourceForge.net coordination and communication tools on the efficiency of open-source projects using data envelopment analysis	• impact of the usage of communication and coordination tools on efficiency • DMUs in this study are open and free source projects that are part of a hosting platform economy • the variance in efficiency scores is much smaller within the first data set of successful projects"

The limitations of the study are twofold. First and foremost, this systematic literature review has been conducted by surveying one single scientific database, i.e., the Scopus database. Therefore, other relevant work regarding the platform economy with the application of DEA may have been published in other globally significant scientific databases. To address this limitation, a future bibliometric study that includes all relevant work published in the field of the platform economy will be conducted, and it will encompass all relevant scientific databases. Second, the authors have conducted a

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

systematic literature review following the PRISMA guidelines, instead of conducting empirical research that could measure the efficiency of a platform-based industry or business. However, it should be taken into consideration that these limitations serve as a proposal and an incentive for further future work in this direction.

In future work, authors would implement the DEA methodology in assessing a small sample of platform economy businesses in order to gain new insights regarding the efficiency of businesses operating in different industries. This paper is novel since it provides new insights into the efficiency and efficiency measurement of the sharing economy, thus being beneficial to managers and entrepreneurs that operate in the dynamic digital/sharing economy today.

REFERENCES

Akrap, Ivan, Rodin, Mirella and Puljas, Ivana. 2020. Introducing Fairness and Transparency for Business Users of Online Platforms. In: *Tipurić, D. & Radić, M. (eds.) 8th International OFEL Conference on Governance, Management and Entrepreneurship: From Corporations to Social Entrepreneurs: Exploring the Different Faces of Social Innovation,* 194-215.

Shao, Benjamin, Lin, Winston T. and Tsai, Y. Juliana. 2017. An Empirical Study of the Telecommunications Service Industries Using Productivity Decomposition. In: *IEEE Transactions on Engineering Management*, *64* (4), 437-449. DOI: 10.1109/TEM.2017.2713771.

Borozan, Đula, and Borozan, Luka. 2018. Analyzing total-factor energy efficiency in Croatian counties: evidence from a non-parametric approach, *Central European journal of operations research, 26* (3), 673-694. DOI: 10.1007/s10100-017-0493-8.

Charnes, Abraham, Cooper, William W and Rhodes, Edwardo L. 1978. Measuring the efficiency of decision-making units. *European Journal of Operational Research, 3*(4), 429–444.

Cooper, William W., Seiford, Lawrence M. and Tone, Kaoru. 2007. *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software*. 10.1007/978-0-387-45283-8.

El-Mahgary, Sami, and Lahdelma, Risto. 1995. Data envelopment analysis: Visualizing the results. *European Journal of Operational Research, 83*(3), 700–710. https://doi.org/10.1016/0377-2217(94)00303-T

Emrouznejad, Ali and Yang, Gio-liang. 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.

Farrell, Michael. J. 1957. The measurement of productive efficiency. *Journal of the Royal Statistical Society, Series A (General), 120*(3), 253-290. https://doi.org/10.2307/2343100

Fotova Čiković, Katerina and Lozić, Joško. 2022b. Application of Data Envelopment Analysis (DEA) in Information and Communication Technologies. *Tehnički glasnik - Technical journal, 6* (1), 129-134. DOI:10.31803/tg-20210906103816.

Katerina Fotova Čiković, Damira Keček, and Mirko Smoljić. 2022. Exploring the efficiency of
Platform Economy: a Prisma Complaint Systematic Review of Data Envelopment Analysis Applications.
UTMS Journal of Economics 13(2): 236–248.

Fotova Čiković, Katerina, Lozić, Joško and Smoljić, Mirko. 2022a. Efficiency of Counties in Eastern Croatia: Applications of Data Envelopment Analysis. In: *Leko Šimić, M. (eds.) RED 2022 Proceedings*, 212-225.

Jacobs, Rowena. 2001. Alternative methods to examine hospital efficiency: data envelopment analysis and stochastic frontier analysis. *Health care management science*, *4*(2), 103-115.

Koch, Stefan. 2009. Exploring the effects of SourceForge.net coordination and communication tools on the efficiency of open source projects using data envelopment analysis. *Empirical Software Engineering 14*, 397–417. https://doi.org/10.1007/s10664-008-9086-4

Xu, Li, Hu, Wen-biao and Guan, Xiao-yan. 2018. Evaluation of the Efficiency of Chinese Makerspace Operation Based on Double-creation Background. *2018 International Conference on Management Science and Engineering (ICMSE),* 47-53, doi: 10.1109/ICMSE.2018.8745260.

Lafuente, Esteban, Ács, Zoltan J. and Szerb, Laszlo. 2022. Analysis of the digital platform economy around the world: A network DEA model for identifying policy priorities. *Journal of Small Business Management*, DOI: 10.1080/00472778.2022.2100895

Lozić, Joško. 2019. *Menadžment ekonomije platformi*. Sveučilište Sjever. Centar za digitalno izdavaštvo. ISBN 978-953-7809-93-5.

Lozić, Joško. 2020a. Netflix Streaming Platforma: Lider „Nove" Medijske Industrije. *Polytechnic and design, 8*(4), 221-228. https://doi.org/10.19279/TVZ.PD.2020-8-4-02

Lozić, Joško. 2020b. Pandora streaming radio: saturacija u industriji streaming platformi. *Zbornik sveučilišta Libertas, 5*(5), 137-157. https://doi.org/10.46672/zsl.5.5.10

Lozić, Joško. 2020c. Spotify Stabilizira Poslovanje: „Unicorn" Ekonomije Platformi Na Pragu Zrele Faze. *Polytechnic and design, 8*(2), 83-88. https://doi.org/10.19279/TVZ.PD.2020-8-2-03

Lozić, Joško. 2021. Financial analysis of Netflix platform at the time of COVID 19 Pandemic. In: *Hammes, K., Volarevic, H. & Kaurova, O. (eds.) Economic and Social Development: 66th International Scientific Conference on Economic and Social Development - Book of proceedings*, 78-86.

Mićković, Ivana, Mićković, Vlatko and Sirovatka. Goran. 2018. Metrika učinkovitosti ekonomskih platformi. *FIP - Financije i pravo 6(2),* 53-64.

Vincova, Kristina. 2005. Using DEA Models to Measure Efficiency. *BIATEC, Volume XIII, 8/2005*, National Bank of Slovakia.

Lusoli, Alberto. 2020. The platform economy. How Japan transformed the consumer internet. *Information, Communication & Society, 23*(1), 155- 156. DOI: 10.1080/1369118X.2019.1668041

Drahokoupil, Jan and Fabo, Brian. 2016. The platform economy and the disruption of the employment relationship. *ETUI Research Paper-Policy Brief*, 5.

Afuah, Allan. 2019. *Business Model Innovation. Concepts, Analysis, And Cases.* Second Edition. Routledge. ISBN: 978-1-138-33051-1