Quality-oriented human resource practices (QHRP), ambidextrous culture and organizational ambidexterity: a study of green agro-food companies

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Abstract

Purpose – The purpose of this paper is to examine the effect of quality-oriented human resource practices (QHRP) on organizational ambidexterity. Furthermore, the mediating role of ambidextrous culture in the relationship between QHRP and organizational ambidexterity was assessed.

Design/methodology/approach – Drawing on data from 350 green agro-food companies with two respondents in each company, structural equation models were used.

Findings – This paper has been drawn up to provide some responses to the needs of the companies to be ambidextrous while applying QHRP. The findings show that there is a positive effect of QHRP on organizational ambidexterity. In addition, ambidextrous culture mediated the relationship between QHRP and organizational ambidexterity.

Practical implications – This research reveals key managerial aspects for QHRP implementation that facilitate firms to be more ambidextrous, and thus more efficient and innovative.

Originality/value – The authors illustrate the connection between quality-oriented human resource practices (QHRPs) and organizational ambidexterity under the dynamic capabilities theory. The findings contribute to the empirical evidence on the antecedents of organizational ambidexterity, and suggest that these specific QHRPs influence an organization's baseline beliefs and values and support the development of ambidextrous capabilities by means of an ambidextrous culture.

Keywords Human resource management, Quality management, Organizational ambidexterity, Organizational culture, Exploitation, Exploration

Paper type Research paper

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1. Introduction

Ambidexterity has featured heavily in the most prestigious management journals (Zhang *et al.*, 2022). Such is this topic's importance that it has been cited by some authors as an emerging paradigm in organizational theory (Raisch and Birkinshaw, 2008; Raisch *et al.*, 2009; Simsek *et al.*, 2009), and as an important and promising research stream (O'Reilly and Tushman, 2013; Farzaneh *et al.*, 2022; Girod *et al.*, 2023).

Ambidexterity is a metaphor – the ability to use both hands with equal skill – which in the management literature context is used to draw attention to organizations aligned with day-to-day activities and efficient enough to meet current demands whilst, simultaneously adapting to and anticipating future change, and it has also been proved as vital for firm prosperity (Fourné *et al.*, 2019; Gualandris *et al.*, 2018; He and Wong, 2004; O'Reilly and Tushman, 2013; Pertusa-Ortega and Molina-Azorín, 2018; Turner *et al.*, 2013). Ambidexterity can also be the answer required to deal with complexity and contradiction (Kassotaki, 2019), allowing companies to deal with the increasing necessity of high technologies, internationalization, aggressive competition and the necessity of innovation (Smith and Lewis, 2011; Tamayo-Torres *et al.*, 2017).

Scholars have emphasized organizational ambidexterity as critical to ensuring a sustainable competitive advantage. Numerous empirical evidences confirm that organizational ambidexterity may not only lead to improved short-term performance but also heighten long-term survival rates in dynamically competitive environments (Tarba *et al.*, 2020). It seems confirmed that ambidextrous firms are better than others at responding to disruptive new business models and emerging technologies (Birkinshaw *et al.*, 2016; Hill and Birkinshaw, 2014; Tarba *et al.*, 2020).

Ambidexterity is contingent on employees' involvement in the work innovative processes. In this vein, it is important to take into account HRM practices aimed at fostering both exploration and exploitation capabilities. However, no clarity exists about which HRM practices contribute to organizational ambidexterity (Swart *et al.*, 2019; Junni *et al.*, 2015; Pak *et al.*, 2023).

This study adds to the academic dialogue on organizational ambidexterity in several relevant ways. First, we contribute to the literature building on the quality management theory (Hackman and Wageman, 1995; Perdomo-Ortiz *et al.*, 2009) to identify those HRM practices which are specific to quality management, and we name them quality human resource management practices (QHRP). In recent decades, quality management has been recognized as a central competitive variable having a positive effect on firms' performance (Escorcia-Caballero *et al.*, 2022). As Hackman and Wageman (1995) stated, company implementation of quality management implies applying several human resource-related practices. In fact, effective people management is increasingly becoming a primary concern for quality management programmes, as it is recognized that quality management hinges on the effective management of human resources (Gutierrez-Gutierrez *et al.*, 2018). Literature has used two different approaches to the study HRM support to the ambidextrous organization. The first one uses the "best practices view" and considers single HRM practices. The second one departs from HRM systems, as a combination of congruent bundles of HR practices operating for the same purpose (Ferraris *et al.*, 2019). In our study, we follow the first option, as we start from the specific quality management-related HR practices; considering single HRM practices by themselves can be configured to support ambidextrous work (Jansen *et al.*, 2008; Mom *et al.*, 2019).

Second, we develop a novel insight about the role of QHRP in relation with ambidextrous organizations introducing organizational culture to explain these relations (Asif and de Vries, 2015; Moreno-Luzon and Gil-Marques, 2015; Moreno-Luzon *et al.*, 2014). Highly capable individuals, together with a unique culture that promotes learning and innovation, are basic elements for a successful organization (Wei and Lau, 2010; Chams-Anturi *et al.*, 2020).

Organizational culture has been signalled as a mediator in some research between certain quality management practices and organizational ambidexterity. For instance, Moreno-Luzon *et al.* (2014) empirically proved the mediating role of cultural divergence between process management practices and organizational ambidexterity.

Third, we contribute to recent research linking the dynamic capabilities framework to quality management and contextual organizational ambidexterity (Escorcia-Caballero *et al.*, 2022; Faridian and Neubaum, 2021; O'Reilly and Tushman, 2013; Weiss and Kanbach, 2022; Yunita *et al.*, 2023).

The dynamic capabilities approach extends the resource-based view (RBV), which posits that firm resources are the source of competitive advantages (Barney, 1991). In today's dynamic and uncertain environment, the dynamic capabilities view enables a firm to continuously change the configuration of organizational resources. Quality management implementation needs training and development to provide employees and managers the tools and the motivation to achieve quality improvement objectives, and to upgrade their skills for the future to allow delegation and increase participation by employees (De Groote *et al.*, 1996). As De Groote *et al.* (1996, p. 543) pointed out: "Capabilities must be actively mobilized to utilize all the knowledge available in the plant, and to bring out employee initiative and ideas in order to encourage employees to 'use their hearts and brains as well as their hands".

Contrary to the structural approach (Jansen *et al.*, 2009), contextual ambidexterity, suggests that balancing challenges may be mitigated by more behaviourally integrated approaches proposing a supportive context in which individual members make their own choices on how to best divide the time and efforts between exploitation and exploration (Fourné *et al.*, 2019; Gibson and Birkinshaw, 2004; Patel *et al.*, 2013).

Our study analyses the antecedents of ambidexterity, focusing on the human dimensions of quality management, and on certain elements of organizational culture, to examine the extent to which QHRP may serve as an antecedent that enables firms to develop a context for ambidexterity, and to what extent an ambidextrous culture plays a mediating role in that relationship.

The paper proceeds as follows: firstly, we present the state-of-the-art on the relationships between human resource practices in a quality management framework, cultural values and organizational ambidexterity. Secondly, we introduce the methodology used in the empirical research. Thirdly, we present the results of the survey and, finally, we conclude by discussing the theoretical and practical implications of these findings.

2. Literature review

2.1 Human resource-related quality management (QHRP) and organizational ambidexterity

Organizational ambidexterity has attracted intense academic interest over the last few decades. Lavie *et al.* (2010), O'Reilly and Tushman (2013), Raisch and Birkinshaw (2008) and Turner *et al.* (2013) have discussed the state-of-the-art. Ambidexterity refers to the ability of an organization to simultaneously foster the exploration of new markets and the business opportunities and the exploitation of current ones (Lubatkin *et al.,* 2006).

To examine the extent to which QHRP may serve as an antecedent that enables firms to develop a context for ambidexterity, we can underline a statement by Fundin *et al.* (2021, p. 1): "the emergent quality management paradigm is an alternative perspective providing the guidance, examples, and practical solutions necessary to solve these dilemmas by recognising the dichotomies as mutually dependent".

Previous studies have demonstrated the capacity of quality management to confront paradoxes (Thompson, 1998), and some authors have signalled its capacity to build two

different models as well – a mechanistic and an organic model (Prajogo and Sohal, 2004) – and have focused on the direction of control or learning (Sitkin *et al.*, 1994).

One way of confronting these paradoxes and promoting control and learning at the same time is through the implementation of human resource practices (Smith and Lewis, 2011). Human resource practices are a particularly valuable organizational resources because they are firm specific, thus being difficult to imitate (Lepak and Snell, 2002). Human resource practices aimed at fostering problem-solving abilities, intellectual stimulation and employees' interaction and participation in the decision-making process have been related to innovation (Gutierrez-Gutierrez *et al.*, 2018).

In the field of quality management, we can find broad and rich evidence of the importance of human resource practices. Quality management provides employees from all levels of the hierarchy with great responsibility through empowerment and decentralization, which enriches their work (Hackman and Wageman, 1995; Perdomo-Ortiz *et al.*, 2009; Arifin *et al.*, 2022).

Jansen *et al.* (2006) empirically demonstrated the relationship between centralization, exploitation and exploration. They proved how centralization has a negative influence on exploratory innovation and does not support exploitative innovation. Since quality management promotes decentralization (Hackman and Wageman, 1995), we can therefore foresee that through these practices, both exploitation and exploration activities can be promoted.

When implementing quality management, delegation is complemented by continuous training and development to encourage participation (Moreno-Luzon, 1993; De Groote *et al.*, 1996; Nosella *et al.*, 2012). It is necessary to provide everyone with specific training to ensure their understanding of quality concepts and tools. It is important that they learn their command of tools, techniques and methodologies, as well as an attitude of participation and cooperation (Randolph, 1995; Wickramasinghe, 2012). Training is often used, therefore, not only to prepare for the use of techniques but also to promote better understanding, acceptance and inculcation of the principles of quality management (Moreno-Luzon and Valls-Pasola, 2011), integrating training with indoctrination (Mintzberg, 1979).

Human resource practices allow employees to recognize and use knowledge and experience to develop innovative ideas (Lopez-Cabrales *et al.*, 2009), thus promoting the development of dynamic capabilities, such as exploration or exploitation.

Nevertheless, limited research has explicitly examined the influence of these human resource practices from quality management programmes on ambidexterity. As far as we know, there are four prior main theoretical contributions. Moreno-Luzon and Valls-Pasola (2011) pioneered the discussion on the main issues in the relationship and proposed a research agenda; Asif and de Vries (2015), Asif (2017) and Moreno-Luzon and Gil-Marques (2015) examined how different quality management practices can be designed and executed to support ambidexterity.

Although Moreno-Luzon and Valls-Pasola (2011) concluded theoretically that there is a positive effect of quality-oriented human resource practices on organizational ambidexterity, and Asif and de Vries (2015) proposed a theoretical model in which empowerment, training and development, in the frame of quality management, positively influenced ambidexterity, no subsequent research has empirically proved these relationships. Human resource practices allow employees to recognize and use knowledge and experience to develop innovative ideas (Lopez-Cabrales *et al.*, 2009), thus promoting the development of dynamic capabilities, such as exploration or exploitation. Little research has examined human resource-related quality practices focused on training, organizational support and employee participation. Therefore, our first objective is to check if QHRP has a direct and positive effect on organizational ambidexterity.

In addition, we argue that QHRP creates a culture that trains, develops and capacitates employees in an organization, in turn, fostering organizational ambidexterity. Organizational culture has been signalled as a mediator in some research between certain quality management practices and organizational ambidexterity. For instance, Moreno-Luzon *et al.* (2014) empirically proved the mediating role of cultural divergence between process management practices and organizational ambidexterity. Due the importance of quality-oriented human resource practices in the quality management field and their foreseeable impact on organizational culture, it is important to delve deeper into this unexplored mediating role.

In trying to increase employee participation through delegating and training, a context of trust and support is created. QHRPs are based on a trust principle, and therefore, a greater degree of freedom for problem-solving without constant supervision is given to employees (Adams *et al.*, 2006). These attributes are what Gibson and Birkinshaw (2004) considered to be key values in facilitating ambidexterity, together with discipline and stretch. In this environment of trust and support, and without fear of reprisals, creativity can be developed further. We therefore find here a positive link between the human resource practices of quality management and ambidexterity. Trust, developed in a quality management framework is fundamental to allow people to make decisions that foster ambidextrous capabilities in the organization (Asif and de Vries, 2015; Moreno-Luzon and Gil-Marques, 2015; Moreno-Luzon *et al.*, 2014). As we have shown, there are arguments in literature to positively connect quality-oriented human resource practices (QHRP) and organizational ambidexterity (OA). Due to the favourable support for this positive relationship, we adopt this perspective and propose our first hypothesis:

H1. QHRP has a positive effect on organizational ambidexterity.

2.2 The role of corporate culture in the relationship between human resource-related quality management and organizational ambidexterity

Human resource practices act as the catalyst for the implementation of quality management, reinforcing human relationships to achieve a cultural change (Wilkinson, 1992). Culture consists of the beliefs, values and underlying assumptions supporting behavioural patterns and artefacts (Schein, 1986, p. 6). Ghobadian and Gallear (1996) posited that education and training, staff participation, improved communication, procedure and policy reviews and top manager behaviour can have an impact on a business culture. Moreover, this cultural effect has been recognized as a key factor for successful quality management implementation (Green, 2012; Tata and Prasad, 1998).

Literature also points out that quality management is related to a wide range of cultures. Drawing on the competing values framework (Quinn, 1988; Quinn and Rohrbaugh, 1983), it has been empirically proven that opposing cultural values such as flexibility and control cohabit in quality management (Al-Khalifa and Aspinwall, 2001; Dellana and Hauser, 1999; Prajogo and McDermott, 2005).

From a dynamic capabilities view, training employees foster problem-solving abilities, which contribute to creating an environment for learning (Flores *et al.*, 2012). Also, training fostered by QHRP enhances intellectual stimulation, dialog, motivation and experimentation, which promote a culture of both exploration and exploitation.

According to Naveh and Erez (2004), quality management has a positive impact on two different types of values: control and attention to detail on the one hand, and creativity, flexibility and experimentation on the other. Moreno-Luzon *et al.* (2013) also found evidence of a diverse cultural change generated by quality management, and pointed out to the role of this ambidextrous culture as a mediator between quality management practices and innovation.

Rafailidis *et al.* (2017) measured cultural ambidexterity following the competing values framework as well, and they concluded that an organizational culture oriented towards exploitation as well as exploitation has a positive impact on innovation performance only through firm's quality capability, revealing an underlying connection mechanism.

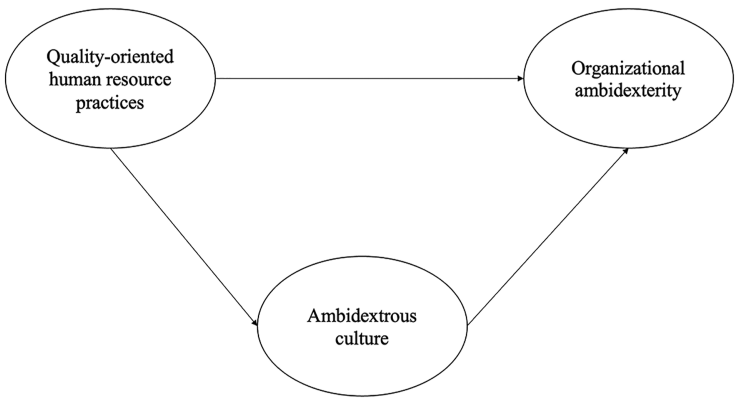
Previous empirical research by Moreno-Luzon *et al.* (2014) in two traditional industries, furniture and textiles, pointed to the importance of culture as a mediator in the relationship between process management practices implemented in a quality management framework and ambidexterity. Although process management practices have been traditionally viewed as mechanical, the empirical results of this study revealed that process management practices could promote an organizational culture made up of diverging values such as security, discipline and improvement on the one hand, and creativity, experimentation, risk-taking and flexibility on the other. These findings suggest that the implementation of QHRP may influence the organization's basic beliefs and values, and therefore support the development of ambidextrous capabilities. The importance of cultural change as a mediator reveals that having a balanced culture comprised of conflicting cultural values can be a key to success (Prajogo and McDermott, 2005).

Conceptual developments in the management literature have analysed what kind of organizational culture enables ambidexterity. In this line, Wang and Rafiq (2014) provide relevant evidence on the connection between organizational culture and ambidexterity. They conceptualize and examine ambidextrous organizational culture, consisting of organizational diversity and shared vision, as an antecedent to contextual ambidexterity and consequently new product innovation outcomes. Their findings sustain that organizational ambidexterity can be achieved through involving individual organizational members, emphasizing the involvement and participation of people (Wang and Rafiq, 2014).

Our objective is to examine the impact of corporate culture as a mediator in the relationship between human resource practices and ambidextrous capability in the organic agro-food sector. Based on the theoretical and empirical studies cited earlier, we propose the following hypothesis:

H2. An ambidextrous culture mediates in the relationship between QHRP and organizational ambidexterity.

Following the specified hypotheses structure, the assumed relationships between variables need to be empirically proven. Figure 1 shows the proposed research model.



Source(s): Figure by authors

Figure 1.
Proposed theoretical model

3. Research methodology

3.1 Sample and data collection

We have chosen this sector because it shows a clear need for organizational ambidexterity as well as quality management. This sector needs combining exploitation, to reduce operating costs and compete on price, and exploration, to be receptive to new markets, technological change and product innovation (Moreno-Luzon *et al.*, 2018). In this sector, companies have a high export profile and compete openly with conventional products. Organic-sector firms need to pursue exploitation to make continuous improvements in efficiency, improve processes, reduce costs and be competitive in terms of price. Companies are required to comply with specific quality standards applicable to the agro-food industry and organic labels. These formal regulations require exploitation and are necessary to ensure quality and create a secure environment for international trade and economic development, but they could discourage risk-taking to avoid possible errors and hamper innovation (Gil-Marques and Moreno-Luzon, 2015). These companies must also promote exploration, as they should be alert to technological changes and impulse product innovation, given that innovation is essential in this niche market. The Spanish organic agro-food industry is then our target research context.

The study is part of a larger project supported by the Spanish Ministry of Economy, Industry and Competitiveness, and the State Research Agency. With the purpose of delimiting the study population, the whole list of 3,984 organic agro-food industrial companies from the Spanish Ministry's website (www.mapama.gob.es) was consulted and downloaded in August 2017. Each company was reviewed to verify that it really belongs to the sector studied, and to ratify the contact information. Once the information was obtained, a very laborious refining and filtering process was carried out to ensure all the firms were industrial companies in the organic agro-food sector. The final population was reduced to 2,317 companies, all of them having organic certification.

The details of the sample used in the study are shown in Table 1 and Table A1.

A previous pilot study was conducted. First of all, the questionnaire was reviewed by relevant academics in the area of business organization who made some specific suggestions for its improvement. Secondly, the questionnaire was sent to the managers of five companies in the organic agro-food industrial sector. Managers made important suggestions as well that were introduced to the measuring instrument. These five previous questionnaires were considered adequate and incorporated into the final sample.

The final questionnaire was answered by two managers from each company, managing director and quality or operation manager; on the one hand, the quality and operations managers answered the questions related with quality management, including the human resource practices for quality, while on the other hand, the managing directors answered the questions related with organizational culture and ambidexterity. We targeted quality and operations managers as we are asking about quality-related human resource management

Geographical scope	Spain
Industry	Spanish agro-food industry
Study population	2,317 companies
Sample obtained with two respondents	350 companies
Response rate	15.10%
Respondents surveyed	Managing directors and quality/operations managers
Means of data collection	Web questionnaire, with e-mail and telephone reminders
Carried out	December 2017–January 2018

Source(s): Table by authors

Table 1.
Summary of sample details

practices. Moreover, the size of these agro-food companies is usually small or medium. They frequently have created a department to manage quality, as it is a demanding issue in this sector. On the contrary, not many of these companies have a HRM department, and quality managers, operations managers or general managers take decisions in this area. A telephone follow-up was done to obtain a larger sample. At the end of the process, a sample of 350 companies was obtained, each of them with two respondents.

3.2 Measures

The scales were constructed based on previous studies that are shown in Appendix A.

3.2.1 Quality-oriented management (QHRP). We used previous human resource measurement literature (Bou-Lusar *et al.*, 2009; Dean and Bowen, 1994) and quality management literature (Gutierrez-Gutierrez *et al.*, 2018) to develop a four-item and seven-point Likert scale. Quality managers were asked about the organizational QHRP (i.e. "Quality management training is continuous and includes all managerial and non-managerial staff"). The scale's α reliability was 0.886.

3.2.2 Ambidextrous culture (AC). We self-developed the ambidextrous culture measurement scale based on a solid literature ground (Al-Khalifa and Aspinwall, 2001; Dellana and Hauser, 1999; Moreno-Luzon *et al.*, 2014; Naveh and Erez, 2004; Prajogo and McDermott, 2005). General managers were asked in a six-item and seven-point Likert scale which included the two dimensions of the ambidextrous culture, namely, exploration values (RVALUES) and exploitation values (TVALUES). Each dimension had three items to measure an ambidextrous diverse culture made of values connected with exploration and exploration. Both dimensions loaded into a single factor. The scale's α reliability was 0.855.

3.2.3 Organizational ambidexterity (OA). An eight-item and seven-point Likert scale, based on Benner and Tushman (2003), Jansen *et al.* (2006) and Lubatkin *et al.* (2006), was used to ask general managers about the two dimensions of organizational ambidexterity, namely, exploration capability (EXPLOR) and exploitation capability (EXPLOT). The scale's α reliability was 0.936.

3.3 Common method bias

We used *post hoc* measures to reduce potential common method bias. Full collinearity test is as a comprehensive procedure for the simultaneous assessment of both vertical and lateral collinearity (Kock, 2015). Variance inflation factors (VIFs) were generated for all latent variables. Given that our research model is a reflective model, it was only necessary to consider the inner model VIF values (Hussain and Endut, 2018). VIF values equal to or lower than 3.3 indicate that the model does not suffer from common method bias. The full collinearity test confirmed no collinearity issues (Table 2).

Table 2. Factor correlations, means and standard deviation

	Mean	SD	Firm age	Firm size	QHRP	AC
Firm age	35.900	90.776				
Firm size	28.130	33.872	0.154**			
QHRP	5.670	1.150	0.005	0.029		
AC	5.686	1.024	0.05	−0.024	0.191*	
OA	5.947	1.043	0.251	−0.054	0.240**	0.760**

Note(s): *$p < 0.05$; **$p < 0.01$
Source(s): Table by authors

3.4 Procedure

Smart PLS 4.0 and the bootstrapping method were used with 10,000 runs to check the proposed hypotheses. It follows a statistical method accepted in HRM research (Ringle *et al.*, 2020). PLS-SEM maximizes the explained variance of dependent variables. We introduced firm size and firm age. Firm size is important as larger companies are expected to have more resources and more defined human resource management policies. Firm age should be considered given the particular sector analysed, as it is a novel industry in which human resource management practices of older firms with higher experience might alter the different effects of the proposed model.

4. Findings

Table 3 shows the means, standard deviations and correlations. There was a significant and positive correlation between quality-oriented human resource practices, ambidextrous culture and organizational ambidexterity. Firm age and firm size were positively and significantly correlated.

First, we checked the measurement model. We used the SRMR fit index to confirm the model fit. Values under 0.10 mean that the mode presents a good fit (Kline, 2005). The results showed a value of 0.062, which confirms a very good model fit. We assessed the measurement model by checking convergent validity and discriminant validity (Hair *et al.*, 2017) to evaluate the measurement model. Convergent validity was evaluated by means of factor loadings, average variance extracted (AVE) and composite reliability (CR). The AVE and CR values were above 0.5 and 0.7, respectively (Table 4). Discriminant validity was checked using the HTMT index. HTMT values above 0.85 indicate problems of discriminant validity (Franke and Sarstedt, 2019). Table 4 reveals that HTM values were all below the recommended value, thus confirming that each construct measured a different concept. We also assessed the predictive accuracy of the model using the Q^2 predict index. The prediction error was above 0, thus revealing predictive significance. VIF values were used to check lateral collinearity, showing values lower than 3.3 (Diamantopoulos and Siguaw, 2006), which supports discriminant validity.

Second, we assessed the structural model. Hypothesis 1 predicted a direct and positive effect of QHRP on organizational ambidexterity. The results revealed that 0 was not included

Mod	S-B $\chi 2$	d. f	*p*-value	BBNFI	CFI	RMSEA	NC (=$\chi 2$/d.f.)
QHRP	23.166	6	0.012	0.973	0.944	0.064	3.861
Ambidextrous culture	21.672	6	<0.001	0.894	0.908	0.078	3.612
Organizational ambidexterity	27.357	17	0.053	0.948	0.965	0.042	1.374

Note(s): All the loadings were significant at $p < 0.001$
Source(s): Table by authors

Table 3. Fit values of the factorial model of QHRP, ambidextrous culture and organizational ambidexterity measurement scales

	AVE	CR
QHRP	0.6648	0.888
AC	0.6181	0.905
OA	0.7317	0.956

Note(s): AC = ambidextrous culture. OA = organizational ambidexterity
Source(s): Table by authors

Table 4. Average variance extracted (AVE) and composite reliability (CR)

in the confidence interval (β = 0.238, t = 3.680, LL = 0.120, UL = 0.371, $p < 0.001$), thus suggesting a direct and positive effect of QHRP on OA. Hypothesis 2 predicted the mediation effect of AC in the relationship between QHRP and OA. To assess mediation, we also used confidence intervals (Zhao *et al.*, 2010), which is a more robust measure compared to other approaches such as pseudo t-values (MacKinnon *et al.*, 2004). The results revealed that 0 was not included in the confidence interval (β = 0.156, t = 3.772, LL = 0.080, UL = 0.241, $p < 0.001$), thus suggesting a direct and positive effect of QHRP on OA (Table 5). Control variables did not reveal a significant effect on the dependent variable.

5. Discussion and conclusions

The main objective of this research is to examine the relationships between QHRP, ambidextrous culture and organizational ambidexterity in order to clarify the emergence of ambidextrous capabilities from a human resource perspective.

This research was framed in the organic agro-food sector, which currently is facing major challenges. There is sustained growth in the demand for organic products, but competition in terms of prices is greater, making the need for improved, more efficient processes essential. The strict requirements imposed on firms via food quality standards and organic regulations require control and discipline. Nevertheless, new markets demand innovative products, and therefore firms must be ready to be creative and take risks. Firms developing ambidextrous capabilities will assure their future as they will be ready to improve the security and efficiency of their processes, as well as to acquire innovative technology and develop new products for new markets, technological change and product innovation (Moreno-Luzon *et al.*, 2018). Due to the necessity to reconcile forces towards exploitation and exploration in the organic agro-food industry, this is an ideal ground to study the connections between ambidexterity and quality management.

The results show the potential of QHRP in building organizational ambidexterity in the companies trading in this industry. This is in line with previous studies stating that human resource-related quality management practices, such as training, foster experimentation and knowledge integration within the organization (Chiang and Shih, 2011). Similarly, Moreno-Luzon and Valls-Pasola (2011) suggested a positive connection between quality management, human resources practices and ambidexterity, and the subsequent by Asif and de Vries (2015), who also theoretically proposed that, in the framework of quality management, training and development could positively influence ambidexterity.

Table 5.
Test results of partial mediation effect: the mediating role of ambidextrous culture (AC) on the relationship between QHRPs (quality-oriented human resource practices) and organizational ambidexterity (OA)

	Coefficient	S.E.	T-value	Percentile Lower	Percentile Upper
Total effect					
QHRP → OA	0.289***	0.061	24.253		
Direct effect					
QHRP → OA	0.248***	0.022	59.211		
QHRP → AC	0.322***	0.023	67.018		
AC → OA	0.349**	0.011	84.174		
AGE → OA	0.011 n.s	0.033	0.08		
SIZE → OA	0.017 n.s	0.041	0.07		
Indirect effect					
QHRP → AC → OA	0.212*	0.012	23.362	0.071	0.197

Note(s): ***$p \leq 0.001$, **$p \leq 0.01$, *$p \leq 0.05$
Source(s): Table by authors

Our study responds to the need for shedding light in the HRM-ambidexterity relationship (Pak *et al.*, 2023) and the lack of research on the influence of human resource management on quality management (Gambi *et al.*, 2022) from a dynamic capabilities perspective, and confirms the high value of the human resource management mechanisms that promote employees ambidextrous capabilities. Therefore, it makes key contributions to human resource management and quality management literature. First, prior research on human resource management has overlooked the quality management perspective. Second, recent research on human resource-related quality management practices has not yet included employees and managers' participation in the quality programmes (Gutierrez-Gutierrez *et al.*, 2018).

In addition, we have found evidence to suggest that the relation between quality-oriented human resource practices and organizational ambidexterity is mediated by cultural change. Accordingly, the importance of cultural values should not be forgotten. Quality management implementation is capable of implementing far-reaching cultural change in companies through human resource practices. As stated in the quality management literature (Bou-Lusar *et al.*, 2009; Hackman and Wageman, 1995; Prajogo and McDermott, 2005; Santos-Vijande and Alvarez-Gonzalez, 2007), quality-oriented human resource practices are central to a quality management programme, and both at the initial implementation stage and the following stages, these practices promote participation, empowerment and continuous training (Arifin *et al.*, 2022).

The RBV, extended through the dynamic capabilities approach, enables us to argue that by implementing a quality management programme, a culture composed of ambidextrous values allows efforts towards exploitation, whilst equally stimulating exploration, favouring the development of ambidexterity as an organizational capability. Our findings contribute to the empirical evidence on the antecedents of organizational ambidexterity, and suggest that these specific human resource practices influence an organization's baseline beliefs and values and support the development of ambidextrous capabilities by means of an ambidextrous culture. An ambidextrous culture based on values related to exploitation (improvement, safety, control, precision and discipline) and exploration (flexibility, creativity, tolerance to uncertainty, risk-taking and interest in experiencing) becomes an important driver of ambidexterity. The simultaneous presence of competing cultural tensions acts as a suitable context for the development of organizational ambidexterity.

Summarizing, our results confirm the hypothesized positive effect of QHRP on ambidexterity, thus indicating that QHRP can be the key to manage tensions and contradictions underlying ambidexterity. This result, combined with our mediating hypothesis findings, suggest that the quality-oriented human resource practices act through a cultural change.

We have shown how to achieve ambidexterity in highly formalized industries, which need quality assurance, security and control. Specifically, we extended previous research by responding to recent calls for investigation in different organizational and industry contexts (Fourné *et al.*, 2019).

Moreover, we consider especially relevant future research about these variables in sectors suffering from high pressure to innovate and to control quality and security. Further research examining different sectors with a high need to innovate, as well as a need for strict controls, would certainly strengthen this field of research.

There are executive implications stemming from this study, one of which is that top managers should be conscious of the impact that implementing quality programmes can have on organizational culture. If leaders wish to move toward a culture that fosters contextual ambidexterity, they will necessarily have to broaden in-house communication to inspire trust and generate confidence, providing clear explanations of policy and working closely with their staff. Managers have the ability to be the inspirational force behind

generating staff creativity and broad-mindedness, while also promoting the culture of discipline, combining the necessity for standardization tools and the search for new ways to resolve problematic issues. In order to implement ambidexterity in the corporate environment, staff should not be scared of difficulties or be averse to conflict. Instead, they should be prepared for exploration and for calculated risk-taking, with a measure of caution, generating positive mindsets towards change. It is also essential to provide a supportive response to any failure if a culture oriented to change is to take root in an organization.

The need for close collaboration between quality departments and human resource departments should also be highlighted. Quality departments, traditionally linked to operations management, have to work closely with human resource departments in order to generate synergies. In terms of human resource practices linked to the implementation of quality management, this research suggests that emphasizing participation at different levels, and continuous training and development, can enable not only quality management success but organizational ambidexterity as well.

The research we have carried out has some limitations, but knowing these represents opportunities that can be addressed in future lines of research. Some of these are described in the following text.

Firstly, we have considered ambidextrous organizational culture and ambidexterity as variables as a whole even though both have two dimensions. This is because we were interested in operationalizing ambidextrous organizational culture as a single concept, and ambidexterity as the balance between exploitation and exploration. New models could be defined to study relationships with only one type of values (exploitation or exploitation) and/or only one type of innovation (exploitation or exploration), for example, the impact of quality-oriented human resource practices on exploitation or the impact of quality-oriented human resource practices on exploration. Future research could also focus on the study of other organizational variables that measure possible mediating effects in this relationship, for example, formalization.

Secondly, our study focuses only in the organizational ontological level; it will be interesting to widen the perspective using a multilevel analysis (Mom *et al.*, 2019) to see how QHRPs influence not only organizational ambidexterity but individual ambidexterity as well.

Thirdly, this research is quantitative in nature. It could be complemented by other research of a qualitative nature based on the case studies of some of the companies in the sample. This would allow us to broaden and deepen the results. Also, the questionnaires were answered by two people, the general manager and the technical or quality manager. Although this is an important strength of our research, a case study would allow us to obtain information from non-management personnel and thus analyse other perspectives.

Fourthly, this empirical research has been carried out only in the Spanish organic agro-food industry sector and only in Spain. Future research could extend the study to other innovative sectors with a strong implementation of quality management, for example, the health or transport sectors, and in other countries, in order to provide greater consistency to the results obtained.

Finally, the cross-sectional nature of the empirical study has not allowed us to explore the causal relationships between the proposed variables. Therefore, analysing their behaviour in a longitudinal study would allow us to improve our understanding of the phenomena studied and their results over time.

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Appendix 1: Measurement and items

Quality-oriented human resource practices – QHRP

V1. Employees understand the quality programme well and actively participate in it.

V2. Quality management training is continuous and includes all managerial and non-managerial staff.

V3. Managers support the quality programme and actively participate in its design and implementation.

V4. Employees are aware of the results of their work and suggest ways to improve it.

Ambidextrous culture – AO

Cultural values related to exploitation

V5. One of our core values is improving and refining what we do.

V6. Our mindset is oriented towards control, precision and discipline.

V7. We prefer to choose safer options and those where sufficient information is already available.

Cultural values related to exploration

V8. We are tolerant of uncertainty and assume the risks inherent to entrepreneurship.

V9. We value flexibility and creativity.

V10. One of our characteristics is searching for and being actively interested in experimentation in new areas.

Organizational ambidexterity – OA

Exploration

V11. We constantly acquire new skills to be able to develop new products and services.

V12. We frequently learn new skills to position ourselves in new markets.

V13. We regularly look for new technologies for our production processes.

V14. We develop new and creative ways to satisfy current and potential clients.

Exploitation

V15. We regularly apply our current knowledge to adapt our products and services.

V16. We regularly use continuous improvement methodologies to improve quality and reduce costs.

V17. We continuously learn to improve the efficiency of our processes.

V18. We try to find out more about our clients to introduce small improvements in what we offer them.

Source(s): Appendix by authors

Appendix 2

Public sector participants	Private sector participants
• General manager of rural development and agricultural policy. Valencian regional government • Chairman of the society of organic agriculture • Head of subdivision of quality and organic agriculture. Ministry of agriculture, food and the environment • Representative of IFOAMs (International Federation of Organic Agriculture Movements) – Organics International	• CEO of The Muesli Up company • Director of quality, RandD and the Environment, Dulcesol Group • Technical director, Herbes del Molí S.L. • General manager of José María Bou S.L.

Source(s): Appendix by authors

Table A1.
Expert panel participants

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Servant leadership, innovative work behavior and innovative organizational culture: the mediating role of perceived organizational support

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Abstract

Purpose – The purpose of this study is to examine the effects of servant leadership (SL) and innovative organizational culture (IOC) on employees' innovative work behavior (IWB). In addition, this paper attempts to examine the mediating role of perceived organizational support (POS) in these relationships.

Design/methodology/approach – Data were collected from 280 employees working in technopark companies located in Turkey, which require intensive IWB. Structural equation modeling and bootstrapping procedure were used to test the hypothesized relationships.

Findings – The findings suggest that SL, and IOC are significantly and positively related to employees' IWB. The results also show that SL and IOC stimulate employees' IWB through POS.

Research limitations/implications – Because this study was carried out by employing a cross-sectional research design with data obtained from the same source, the inferences about the causality among the variables cannot be inferred.

Practical implications – The empirical findings suggest that organizations should make efforts to promote SL and improve IOC in order to harvest IWB from their employees. Moreover, organizations and managers need to recognize the importance of the POS by employees, and therefore form an adequate working environment, create and utilize policies and procedures accordingly.

Originality/value – This study suggests ways for organizations to enhance their innovativeness through IOC and SL applications in pursue of harvesting employees' IWB using POS by employees as mediator. This study is also original, in that no previous studies have investigated the mediating role of POS in the relationship between IOC, SL and IWB.

Keywords Servant leadership, Innovative behaviour, Organizational culture, Organizational support, Work behaviour

Paper type Research paper

Introduction

Innovative behaviors are critical to a company's success, improved performance, and survivability (Anderson *et al.*, 2014; Canet-Giner *et al.*, 2020). In times of limited resources and

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intense competition, innovative work behavior (IWB), which can be defined as the generation and implementation of new and useful ideas (Scott and Bruce, 1994), is a significant source for organizations (Shin *et al.*, 2017). In developing countries such as Turkey, this could not be more true. Thus, enhancing employee IWB requires an understanding of and depiction of the required structure.

Numerous studies have demonstrated that both organization culture and leadership style have an impact on employees' innovation behavior (Feng *et al.*, 2016; Wang *et al.*, 2019). In technology-driven, knowledge-sharing, and innovation-focused business environments, other leadership styles need to be considered, such as servant leadership (SL). A good example of such an environment is technology development zones (TDZs). TDZs are places focused on technological development, and include terms like technopark and technocenter (Gürlek, 2020). So, TDZs are integrated research and development ecosystems, and they encompass industries and research institutions conducting research, development, and innovation activities at the same time (Park and Shin, 2017). Turkish TDZs that permit direct research and development activities and produce innovative products are vital for a developing country like Turkey. Turkey's innovation capability depends on the TDZs. Turkey had 97 TDZs in December 2022, according to data from the Republic of Turkey Ministry of Industry and Technology (2022). These technology development areas require leadership style, innovative organizational culture (IOC), and creativity to achieve positive outcomes (Gürlek, 2020; Hughes *et al.*, 2018).

SL prioritizes serving others, establishes a relationship with followers to grasp their skills, necessities, potential and desires (Liden *et al.*, 2008) as SL's follower-oriented characteristic offers secure and sturdy communication links across the organization (Van Dierendonck, 2011). SL has become increasingly popular among researchers because it stimulates creativity through its distinctive characteristics (Liden *et al.*, 2014). While numerous studies were conducted about SL's effect on employees' IWB (Cai *et al.*, 2018; Iqbal *et al.*, 2020; Newman *et al.*, 2018; Zhu and Zhang, 2020), further studies regarding the nature of SL and its influence on the IWB are needed (Eva *et al.*, 2019; Newman *et al.*, 2018).

Another element that entices scholars to investigate the sources of innovation in organizations is the organizational culture (Senbeto *et al.*, 2022). The employees' perspectives on innovation are influenced by the importance that their employer places on fostering an innovative culture as an organizational value (Lam *et al.*, 2021). The beliefs that individuals have on the behavior that is required of them by the organization, also known as organizational culture, are what determine the individuals' actions with regard to innovation (Khan *et al.*, 2020). As a result, when the organizational culture focuses on innovation, the organizations become competitive and perform better (Acar and Acar, 2012; Wu *et al.*, 2019). Despite research with its broad description studying organizational culture, future studies with subcategories or attributions like IOC need to be conducted (Scaliza *et al.*, 2022).

Eisenberger *et al.* (1986) described perceived organizational support (POS) as the belief employees have about the degree of appreciation and care the organization shows for their contributions, in line with organizational support theory. Social exchange theory (SET) and norms of reciprocity determine how POS affects employee behavior (Eisenberger *et al.*, 1986; Rhoades and Eisenberger, 2002).

Besides, we believe SL contributes to POS by enabling an appropriate working environment for employees (Gaudet and Tremblay, 2017) and empowering and helping followers to succeed (Liden *et al.*, 2015). Additionally, IOC is designed to create a favorable environment for creativity, liberate employees to take risks, reward employees for presenting IWB, and therefore increase employees' POS.

Contributions of the present study are numerous. Furthermore, although much has been done on the relationship between SL and IWB (Cai *et al.*, 2018; Karatepe *et al.*, 2020; Wang *et al.*, 2019; Zhu and Zhang, 2020), testing the mediating role of POS extends our

understanding of how SL and IOC can contribute to employee innovation. By examining the mediating role of POS, this study provides different insights into how SL and IOC influence employee's IWB.

A second significance of this study is that it extends the existing literature by studying SL, IOC, POS and IWB in Turkish organizations located in TDZs. Third, we are interested in understanding how SL motivates subordinates to innovate positively, as opposed to the dominant patterns of traditional leadership in Turkey (Hofstede, 1983). It is also vital to highlight that this study demonstrates how employees in TDZs have the potential to advance IWB and how an IOC can reinforce IWB. We suggest that SL and IOC both affect IWB via POS as a mediator. Therefore, the main purpose of this study is to examine how SL and IWB affect the IWB of employees in TDZs in Turkey and the mediating role of POS in these relations.

Literature review

The purpose of leadership theories is to seek to understand and sort out the intricacy of the nature of leadership and the effects it has (Northhouse, 2012). The ever-changing socioeconomic environment has revealed the need for a sustainable leadership theory (Jaiswal and Dhar, 2017). Scholars working on leadership have drawn attention to the implicit link between ethics and leadership, and they have embraced SL as an emerging new type of leadership that is linked to ethics, virtues and morality (Parris and Peachey, 2013). SL, a concept first developed by Greenleaf (1977), focuses on putting the needs of the followers before the personal interests of the leader in order to achieve higher levels of performance and success. Servant leaders seek to encourage and cultivate development in their followers by offering feedback, expressing gratitude, creating ideal challenges and holding followers responsible for their performance (Van Dierendonck, 2011). They accordingly prioritize the development and well-being of their subordinates (Roberts, 2021). In contrast to the traditional model of leadership, SL involves the sharing of authority, the prioritization of the requirements of others above one's own and the encouragement of others to develop to their full potential while also maximizing their performance (Kaltiainen and Hakanen, 2022). Self-interest takes a back seat to the advancement of others as a common goal under SL (Parris and Peachey, 2013). According to Van Dierendonck and Patterson (2015), the need to serve, which is the primary focus of SL, originates from "compassionate love", which is the foundation of SL and is considered to be the cornerstone of the relationship between a servant leader and follower. Compassionate love is congruent with SL in the sense that servant leaders are required to have such a profound love for the people they serve that they are eager to get an understanding of the unique skills and capabilities possessed by every single one of their followers (Van Dierendonck and Patterson, 2015). By supporting the success and growth of all stakeholders while emphasizing the well-being and development of followers (Jaiswal and Dhar, 2017), compassionate love distinguishes SL from other leadership theories (Van Dierendonck *et al.*, 2014).

Organizational culture is a collection of shared norms, values and beliefs that assist people in comprehending organizational functions and directing the behavior required for organization-related tasks (Jones *et al.*, 2005). Further, IOC is the extent to which the business's norms and values foster innovation (Stock and Zacharias, 2011). To put it another way, it is a reference to the strongly held beliefs and values that are associated with innovation (Park *et al.*, 2015). IOC encourages new ideas, risk taking and innovation (Menon *et al.*, 1999). The existence of a culture that will develop employees' enthusiasm for and dedication to innovation may make them believe that the organization is dynamic and keeping up with environmental changes, and this can lead to positive organizational and individual outcomes (Wei *et al.*, 2013). For instance, Wei *et al.* (2013) found that employees'

perceptions of an innovative culture have a positive effect on their job satisfaction, organizational dynamism and the performance of the firm. Given that employee innovation is critical to an organization, it is vital to cultivate IOC that can encourage employees to show IWB and develop new and creative ideas. These arguments show that it is necessary to build up the innovative culture of the organization so that employees exhibit IWB (Skerlavaj *et al.*, 2010; Tian *et al.*, 2018).

POS is theoretically defined as the "*employees develop global beliefs concerning the extent to which the organization values their contributions and cares about their wellbeing*" (Eisenberger *et al.*, 1986, p. 501). POS theory emphasizes the significance of considering employees as valuable organizational assets (Eisenberger *et al.*, 1986). Employees who perceive high levels of POS are more likely to feel a responsibility to care for the organization's growth and aid in its goal-achieving (Wen *et al.*, 2019). Moreover, they have a sense of obligation to repay the favor to the business by going above and beyond what is required of them in their job (Rhoades *et al.*, 2001). Accordingly, POS can enable employees to develop novel ideas and positively predict IWB (Nazir *et al.*, 2019). At this point, leadership style can affect innovative behavior through its influence on the POS of employees (Qi *et al.*, 2019). Employees are more likely to perceive greater organizational support and become more innovative if their leader took on the role of a servant leader and provide a setting in which it was secure and encouraging for employees to share their thoughts and suggestions. In addition, in an organizational culture that encourages innovation, employees feel that their ideas and creative efforts are valued and that the organization cares about them, which may lead to more IWB (Nazir *et al.*, 2019).

Hypothesis development

SL and IWB. Today's business environment is highly competitive, dynamic and technology-driven, making innovation crucial for organizations (Tsuji *et al.*, 2018). To develop a creative and innovative environment, organizations and leaders should create conditions and spaces that encourage employees' participation (Newman *et al.*, 2018). This is when SL becomes prominent, since it stimulates the employees' creative thinking (Liden *et al.*, 2014).

SL has characteristics that are associated with several outcomes (Iqbal *et al.*, 2020) that lead to empowered followers, effective theoretical skills, growth and success, ethical behavior and emotional healing. By catching followers in relational, ethical, spiritual ways, SL allows followers to reach their fullest potential (Eva *et al.*, 2019).

In the role of a servant leader (Liden *et al.,* 2008), he/she always puts their followers and relationships before the task and outcome. Performing at their best for the organization, the followers are trusted, flourishing, and care for their own well-being. Thus, the organization will reach its goals over the long term (Stone *et al.*, 2004) with employees reflecting a deep moral commitment to their leader (Harvey, 2001). In addition, a servant leader inspires followers to serve others by changing their behavior. SL's focus on employees and their welfare leads to innovative behavior (Wang *et al.*, 2019).

From this perspective, relationship between SL and IWB is consistent with SET (Blau, 1964). Such social exchange occurs in the form of reciprocity (Gouldner, 1960). Employees feel obliged to reciprocate in positive and useful ways as a result of the SL's constructive and valuable behaviors (Eisenberger *et al.*, 1986). Additionally, this supports the research finding that the employee's work behavior exceeds their expected performance when supervisors and subordinates exchange information based on mutual trust, loyalty and esteem (Settoon *et al.*, 1996). Serving as a servant leader activates the sense of obligation to reciprocate with IWB (Jaiswal and Dhar, 2017) through empowering the followers with autonomy and decision-making authority (Van Dierendonck, 2011). In this case, the obligation is generated after building trust in leader (Schaubroeck *et al.*, 2011) and improving relational identification (Yoshida *et al.*, 2014).

IWB, which is derived from employees' engagement in innovation activities (Hughes *et al.*, 2018), is a critical resource for organizations to have competitive advantage (Shin *et al.*, 2017), which makes leadership styles an important aspect of innovation. On the other hand, few studies have examined the effects of non-traditional leadership styles, especially human oriented leadership styles (Newman *et al.,* 2018).

Yoshida *et al.* (2014) reported that SL positively affected employees' IWB by providing a safe and supportive environment for employees to present their ideas. By focusing on the needs of the followers and forming a social exchange, Panaccio *et al.* (2015) claim that SL influences employees' IWB. Krog and Govender (2015) found that employee perceived empowerment mediated the correlations between the SL and innovative behavior. In the case of Pakistani commercial banks, Rasheed *et al.* (2016) found that work engagement mediates the relationship between SL and IWB. Jaiswal and Dhar (2017) concludes that IWB improves when SL is constantly demonstrated by employees, demonstrating their creative abilities and gaining the followers' trust and confidence. According to Opoku *et al.* (2019), SL encourages employees' innovative behavior by enhancing followers' sense of insider status. Wang *et al.* (2019) discovered that serving others has a positive impact on innovative behavior when mediated by thriving at work, while team reflexivity has a moderating effect on serving others and thriving at work. By using SET, particularly in knowledge-intensive work contexts, SL is found to enhance employees' IWB (Iqbal *et al.*, 2020). By serving as a resource for employees and establishing trust in followers, Khan *et al.* (2021) suggest that SL may positively influence innovative behavior at two stages, including creativity and implementation. Zeng and Xu (2020) found that SL has a positive effect on followers' self-concept, and that SL increases innovative behavior. Furthermore, Zhu and Zhang (2020) report that SL influences innovative behavior by setting up a knowledge sharing process, with the moderating effects of aspects of employee identity and learning goal orientation.

With regard to SET and the above theoretical background, we formulate the following hypothesis,

H1. SL is positively related to employees' IWB.

IOC and IWB. Organizational culture entails a set of shared beliefs, values, practices and manners influencing the behaviors of an organization's members (Ouchi and Wilkins, 1985). Organizational culture, an important factor for organizational success (Martins and Terblanche, 2003), affects employees' behavior towards innovation by ensuring that innovation is an organizational value, and the necessary structure is established to facilitate innovation (Hartmann, 2006).

Since the innovation depends on the employees' IWB, and organizational culture affects the members' behaviors (Sharifirad and Ataei, 2012), the researchers found it valuable to study the relationship between organizational culture and innovation (Büschgens *et al.*, 2013; Harel *et al.*, 2021; Naranjo-Valencia *et al.*, 2011). Because employees' assumptions on how to demonstrate behavior impacts the extent of organizational creativity and innovation (Martins and Terblanche, 2003), the innovation culture helps companies in novel product development by changing organizations to facilitate innovation and entrepreneurial behaviors (Lau and Ngo, 2004).

Tesluk *et al.* (1997) proposed that organizations with a clear vision for innovation, a space for failure and risk taking, reward systems that acknowledge individual contributions and proper organizational structure, nourish innovation. Naranjo-Valencia *et al.* (2016) contends that while organizations with highly formal and centralistic decision-making processes hinder innovation, organizational cultures associated with risk-taking, creativity and freedom foster it. Wallach (1983) suggests that innovative cultures provide employees with creative workplaces, offer challenges, enable and stimulate employees to take risks and be creative.

This literature review led to the following hypothesis.

H2. IOC is positively related to employees' IWB.

Mediating role of POS. Eisenberger *et al.* (1986) suggest that POS help employees accomplish their tasks by boosting individuals' effort-outcome expectations. Parallel to SET, POS occurs when an employee performs their job duties in an effort to achieve the organization's goals (Rhoades *et al.*, 2001). The degree of POS enhances employees' ties to organizations and induces individuals to exercise extra-role behavior with a reward expectation (Eisenberger *et al.*, 1986). The opposite is true when organizations underestimate individuals' well-being and efforts, with their performance and commitment (Eisenberger *et al.*, 1997). Through arousing the need for reciprocation in the employees' inner world, POS drives them to increase their commitment to the organization, work harder than planned, and reduce negative behavior towards the organization (Chung, 2017; Rhoades and Eisenberger, 2002).

As Eisenberger *et al.* (1986) report, the employees view the actions of their agents as the act of their organization. Because employees tend to personify the organization, their treatment of the employees forms a perception about how biased the organization is (Rhoades *et al.*, 2001). Leaders are also seen as serving the organizations and not only themselves (Gaudet and Tremblay, 2017). Leaders' actions and attitudes towards employees will significantly impact employees' POS. Employees' level of identification with their leaders determines their relationship strength (Rhoades and Eisenberger, 2002). POS by employees can further satisfy their socioemotional needs, strengthen their connections and status with the organization (Rhoades and Eisenberger, 2002).

By providing the necessary resources, leaders ensure an appropriate working environment (Gaudet and Tremblay, 2017). The servant leaders help followers grow, prioritize subordinates, behave ethically, support individuals emotionally (Liden *et al.*, 2015), care for members' wellbeing (Liden *et a.,* 2008), allow followers to do their best through relational, ethical, spiritual connection (Eva *et al.*, 2019). Thus, it can be suggested that the unique aspects of SL encourage the perception of strong organization support among employees.

The following hypothesis is developed with this theoretical context.

H3. POS mediates the relationship between SL and employee's IWB.

The IOC aims to support employees seeking an environment fostering creativity, liberate employees to take risks, reward innovation, and to inspire them to show true personalities that reflect creativity (Nazir *et al.*, 2019). Thus, employees feel that organizations appreciate their opinions and creative efforts. A creative and innovative employee would feel that the organization strongly cares about his/her opinion (Martins and Terblanche, 2003). Additionally, an organization permitting risk-taking behavior might forgive honest mistakes on the road to innovation. Eisenberger *et al.* (1997) present several items to measure the positive POS by employees, such as caring about employees' opinions, caring about employees' goals, and being forgiving of their honest mistakes.

We formulate the following hypothesis based on our approach and the theoretical framework.

H4. POS mediates the relationship between IOC and employee's IWB.

Figure 1 depicts the proposed theoretical model of this study.

Methodology

Sample and procedures

We collected the data from employees working in companies located in TDZs which are in Turkey. TDZs are examples of integrated research and development ecosystems. TDZs are a

kind of integrated research and development ecosystem, and they are comprised of different sectors as well as research institutions that are all engaged in research, development, and innovation at the same time (Park and Shin, 2017). It is crucial for a developing country to have TDZs, research and technology organizations and as well as the manufacturing of innovative products (Rincon Diaz and Albors Garrigos, 2017). TDZs are of utmost significance in the process of enhancing Turkey's innovative capabilities. It is necessary to have an effective leadership style, a culture that encourages innovation, and creative thinking in order to achieve success in the aforementioned fields of technological growth. Therefore, employees working at TDZs are an appropriate population to sample for the purposes of this study.

First and foremost, the companies located in this development regions throughout Turkey were determined by the researchers and we contacted the employees via e-mail communication and delivered the online questionnaires by adopting convenience sampling. The time frame that the data collection period included was from November 2021 to January 2022. The introduction of the survey was established to inform participants about the aim of the research, and it was reminded that the participation is voluntary bases. Moreover, to reduce the likelihood of socially desirable responses, the respondents were assured that their answers would be kept confidential and that the results would only be used for academic research.

We distributed questionnaires to 400 employees, and 286 of the surveys returned (with a 71.5% response rate). Six questionnaires were discarded due to missing data. Approximately 78.9 (n = 221) percent of the respondents were male and 21.1 (n = 59) percent of the respondents were female. The mean age was 34.02 years, and ages ranged from 22 to 52 years. The majority had at least a bachelor's degree (75%). Participants' mean organizational tenure in the relevant company was 1.88 years.

Measures

Although all the measures were originally developed in English, the measures were translated into Turkish adopting a translation-backward translation approach (Brislin, 1980). Except for the control variables, all items of measures were rated based on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Servant leadership. SL was measured by Liden *et al.*'s (2015) seven-item scale. One sample item is "My leader puts my best interests ahead of his/her own." Cronbach's α coefficient for this scale is 0.93.

Innovative work behavior. Each respondent's IWB perception assessed by using the six-item scale developed by Scott and Bruce (1994). One sample item includes "I generate creative ideas." Cronbach's α coefficient for this scale is 0.95.

Perceived organizational support. Each respondent's POS assessed by using the eight-item scale developed by Eisenberger *et al.* (1997). One sample item includes "My organization strongly considers my goals and values." Cronbach's α coefficient for this scale is 0.93.

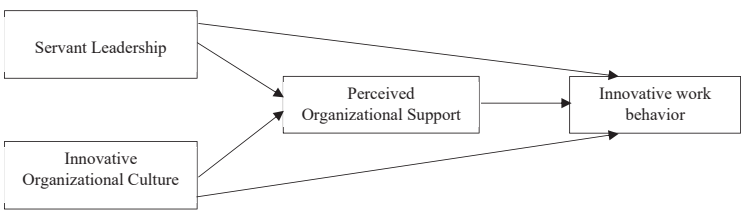


Figure 1.
Proposed
theoretical model

Source(s): Figure by authors

Innovative organizational culture. The organization's cultural characteristics affiliated to innovation assessed by using the eight-item scale developed by Wallach (1983). One sample item includes "My organization is result-oriented." Cronbach's α coefficient for this scale is 0.96.

Control Variables. Following advice from previous studies (Cai *et al.*, 2018; Scott and Bruce, 1994; Yoshida *et al.*, 2014; Zhu and Zhang, 2020), we controlled for employees' gender (1 = male; 2 = female), age (in years), education (1 = associate's degree; 2 = bachelor's degree; 3 = master's degree), tenure (in years). As shown in Table 2, none of the control variables were related to the study variables and were therefore excluded from the analysis, since such impotent control variables can lead to biased parameter estimates (Becker, 2005). Wang *et al.* (2019) concluded that the control variables (gender, age, education, and job tenure) were not associated with IWB, which lends support to the current study.

Results

Common method variance

To test common method variance, we used Harman's one-factor test, as proposed by Podsakoff *et al.* (2003). Therefore, unrotated exploratory factor analysis to all variables was conducted. The one-factor solution explained only 40% of the total variance, which is below the 50% cutoff, indicating that there was no dominant factor in the study. Harman's one-factor test results showed that common method variance was not a concern.

Measurement model

Before testing the structural model, a series of confirmatory factor analyses (CFA) was performed to validate the discriminability of SL, IOC, POS and IWB. The four-factor (hypothesized) model provides an excellent fit to the data (χ^2/df = 711.076/363 = 1.95, $p < 0.001$, IFI = 0.97; TLI = 0.96, CFI = 0.97, RMSEA = 0.05, SRMR = 0.03). The hypothesized model was compared to alternative models as well. As depicted in Table 1, alternative models resulted in a significantly worse fit than our hypothesized model, which indicates that all variables are distinguishable in this research.

To evaluate convergent and discriminant validity, as well as composite reliability, a CFA for the four-factor full-measurement model was performed. The results showed that all the items loaded significantly ($p < 0.001$) on their respective constructs and exceeded 0.70. As shown in Table 2, composite reliability (CR) for all variables are greater than the cutoff value

Models	χ^2	(df)	χ^2/df	RMSEA	IFI	TLI	CFI	SRMR	χ^2 diff
Four-factor (hypothesized)	711.07	363	1.95	0.05	0.97	0.96	0.97	0.03	–
Three-factor (merged SL and IOC)	2565.69	366	7.01	0.14	0.81	0.79	0.81	0.15	1854.62***
Three-factor (merged SL and POS)	2617.77	366	7.15	0.15	0.80	0.78	0.80	0.17	1906.70***
Two-factor (merged SL, POS and IOC)	4332.79	368	11.77	0.19	0.65	0.62	0.65	0.25	3621.72***
Single-factor (merged all constructs)	5672.30	369	15.37	0.22	0.54	0.50	0.54	0.25	4961.23***

Note(s): n = 280, ***$p < 0.001$, χ^2diff.: difference in chi-square, SL=Servant Leadership, IOC = Innovative Organizational Culture, POS= Perceived Organizational Support; IWB = Innovative Work Behavior; All models compared to four-factor hypothesized model
Source(s): Table by authors

Table 1. Comparison of alternative measurement models

Variable	Mean	S.D	CR	AVE	α	1	2	3	4	5	6	7	8	9
1.Gender	1.21	0.40	–	–	–	–								
2.Age	34.02	6.93	–	–	–	−0.03	–							
3.Education	2.09	0.49	–	–	–	−0.08	−0.10	–						
4.Tenure	1.88	0.79	–	–	–	0.04	0.51**	−0.10	–					
5.SL	3.80	1.00	0.93	0.76	0.93	−0.09	0.07	−0.09	0.06	*(0.87)*				
6.IOC	3.16	1.09	0.95	0.77	0.96	−0.02	0.15	−0.13	0.13	0.36**	*(0.87)*			
7.POS	3.06	1.18	0.94	0.74	0.93	−0.04	0.02	−0.16	0.05	0.32**	0.27**	*(0.86)*		
8.IWB	3.19	1.60	0.96	0.89	0.95	−0.06	0.09	0.12	0.04	0.42**	0.59**	0.39**	*(0.94)*	

Note(s): n = 280. Values in parentheses on the diagonal are the square of AVE of each scale. *$p < 0,05$; **$p < 0,01$; SL=Servant Leadership, IOC = Innovative Organizational Culture, POS= Perceived Organizational Support; IWB = Innovative Work Behavior
Source(s): Table by authors

Table 2.
Correlation analysis

of 0.70, and the average variance extracted (AVE) for all four constructs surpass 0.50, indicating that each construct has acceptable psychometric properties (Hair *et al.*, 2006). Further, for each of the five structures, the CR values are greater than AVE values (CR > AVE), suggesting convergent validity (Hair *et al.*, 2006). The square roots of the AVE values for each construct was greater than the correlations between each pair of constructs, as seen in Table 2, supporting discriminant validity (Hair *et al.*, 2006). These results indicated the satisfactory level of construct validity and internal consistency.

Descriptive statistics and correlations

Table 2 presents descriptive statistics and correlations for all variables. Results reported in Table 2 indicated that IWB is positively and significantly related to SL ($r = 0.42$, $p < 0.01$), IOC ($r = 0.59$, $p < 0.01$), and POS ($r = 0.39$, $p < 0.01$). POS is also positively and significantly related to SL ($r = 0.32$, $p < 0.01$), and IOC ($r = 0.27$, $p < 0.01$). Further, SL is positively and significantly related to IOC ($r = 0.36$, $p < 0.01$).

Hypotheses testing

Following the validation of the measurement model, the structural equation modeling (SEM) was conducted to test the hypothesized relationships among the study variables. SEM results provided a satisfactory match to the data (χ^2/df = 711.076/363 = 1.95, $p < 0.001$, IFI = 0.97; TLI = 0.96, CFI = 0.97, RMSEA = 0.05, SRMR = 0.03). Further, Table 3 includes the findings of the structural model that was tested.

	Total effect	Direct effect	Indirect effect
IOC→POS	0.17*	0.17*	–
SL→POS	0.25*	0.25*	–
IOC→POS→IWB	0.53*	0.50*	0.03* (LLCI = 0.01; ULCI = 0.08)
SL→ POS→IWB	0.20*	0.15*	0.05*(LLCI = 0.02; ULCI = 0.10)
POS →IWB	0.19*	0.19*	–

Note(s): n = 280; *$p < 0.01$; IOC=Innovative Organizational Culture, POS = Perceived Organizational Support, SL= Servant Leadership; IWB = Innovative Work Behavior; Bias-corrected bootstrapping analysis was made with a bootstrapped 2,000 sample at 95% confidence interval. LLCI = Lower levels for confidence interval; ULCI =Upper levels for confidence interval
Source(s): Table by authors

Table 3.
Standardized direct, indirect and total effects

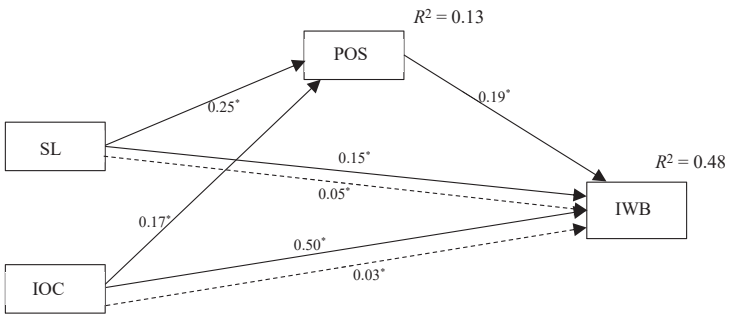
H1 proposes that SL is positively related to employees' IWB. The results indicated that SL had a significant and positive direct impact on IWB ($\beta = 0.15$, $p < 0.01$), Thus, *H1* was supported. *H2* predicts IOC is positively related to employee's IWB. The results pointed out that, as predicted, IOC had a significant and positive direct impact on IWB ($\beta = 0.50, p < 0.01$). Therefore, *H2* was supported. The results also showed that SL had a significant positive direct impact on POS ($\beta = 0.25, p < 0.01$); POS had a significant positive direct impact on IWB ($\beta = 0.19, p < 0.01$). Further, the impact of IOC was found to have a significant positive direct impact on POS ($\beta = 0.17$, $p < 0.01$).

The mediation hypotheses (H3 and H4) were further tested by using the bootstrapping procedure. Particularly, to investigate the significance of the indirect effects, 2,000 bootstrap samples were used to generate 95% bias-corrected confidence intervals (CI) around the indirect effects. We adopted the bootstrapping approach because of its accuracy in establishing confidence intervals for mediation effects when the mediation effect is nonzero. If the 95% bias-corrected CI do not contain a zero, the induced effect is considered significant (Mallinckrodt *et al.*, 2006). As depicted in Table 3, results indicated that there were significant indirect effects from SL to IWB ($\beta = 0.05$, 95%CI = [0.02, 0.10], $p < 0.01$), and IOC to IWB ($\beta = 0.03$, 95%CI = [0.01, 0.08], $p < 0.01$), providing support for H3 and H4. Furthermore, the total effect (direct + indirect effects) of SL on IWB, and IOC on IWB is 0.20 (0.15 + 0.05) and 0.53 (0.50 + 0.03), respectively (see Figure 2). The results also showed that R^2 of POS was 0.13 and R^2 of IWB was 0.48.

Conclusion and implications

This study attempts to contribute to the existing body of knowledge on SL and innovation by investigating the role that a POS acts as a mediator in the connection between SL and IWB, as well as IOC and IWB. The findings contribute to a better understanding of the ways in which a SL style and an organizational culture that encourages innovation may have a significant impact on employees' POS, which in turn contributes to maintaining and improve employee IWB.

Aside from a few studies, there are very few empirical studies conducted in the context of Turkey on the topic of the establishment of a culture in which organizations encourage innovative behavior from their employees and employ a leadership style that is based on serving others. In addition, there is a lack of evidence that investigates the mediation role played by POS in these relationships. The findings of the study show that IOC, and SL significantly and positively affects employees' IWB through POS. This important finding suggests that an innovative culture, and SL also creates positive outcomes at the individual



Source(s): Figure by authors

Figure 2.
Direct (solid lines) and indirect effects (dashed lines)

employee level (e.g. innovative behavior) through POS. This finding constitutes an intriguing new empirical addition to the existing literature on innovation.

These results may have emerged from the positive and supportive role of the servant leader and the provision of an innovative culture by the organization. Because, SL, which is known for providing opportunities for employees to develop new skills and supporting them to reach their creative goals, and an innovative culture that allows employees to improve their creative performance by better understanding their skills, competencies and abilities, cause employees to perceive a high level of organizational support; this can pave the way for them to exhibit higher levels of IWB.

The findings of this study provide evidence in favor of previous studies which recommended that SL should contribute to boosting employees' IWB (Cai *et al.,* 2018; Iqbal *et al.*, 2020; Khan *et al.*, 2021; Opoku *et al.*, 2019; Panaccio *et al.*, 2015; Su *et al.*, 2020; Wang *et al.*, 2019; Yoshida *et al.*, 2014; Zeng and Xu, 2020; Zhu and Zhang, 2020). Further, it is presented as evidence in the present study that IOC, which is an important element for the success of organizations, has a positive effect on IWB. This finding shows that organizational culture can increase the effectiveness of the organization (Martins and Terblanche, 2003; Hartmann, 2006), and a culture that supports innovation can exhibit innovative and creative employee outputs (Wallach, 1983).

This study makes two significant theoretical contributions to the existing body of knowledge. The first theoretical contribution made by this research is that it adds to the existing body of knowledge by enhancing our comprehension of the indirect link that exists between SL and IWB through POS, as well as the indirect relationship that exists between IOC and IWB via POS. The direct effects of SL and IWB (Krog and Govender, 2015; Oliveira and Ferreira, 2012; Rasheed *et al.*, 2016), and IOC and IWB (Abdi *et al.,* 2018; Acar and Acar, 2012; Naranjo-Valencia *et al.*, 2016) have been examined in a few empirical studies, but the mediating role of POS between these constructs is yet to be investigated. Our study contributes to a more in-depth understanding of how SL and IOC influence the psychological processes of employees and how employees develop IWB. The results of the study revealed that employees' POS as an underlying mechanism channels the positive effect of SL and IOC on individual employees' IWB in the TDZs. Second, even though there is a substantial amount of discussion on IWB among employees in countries of the West and Europe, its implications and debates in the context of Turkey continue to be mainly unexplored (Koroglu and Ozmen, 2022). We believe that the best way to address the gaps that have been identified in the existing body of literature is to conduct research in these areas that may provide practical guidelines to businesses in TDZs in emerging countries like Turkey. To that end, doing research on IWB among employees in Turkey within the context of a growing country would contribute to the expansion of the existing body of knowledge.

The IWB of employees, resulting from their engagement in innovation activities (Hughes *et al.*, 2018), is a critical source of competitive advantage (Shin *et al.*, 2017). To produce and realize original ideas, as well as solve emerging problems, organizations must expose employees' IWB (Wang *et al.*, 2019). As a result of this perspective, we suggest several implications for organizations. These implications are especially beneficial for the companies in Turkey competing in industries requiring novel products and solutions, since it is a collectivist country where authoritarian leadership style is commonly experienced (Giritli and Oraz, 2004; Pasa *et al.*, 2001). By utilizing the proposals below, organizations can shape their culture and recruit servant leaders in order to reveal employees IWB.

Servant leaders can be effective for organizations even if their first goals or aim are not the organization's. Thus, organizations can hire servant leaders, or train existing leaders to become servant leaders, or reward current servant leaders to promote innovation. Human resources departments can apply unique tools to assess whether candidates have characteristics or potential that fit SL style. The organization can conduct training programs to promote SL among existing managers. Also, SL characteristics can be included in performance evaluation

processes to show the organization's value for SL. Furthermore, the IOC affects significantly IWB through POS. Hence, organizations can change their culture to foster innovation. They can design the interior and exterior accordingly, recognize risk-taking and creative employees and incentivize their employees to be innovative. Training programs and entertaining workshops can also promote employees' innovative behavior. Moreover, organizations can develop methods to assess IWB and implement honor programs for highly creative employees.

Several limitations in our study suggest useful avenues for future research. The study was a cross-sectional one in which independent (SL and IOC) and mediator variables (POS) were measured at a single point in time, along with a dependent variable (IWB). Using longitudinal studies or controlled experiments in future research could help explain the relationship between variables in the model more effectively.

Second, the results are affected by the personal judgment of the employees, since all the variables were measured by subjective perception of them. For instance, the IWB was measured by the employees replies to questionnaires. In future studies, to generate more convincing data researchers could include both subjective evaluations and objective variables such as the number of suggestions, patents, or research outputs to their research.

Third, the sample is limited to TDZ companies because they compete with companies in Western cultures and are similar in terms of organizational structure and leadership style. The results are consistent with those found in other western studies. Future studies can examine various industries, which require continuous innovation.

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The interplay of servant leadership behaviors and Machiavellianism on perceived leader effectiveness: the role of team conflict management

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Abstract

Purpose – This paper aims to examine the influence of the interplay between servant leadership behaviors and Machiavellianism on leader effectiveness.

Design/methodology/approach – Drawing on trait activation theory and motivation to lead theory, the authors hypothesize that the effect of servant leadership behaviors on perceived leadership effectiveness is manifested differently in teams with high-Machiavellian vs. low-Machiavellian leaders. In teams with low-Machiavellian leaders, servant leadership behaviors are expected to be associated with a cooperative way of handling team conflicts, which enhances employees' leader effectiveness ratings. In contrast, in teams with high-Machiavellian leaders, this mediation role vanishes due to the incongruency between Machiavellian traits and the cooperative context. The authors conducted a two-wave survey-based study and tested the hypotheses with a matched supervisor-employee sample from 310 employees and their leaders in 91 teams.

Findings – The results showed that servant leadership behaviors positively impact leadership effectiveness and that this effect takes place through cooperative team conflict management (TCM) without controlling for leaders' Machiavellian trait. Further analysis shows this mediation mechanism is only strong and significant in teams led by low-Machiavellian leaders, but not high-Machiavellian leaders.

Originality/value – To the authors' best knowledge, this is the first study that examines the interplay of servant leadership behaviors and Machiavellianism on perceived leader effectiveness.

Keywords Servant leadership, Leadership effectiveness, Team conflict management, Machiavellian

Paper type Research paper

Introduction

In today's dynamic socioeconomic environment, we have seen the adoption of different leadership styles in businesses, most notably to achieve high performance among subordinates in response to a constantly changing business environment (Jaiswal and Dhar, 2017). One leadership style of particular relevance is servant leadership which at its core puts the priority on the well-being of people in an organization. It also promotes strong

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trust in the idea that leaders by taking care of the people in the organization, will take care of the organization. The growing literature on servant leadership has confirmed its impact, relevance and positive influence on subordinates' needs (Eva *et al.*, 2019). One of the most intriguing challenges of servant leadership is the paradox incorporated in the term itself: "Serving and leading become almost exchangeable. Being a servant allows a person to lead; being a leader implies a person serves" (van Dierendonck, 2011, p. 1231). How one can simultaneously lead and serve is the underlying question and challenge. In particular, when it comes to perceived effectiveness, a strong balance may be needed between focusing on people and on the organization (van Dierendonck *et al.*, 2014). Most studies in the servant leadership literature, however, have placed greater emphasis on the servant part than the leader part (van Dierendonck, 2011), hereby limiting our understanding of leaders' values and behavior regarding influence skills and the use of power (Yukl, 2012).

Previous research has confirmed that perceived leadership effectiveness is associated with outcomes relevant for both the leaders themselves (e.g. promotions to elite leadership positions) and the organization as a whole (e.g. leadership styles most likely to be embraced and serve as models for other leaders) (Paustian-Underdahl *et al.*, 2014). To be viewed as an effective leader typically requires that the leader possesses influencing skills to get things done and pays attention to the needs of the people in an organization. These influencing skills are at their darkest when they fall into the category of Machiavellianism, which, at first glance, is antithetical to servant leadership.

However, as recently called for by leadership scholars (e.g. Cunha *et al.*, 2021; Pfeffer, 2021), it is important to ground leadership studies in organizational reality. Alvesson and Einola (2019) note that "making efforts to serve 'everybody' may call for extreme altruism, possibly rare among people in business" (page. 392). Although some argued that Machiavellianism is a redundant and irrelevant construct in leadership studies (McHoskey *et al.*, 1998), more research has demonstrated that studying Machiavellianism is important, especially when conducting leadership studies grounded in business relativities and argued that there is more to lose than gain if Machiavellianism is not considered (e.g. Alvesson and Einola, 2019). In the meanwhile, besides the dark view of Machiavellianism that is widely recognized, some authors note the potential bright sides of leader's Machiavellian traits such as being highly adaptive and able to use a variety of leadership and influence tactics when navigating power dynamics in complex business organizations (Judge *et al.*, 2009). This view echoes Pfeffer's (1992, 2021) works on the role of power in leadership and organizations. Specifically, Pfeffer (2021) argued that the current leadership literature has emphasized too much on the dysfunctional side of the leader's personality traits (e.g. Machiavellianism), and called for leadership studies to give more consideration to the organizational reality and complexity and the role of power in leadership.

Indeed, Machiavellian leaders could calculatedly and manipulatively employ servant leadership behaviors to reach preferable leadership outcomes. Such a possible interplay reminds us of the motivation to lead (MTL) theory (see a meta-analytic review in Badura *et al.*, 2020). Machiavellianism, with its attention to manipulation to gain influence and power, is closely related to affective identity motivation, defined as individuals' "intrinsic interest in leading and seeing oneself as a leader" (Badura *et al.*, 2020, p. 332) manifested in strivings for power and influence to "enhance and protect differentiation" (p. 332). In contrast, servant leadership, with its other-oriented focus, is in line with the social normative motive that "entails a focus on one's responsibilities to others" (p. 332).

Thus, the main aim of this paper is to enhance our insights into the interplay of the "light" of servant leadership behaviors with the "darkness" of Machiavellianism. Drawing upon trait and behavioral theories of leadership (DeRue *et al.*, 2011) and contingency theories of leadership (Fiedler and House, 1994), we question how the interplay of power-pursuing and manipulation-oriented traits (i.e. Machiavellianism) and other-oriented leadership behaviors (i.e. servant leadership) influences perceived leadership effectiveness. The underlying

question and paradox are how, if one possesses an internal concept of Machiavellianism but demonstrates servant leadership behaviors, the Machiavellian concept and servant leadership behaviors interact to influence perceived leadership effectiveness. Furthermore, drawing upon Trait Activation theory that holds "Machiavellianism is a trait that is associated with person × environment interactions" (Jones and Mueller, 2022, p. 535), our theoretical model pays particular attention to the team context that is likely to be influenced and fostered by the leadership behaviors, and explores how a leader' Machiavellian trait interacts with the team conflict handling context and together impacts employees' perceived leadership effectiveness.

Conflicts in organizations are unavoidable. Leaders' behaviors impact how conflicts in the workplace are handled (Saeed *et al.*, 2014). Leaders who exhibit servant leadership behaviors, with their orientation to develop followers' competencies and enhance a knowledge-sharing team climate (Song *et al.*, 2015), influence a collaborative way of handling conflicts. Leaders' Machiavellian traits, however, may interact with this conflict management context, given Machiavellism's more competitive nature. Our study adopts an integrative approach to examine the interplay of Machiavellian traits and servant leadership behavior and how they influence leadership effectiveness using a process-based model.

Such an integrative consideration responds to recent calls for a more holistic understanding of leadership (Kearney *et al.*, 2019; Yukl, 2012). Our study joins attempts to examine the paradoxes in leadership literature, such as the interactive effects of visionary and empowering leadership (Kearney *et al.*, 2019) and the interplay of leader narcissism and humility (Zhang *et al.*, 2017), to develop a more holistic view of leadership. Organizational leaders work in a complex environment, highlighted by contradictory demands that are inherent to leader–follower relationships and embedded in the challenges in organizational and external business environments. Thus, it is imperative to acknowledge and understand the paradoxes inherent in leaders' traits and behaviors and how they relate to perceived leader effectiveness.

The remainder of the paper will first describe servant leadership, the mediating role of the cooperative team conflict management (TCM) strategy for leadership effectiveness, and the moderating role of Machiavellianism. The full conceptual model can be found in Figure 1. We will then describe the sample, measures and methodologies and present the results. Finally, we will present our findings and discuss the theoretical and practical implications.

Theoretical background and hypotheses

Servant leadership has gained considerable attention in leadership research in the last two decades (for a review, see Eva *et al.*, 2019). The general idea behind this leadership style was introduced by Greenleaf (1970) in his seminal work *The Servant as Leader*. Since then, the

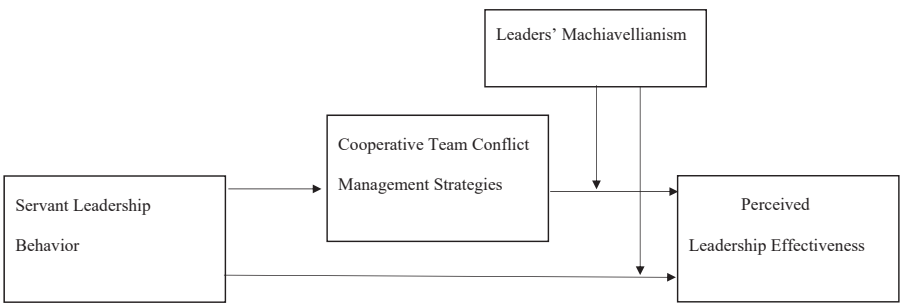

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Figure 1.
Theoretical framework of servant leadership, Machiavellianism and perceived leadership effectiveness

theoretical and nomological network of servant leadership has further developed with advancement in its conceptual clarity, rigorous measures, and exploration of its antecedents, outcomes, moderators and mediators (Eva *et al.*, 2019). Depending on the conceptualization of the construct, servant leadership generally encompasses dimensions of empowerment, humility, providing direction, authenticity, interpersonal acceptance and stewardship (van Dierendonck, 2011). These features of servant leadership distinguish it from transformational leadership that emphasizes building enlightened values, beliefs and goals to influence and motivate followers (Stone *et al.*, 2004), and transactional leadership that focuses on reward-based social exchanges in directing and monitoring followers (Avolio *et al.*, 1999).

In a social and organizational context of vertical hierarchy in which individual "heroic" traits are viewed as leading factors driving performance outcomes, traditional leadership characteristics such as charisma were given considerable attention (Grabo *et al.*, 2017). As organizations have operated and competed in more dynamic, uncertain and unpredictable organizational environments, a hierarchical or "top-down" business approach has given way to a flatter, "bottom-up" strategy (Owens and Hekman, 2012). Servant leadership promotes and supports this "bottom-up" strategy (Sinek, 2014). The emphasis of servant leadership is, hereby, not to please followers but to develop followers, which gives employees a sense of belonging and enhances their perceived effectiveness of leadership. Furthermore, in the wake of corporate scandals attributed to leaders' arrogance, sense of entitlement and self-importance, recent leadership research has specifically alluded to servant leadership characteristics such as humility and empowerment (Dust *et al.*, 2018) as critical for leader effectiveness. Previous research shows servant leadership is positively associated with strong trust in managers (Hoch *et al.*, 2018), positive work engagement, job satisfaction, organizational performance (Peterson *et al.*, 2012), employees' organizational citizenship behavior and team performance (Lee *et al.*, 2020). These personal, team and organizational successes can be expected to go hand in hand with positive evaluations of leadership effectiveness. In particular, in terms of changes in the external environment that call for collaborative and empowering leadership behaviors, we can expect that followers will recognize the value of the empowering and humble behaviors of servant leaders and reciprocally evaluate servant leadership behaviors as being more effective. This leads to the first hypothesis:

H1. Servant leadership is positively associated with employees' ratings of leadership effectiveness.

The mediating role of team conflict management strategies

Servant leadership builds a sense of social identity in its followers and promotes trust and fairness in the workplace (Lee *et al.*, 2020). Servant leaders' commitment to helping followers grow entails a focus on cultivating a sense of community within the team (Yoshida *et al.*, 2014). We posit that such a commitment to building a sense of community has strong implications for the way team members deal with controversies, arguments, and different views among each other on the way work should be done and how to deal with conflicts. We propose that an essential mediating mechanism through which servant leadership behaviors exert influence is TCM strategies.

To understand conflict management strategies, previous studies have adopted the dual concern model, which posits that the drive underlying how people manage conflicts is a consideration of two motives: concern for the self and concern for the other party (Somech *et al.*, 2009). Similarly, the TCM theory was developed and extended by Tjosvold (1989) who integrated the TCM theory with the conflict resolution theory of cooperation and competition (Deutsch, 1973) and proposed that individuals' chosen strategies of managing team conflicts

are driven by their perceptions of their own goals in relation to those of their counterparts. Based on these perceptions, when handling conflicts with other team members, individuals form cooperative or competitive intentions. The cooperative strategy involves concern for both oneself and others in conflict, while the competitive strategy involves a higher level of concern for oneself than for others.

Conflict resolution theory indicates that individuals who are concerned for others at a similar level as for themselves are more likely to choose the cooperative strategy when managing conflicts (Deutsch, 1973; Somech *et al.*, 2009). Given that servant leadership is directly linked to pursuing empowerment and using persuasion and listening to convince others, leaders who show servant leader behaviors are less likely to forcefully push their agenda through. Instead, they will adopt a cooperative conflict management strategy for themselves and will promote this strategy in their team. Social learning theory suggests that individuals learn by observing the behavior of others (Bandura, 1986). In teams led by servant leaders, team members individually and collectively observe that the leaders care for the growth and development of their people and emphasize humility. The more the cooperative strategy is modeled by leaders, the more likely it is that team members will consistently behave similarly. As such, servant leadership is more likely to encourage a climate in which conflicts are handled cooperatively, which, in turn, results in positive leader effectiveness ratings. This leads to the second hypothesis.

H2. Servant leadership behaviors are positively related to cooperative TCM within the team, which in turn enhances perceived leadership effectiveness.

The moderating role of leaders' Machiavellianism

The concept of Machiavellianism was introduced to the scholarly field by Christie and Geis (1970) who, in their collection of Machiavelli's original statements, described the personality traits of individuals who successfully manipulate the behavior of others. Leaders high on Machiavellianism (high-Machiavellianism) have a strong tendency to manipulate others and tend to initiate and control the structure of group interactions in a team setting. Extant studies show that Machiavellianism is closely related to leaders' effectiveness, and yet findings on the link have been mixed. Whereas some studies found that high-Machiavellianism were rated more positively than low-Machiavellianism in the degree of leadership displayed and the associated contributions to group performance (Kwak and Shim, 2017), others show that followers may perceive Machiavellian leaders as less sympathetic, less effective and abusive (e.g. den Hartog and Belschak, 2012).

Such inconsistent findings regarding the effect of Machiavellianism on leadership outcomes suggest that, in seeking to understand how Machiavellianism relates to followers' reactions, a specific leadership style adopted by Machiavellian leaders may provide a useful starting point. Servant leadership, as the name suggests, is a leadership philosophy in which the leader is strongly focused on the needs of their followers and encourages their growth. Machiavellianism, on the other hand, is a leadership theory that emphasizes the acquisition and maintenance of power through political skills and control, and in its extreme with manipulation and deceit. Studying the interplay between the two can help enhance our understanding of leadership effectiveness in organizational reality.

Machiavellian individuals may have cognitive and social skills that better enable them to evaluate a group's social and business context and manage the group's performance in a dynamic and unpredictable environment (Bereczkei, 2018). It may be that Machiavellianism itself leads to antisocial outcomes; however, when coupled with servant leadership behaviors, the negative effect of Machiavellianism is mitigated, and the impact of servant leadership behaviors on perceived leadership effectiveness can be more pronounced for Machiavellian leaders. The combination may allow for a synergy in which

leaders' complex social manipulation skills to build adaptive advantages for the group are interlinked with showing care toward followers. This may cause followers to rate these high Machiavellian leaders higher in leadership effectiveness than servant leaders who are low on Mach.

Furthermore, Machiavellianism is seen as a strategy of social conduct and involves using others as devices to pursue one's own goals (Wilson *et al.*, 1996). Recent social psychological studies have found Machiavellians to be successful by adapting to their social environment, pursuing long-term plans and in social dilemma games by monitoring their playmates' decisions (Bereczkei and Czibor, 2014). Combining a Machiavellian trait with servant leadership behavior may result in leaders using their manipulative skills and impression management abilities to attain high leadership effectiveness (Becker and O'Hair, 2007). Recent research has shown that ethical leader behaviors demonstrated by Machiavellian supervisors were seen as effective even when they are not genuine (Kwak and Shim, 2017). Indeed, because the others-promoting initiatives of Machiavellian leaders are less expected, they may need to engage in more others-serving behaviors than low-Machiavellian leaders to be endorsed as effective leaders. As such, for high-Machiavellian leaders, leadership effectiveness should be more contingent on the extent to which the leader engages in servant leadership behaviors. This analysis is congruent with research that shows the influence of self-sacrificing behaviors on leadership effectiveness is greater for less prototypical leaders (van Knippenberg and van Knippenberg, 2005) and that the positive effects of leader humility on leadership outcomes are more pronounced when leaders' narcissism is high (Zhang *et al.*, 2017). This leads to our third hypothesis,

H3. The relationship between servant leadership and perceived leadership effectiveness is stronger in teams with leaders high on Machiavellianism.

Leaders' Machiavellian traits may also play an important role in the process model that involves cooperative TCM styles (H2) as a mechanism through which servant leadership behaviors influence perceived leadership effectiveness. Machiavellian leaders are good at competing with others but less likely to be cooperative (Paal and Bereczkei, 2007). Although several scholars noted that high Machs are able to be cooperative (e.g. Hawley, 2003), a general consensus in the literature is that Machiavellian trait tend to be associated with a competitive world view (e.g. Bereczkei, 2018). Drawing upon trait activation theory that suggests the interplay between the Machiavellian trait and the environment (Jones and Mueller, 2022), we hypothesize that the impact of a cooperative conflict management climate on leadership effectiveness differs for low and high-Machiavellian leaders. For low Machiavellian leaders, servant leadership behaviors would model a cooperative way of handling conflicts by respecting followers' interests, and thus, cooperative TCM would in turn lead to a higher level of perceived leadership effectiveness. In contrast, high-Machiavellian leaders tend to rely on manipulation tactics to influence followers' perception of their leadership effectiveness, but not through the conflict management styles that are derived from servant leadership behaviors. This is because cooperative strategy is more of a shared experience among followers whereas Machiavellianism is associated with a strong desire to maintain power and control in a relationship. The control and manipulation dictated by high-Machiavellian leaders would conflict with a cooperative conflict handling environment. Given this mismatch, team members would most likely judge a Machiavellian leader as less effective. This leads to the following hypothesis:

H4. The influence of cooperative TCM on employees' ratings of leadership effectiveness is weaker when team leaders are high versus low on Machiavellianism.

The theoretical framework summarizing the hypothesized relationships is presented in Figure 1.

Methods

Sample and procedure

We collected data from employees and leaders in a large insurance company. Online questionnaires were distributed to them in two waves, one month apart. Collecting data in two waves is a recommended approach and preferred practice in the literature for testing causal ordering effects (e.g. Liang *et al.*, 2012). Employees working in teams and their team leaders were asked to complete separate surveys. At Stage 1, the employees were asked to respond to questions on servant leadership and TCM, while the team leaders were asked to provide answers to the questions on Machiavellianism. At Stage 2 (one month later), the employees were asked to rate their leaders' effectiveness. We then matched the employee IDs and the team leader IDs across the two stages. A total of 1,010 employees and 189 team leaders were asked to participate. Of these, 701 employees in 150 teams participated in the first round of the survey, of which 310 employees in 91 teams, with the same leaders, participated in the second stage of the survey. The final supervisor-employee matched sample included 310 employees in 91 teams across the two waves. In general, the two-stage matched data set was representative of the initial sample of 701 employees in terms of the participants' age (35.8 years in Stage 1 vs. 34.9 years in the matched sample), gender (72.3% female in Stage 1 vs. 71.9% female in the matched sample), and individual ratings of servant leadership (6.31 in Stage 1 vs. 6.21 in the matched sample). The differences were small and non-significant. All materials were originally drafted in English. They were translated into Chinese and validated through a double-translation process for use in China.

Measures

Servant leadership. This was measured by asking the employees to respond to the 14 items on the servant leadership scale for direct supervisors, which was developed by Ehrhart (2004). This scale reflects the core aspects of Greenleaf's (1977) conceptualization of servant leadership within a one-dimensional scale and is currently one of the most prominent operationalizations of servant leadership (Lemoine *et al.*, 2019). According to a recent meta-analytical study on servant leadership scales in China, the most often used scale and a valid measure of servant leadership in the Chinese context is the scale developed by Ehrhart in 2004 (McCune Stein *et al.*, 2020). A sample item was "my direct supervisor makes me feel like I work with him/her, not for him/her." Cronbach's Alpha was 0.95.

Team conflict management. Employees were asked to rate how team conflicts were managed using the 12-item TCM scale developed by Somech *et al.* (2009), including seven items on "cooperative strategy" and five items on "competitive strategy." Sample items included "Team members collaborate to come up with decisions acceptable to us" (cooperative strategy) and "Team members sometimes use their power to win in a competitive situation" (competitive strategy). The competitive strategy is included in the study as a control variable. A seven-point Likert scale was used to indicate answers ranging from "strongly disagree" to "strongly agree." Cronbach's alpha was 0.99 for the cooperative strategy and 0.88 for the competitive strategy.

Leadership effectiveness. Leaders' effectiveness was rated by employees using a three-item scale adapted from the leadership effectiveness scale in De Hoogh *et al.* (2005). Cronbach's alpha was 0.96.

Machiavellianism. Team leaders were asked to respond to the 16-item scale of Machiavellianism (Dahling *et al.*, 2009) on a seven-point scale. Sample items included "I enjoy having control over others" and "People are only motivated by personal gain." Cronbach's alpha was 0.84.

Methods

We conducted multilevel analyses (mixed models in SPSS) to test the hypotheses, given that the analysis involved variables at different levels. The independent variable (servant leadership),

mediators (TCM-cooperative) and dependent variable (leader effectiveness) were at the individual level, while the moderator (leaders' Machiavellianism) was at the group level. The ICC values of 0.154 for servant leadership, 0.075 for TCM-cooperative, and 0.129 for leadership effectiveness. These ICC values indicate that a cross-level analysis is more appropriate than aggregating the individuals' responses at the team level or handling the data only at the individual level. Followers' age, gender and leaders' gender and team competitive conflict management strategy were included as control variables. We then conducted a robust check to verify the moderated mediation results using the SPSS-based MLmed program (Hayes and Rockwood, 2020) to estimate the multilevel moderation and mediation effects simultaneously and reported estimates of the conditional direct and indirect effects.

Results

The correlation coefficients among perceived servant leadership, TCM strategies (cooperative and competitive), leadership effectiveness, leaders' Machiavellianism, followers' age, followers' gender and leaders' gender are presented in Table 1. As shown in the table, servant leadership behaviors are not significantly correlated with leaders' Machiavellian trait ($r = 0.01, p > 0.10$). This confirms our position that the values behind a leader's behavior and their actual behavior might differ and should be acknowledged as such.

We hypothesized that servant leadership was positively associated with higher ratings of leadership effectiveness via cooperative TCM strategies. We conducted a multilevel analysis to examine the relationship between servant leadership and leadership effectiveness. As shown in Table 2, Model 1 shows that servant leadership had an overall positive effect on leadership effectiveness ($B = 0.398, SE = 0.044, p < 0.01$), thereby supporting H1.

Variables	M	SD	1	2	3	4	5	6	7	8
1. Servant Leadership	6.31	0.96	(0.95)							
2. Team Conflict Management - Cooperative	6.49	0.94	0.33**	(0.97)						
3. Team Conflict Management - Competitive	5.09	0.99	0.20**	0.77**	(0.88)					
4. Leadership Effectiveness	6.46	0.84	0.48**	0.48**	0.30**	(0.96)				
5. Leaders' Machiavellianism	2.92	0.77	0.01	0.04	−0.01	0.06	(0.84)			
6. Followers' Age	34.86	6.08	−0.03	−0.14*	−0.07	−0.08	−0.10			
7. Followers' Gender (female = 1)	0.72	0.45	−0.04	0.01	−0.02	−0.09	−0.01	0.24**		
8. Leaders' Gender (female = 1)	0.56	0.50	−0.06	−0.02	−0.03	−0.01	0.06	0.08	0.03	

Note(s):
1. Scale reliabilities are reported on the diagonal. The reliability coefficients for servant leadership, team conflict management strategies, leadership effectiveness are calculated at the individual levels; the reliability coefficient for leaders' Machiavellianism is computed at the team level. Means and standard deviations for the leaders' gender and Machiavellianism are provided at the individual level. The means and standard deviations would be 0.56 (0.45) for leaders' gender and 2.84 (0.80) if computed at the team level. The correlation between these two team level variables when computed at the team level would be 0.03 ($p = 0.801$)
2. **$p < 0.01$; *$p < 0.05$

Source(s): Table by authors

Table 1.
Means, standard deviations, reliabilities, and correlations

Table 2. Results of mixed-model analyses predicting perceived leadership effectiveness

Parameter	Model 1 Predicting leadership effectiveness Estimate			Model 1 Predicting leadership effectiveness			Model 1 Predicting leadership effectiveness Estimate			Model 4 Predicting leadership effectiveness Estimate		
Estimates of fixed effects	b.	s.e.	*p*	b.	s.e.	*P*	b.	s.e.	*P*	b.	s.e.	*p*
Intercept	6.50**	0.097	0.000	−0.10	0.113	0.364	6.54**	0.090	0.000	6.57	0.087	0.000
Followers' Age	−0.01	0.007	0.341	−0.02**	0.009	0.009	0.00	0.006	0.880	0.00	0.006	0.607
Followers' Gender (f = 1)	−0.09	0.095	0.331	0.12	0.115	0.295	−0.14	0.088	0.116	−0.15	0.086	0.082
Leaders' Gender (f = 1)	0.05	0.096	0.598	0.03	0.109	0.272	0.04	0.090	0.692	0.01	0.085	0.849
Servant Leadership	0.40**	0.044	0.000	0.32**	0.053	0.000	0.29**	0.043	0.000	0.30**	0.042	0.000
TCM-Cooperative							0.41**	0.066	0.000	0.38**	0.065	0.000
TCM-Competitive							−0.10	0.060	0.088	−0.10	0.059	0.098
Leaders' Machiavellianism										0.05	0.055	0.330
Leaders' Machiavellianism*Servant Leadership										0.18**	0.057	0.002
Leaders' Machiavellianism*TCM Cooperative										−0.25**	0.088	0.005
Leaders' Machiavellianism*TCM Competitive										−0.03	0.072	0.723
Estimates of covariance parameters												
Residual	0.493**	0.047	0.000	0.742**	0.070	0.000	0.412**	0.039	0.000	0.400	0.038	0.000
Intercept	0.052	0.034	0.128	0.043	0.044	0.336	0.050	0.028	0.081	0.036	0.027	0.178
Model of fit statistics												
Schwarz's Bayesian (BIC)	716.346			830.352			671.134			666.682		
Akaike (AIC)	708.905			882.911			663.707			659.281		
Pseudo R-Square	0.293			0.175			0.410			0.431		

Note(s): 1. *$p < 0.05$ **$p < 0.01$
Source(s): Table by authors

As shown in Table 2, when TCM strategies were added to the regression in Model 3, the association between servant leadership and leadership effectiveness decreased but remained significant, whereas the coefficient of the cooperative TCM strategy was significant ($B = 0.409, SE = 0.066, p < 0.01$). Furthermore, as shown in Model 2, servant leadership was positively associated with the cooperative TCM strategy ($B = 0.324, SE = 0.053, p < 0.01$). Applying the mediation criteria, the result shows that cooperative TCM partially mediated the relationship between servant leadership and leader effectiveness. We computed the confidence intervals (CIs) using the Monte Carlo method (Preacher and Selig, 2012), with 20,000 repetitions to further examine the indirect effect of servant leadership via cooperative TCM strategies. The indirect relation from servant leadership to leadership effectiveness via cooperative TCM was significant (indirect effect = 0.090, 95% CI = [0.044, 0.144]), providing support for H2.

We then tested the moderating effect of Machiavellianism on the direct and indirect relationships between servant leadership and leadership effectiveness. As shown in Model 4, the interaction terms between Machiavellianism and servant leadership were positive and significant ($B = 0.177, SE = 0.057, p < 0.01$), showing that the direct effect of servant leadership varied as the leaders' Machiavellianism changed. Similarly, the interaction term between leaders' Machiavellianism and cooperative TCM was also statistically significant ($B = -0.247, SE = 0.088, p < 0.01$), showing that the relationship between cooperative TCM and leadership effectiveness varied across different levels of Machiavellianism. The negative sign of the interaction term coefficient indicates that the positive relationship between cooperative TCM and leadership effectiveness was smaller for high Mach. Thus, both H3 and H4 are supported.

As for the model fitness, following Nakagawa and Schielzeth (2013)'s suggestions for measuring model fitness in multi-level analysis, we use AIC and Pseudo R-square statistics to test model-fitting, shown in Table 2. The comparison of AIC statistics in the nested models shows that including the interaction terms in Model 4 improves the fit of the model, and the conditional Pseudo R-square in Model 4 has a value of 0.431, showing that 43.1% of the total variance in perceived leadership effectiveness can be explained through the fixed and random effects in the multiple-level model.

Added insights into both two-way interactions can be gained by Figures 2 and 3. Figure 2 shows that servant leadership is related to more perceived leader effectiveness and that this

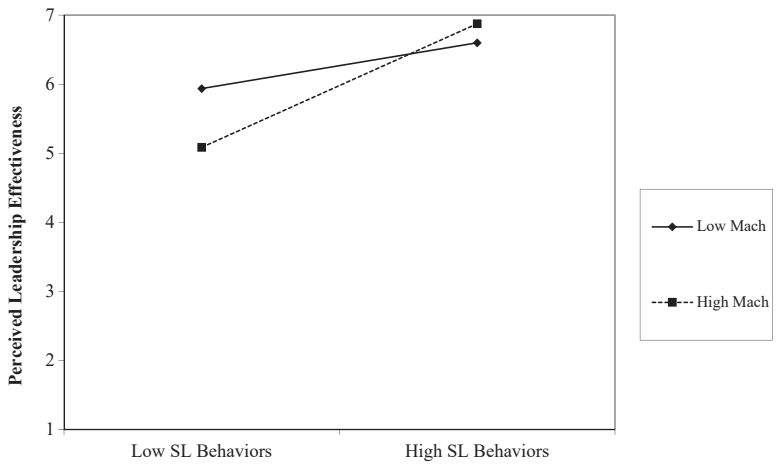
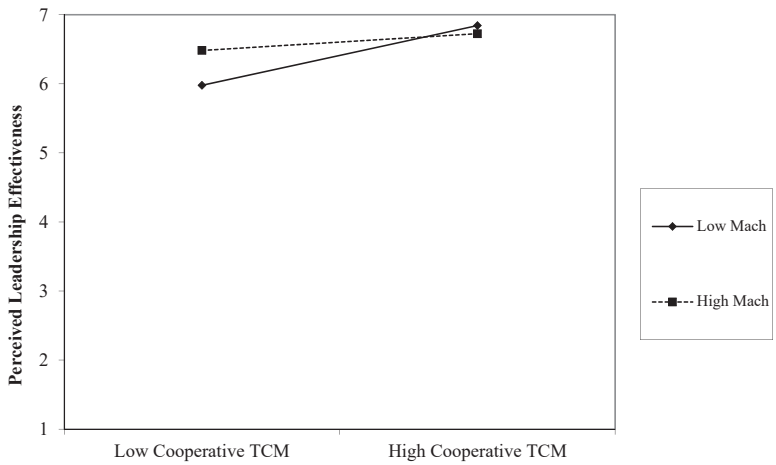


Figure 2.
Two-way interaction of servant leadership and Machiavellianism on perceived leadership effectiveness

Source(s): Figure by authors



Source(s): Figure by authors

Figure 3.
Two-way interaction of leader Machiavellianism and cooperative team conflict management strategies on perceived leadership effectiveness

influence is enhanced for leaders high on Machiavellianism. Figure 3, on the other hand, shows that the positive link between cooperative TCM and perceived leadership effectiveness only exists for leaders low on Machiavellianism.

As a robust check, we conducted a multilevel moderated mediation analysis using the MLmed approach (Hayes and Rockwood, 2020) to examine whether and the extent to which leaders' Machiavellianism moderated the direct and indirect relationships between servant leadership and leadership effectiveness. As shown in Table 3, the index of moderated mediation was significant (index = −0.046, 95% CI = [−0.081, −0.018]. The indirect effects varied across high (+SD) and low (−SD) levels of leader Machiavellianism. At high (+SD) levels of Machiavellianism, the direct effect was significant (B = 0.408, 95% CI = [0.268, 0.549], and the indirect effect via cooperative TCM was not significant (B = 0.021, 95% CI = [−0.011, 0.059]. Thus, cooperative TCM did not account for the effect of servant leadership on leadership effectiveness at high levels of Machiavellianism. In contrast, at low (−SD) levels of Machiavellianism, the total effect in this relationship could be fully explained by cooperative TCM, shown as a full mediation (indirect effect = 0.095, 95% CI = [0.047, 0.154]; direct effect = 0.131, 95% CI = [−0.001, 0.263]). These results confirm that the relative standing of individuals on the perception of cooperative TCM strategies mediated the relationship between the servant leadership perception on leadership effectiveness at low

		Indirect effect (via cooperative TCM)		Direct effect	
	Machiavellianism	Effect	95% CI	Effect	95% CI
Low Level of Leaders' Machiavellianism (−SD)	2.186	0.095	[0.047, 0.154]	0.131	[−0.001, 0.263]
Average Level of Leaders' Machiavellianism (mean)	2.938	0.069	[0.032, 0.138]	0.321	[0.239, 0.404]
High Level of Leaders' Machiavellianism (+SD)	3.578	0.021	[−0.011, 0.059]	0.408	[0.268, 0.549]

Source(s): Table by authors

Table 3.
Conditional direct and indirect effects of servant leadership behaviors on perceived leadership effectiveness

levels of leader Machiavellianism. Accordingly, H3 and H4 were supported. Figure 4 shows the conditional direct and indirect effects of servant leadership on perceived leadership effectiveness at different levels of leaders' Machiavellianism. As leaders' Machiavellianism increases, the direct effect goes up while the indirect effect goes down.

In short, we have the following findings. First, managers who demonstrated more servant leadership behaviors were generally rated as more effective by their followers. Second, servant leadership tended to promote a general sense of a cooperative TCM strategy, which was associated with higher perceived leader effectiveness. Third, the direct relationship between servant leadership and a leader's effectiveness varied with the leader's Machiavellianism. Cooperative TCM strategies mediated the relationship between servant leadership and employees' perception of leadership effectiveness at low levels of leader Machiavellianism but did not play a role when leaders have a high Machiavellian trait.

Discussion

Our studies extend the servant leadership theory by providing additional insights into the relationship between servant leadership behaviors and leader effectiveness. We paid specific attention to both process and contingent factors, in particular teams' conflict management strategies and leaders' Machiavellianism. We confirmed the relationship between servant leadership and perceived leadership effectiveness, the moderating role of Machiavellianism on their direct relationship, and the contrasting roles that cooperative TCM plays at high and low levels of leaders' Machiavellianism. We find that for non-Machiavellian leaders, the cooperative conflict management style serves as the pathway through which servant leadership behaviors affect perceive leadership effectiveness. In contrast, for Machiavellian leaders, a cooperative conflict management style does not play a role. When leaders are low on Machiavellianism, cooperative team conflict management strategies serve as an important bridge between servant leadership behavior and perceived leadership effectiveness. The effect of cooperative TCM strategies fostered by servant leadership behaviors is

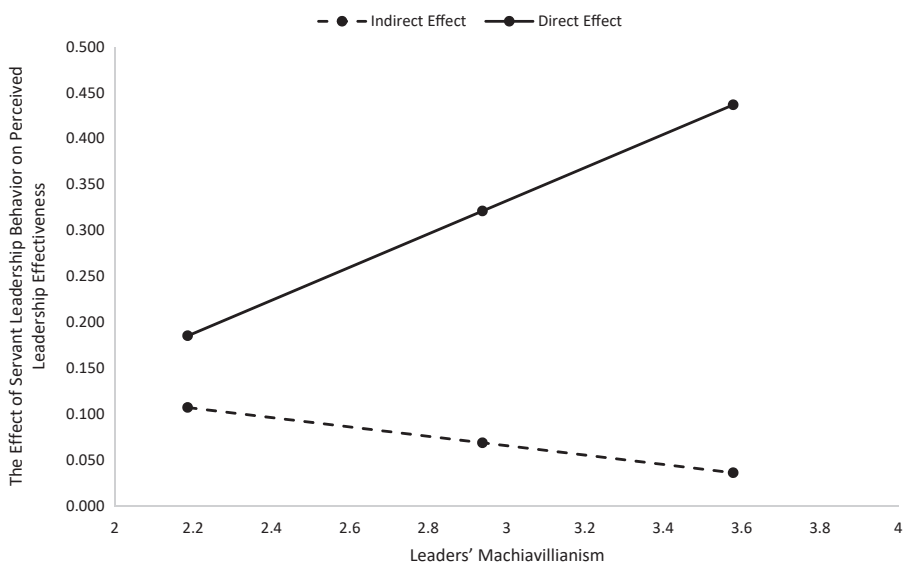


Figure 4.
A visual representation of the conditional indirect and direct effects of servant leadership behavior on perceived leadership effectiveness

Source(s): Figure by authors

strengthened. In contrast, when leaders are high on Machiavellianism, even though servant leadership behaviors would still promote the use of cooperative conflict management strategies in the team, this context is contradictory to leaders' high Machiavellianism, leading to a non-significant role of TCM strategies. In the meanwhile, the direct effect of servant leadership behaviors on leadership effectiveness remains significant. We will explore the implications of these findings in this section.

Theoretical implications

Our studies introduced and confirmed a two-level process model that provided insights into the pathways through which servant leadership behaviors affect perceived leadership effectiveness. Previous literature has shown that servant leadership behaviors are related to fulfilling followers' psychological needs (van Dierendonck *et al.*, 2014) as well as fostering a knowledge-sharing climate (Song *et al.*, 2015) and a sense of psychological safety, fairness and trust in the work context (Yoshida *et al.*, 2014). Adding to this research stream, we find convincing evidence that servant leadership behaviors relate to followers' perception of leadership effectiveness. This builds on earlier research on the impacts of leadership styles such as transactional leadership and transformational leadership on perceived leadership effectiveness (Avolio *et al.*, 1999; van Dierendonck *et al.*, 2014). Extending this line of research, our findings suggest that servant leadership behaviors affect team dynamics, in particular how conflicts are handled within a team. Managers' servant leadership behaviors encourage teams to use cooperative TCM strategies, which, in turn, influence the extent to which followers view their leaders as effective. This study extends the current literature on servant leadership by considering how teams that experience servant leadership behaviors handle conflict as well as explaining why servant leaders are viewed as more effective (Eva *et al.*, 2019).

Our findings shed light on the paradox of "serving" others (servant leadership behaviors) and "seeking" self-interest (Machiavellianism) as two seemingly contrasting characteristics of leaders and how they interact to influence leader effectiveness. It should be noted here that analysis shows is a lack of correlation between leaders-reported Machiavellian traits and followers-reported servant leadership behaviors demonstrated by their leaders, suggesting that it is probable for both high and low Machiavellian leaders to engage in servant leadership behaviors, which, however, may result in different outcomes. Also, the average rating of Machiavellian traits was at a low to medium level (mean = 2.92, SD = 0.77 on a seven-point scale). Even a leader who scored relatively high (e.g. 1 SD above the mean) was still low compared to the mid-point of the scale. Whether or not leaders rated themselves as relatively low or high on Machiavellianism was not related to their followers' perception of their servant leadership behaviors. We also found that relatively high-Machiavellian leaders who adopted servant leadership behaviors were perceived as more effective by their followers compared to low-Machiavellian leaders. This result confirms our expectation that individuals with Machiavellian traits may be encouraged to engage in more other-serving behaviors to be considered effective. Kwak and Shim (2017), for instance, found that Machiavellian leaders who show ethical leadership behaviors tend to be perceived as genuine by their followers and are associated with desirable employee work behaviors. In this regard, our analysis of the interplay between servant leadership behaviors and Machiavellian traits is in line with literature that aims at building a holistic view of leadership by recognizing the paradoxes in leaders' traits and behaviors (van Knippenberg and van Knippenberg, 2005; Zhang *et al.*, 2017).

Practical implications

From a practical perspective, Machiavellian leaders are unavoidable in the realities of business practices. Earlier research shows both high and low Machiavellian leaders can attain similar levels of career success (e.g. Pfeffer, 2021). Then, a practical question for

organizations is to what extent they could manage Machiavellian leaders to avoid undesirable behaviors and attain the better outcomes. Our study shows that Machiavellian leaders have the potential to achieve leadership effectiveness when engaging in servant leadership behaviors such as caring for followers' well-being. This finding has important practical implications.

On the one hand, organizations may design and implement servant leadership development programs to help leaders learn the components of servant leadership behaviors and communicate with leaders about the importance of engaging in these behaviors. Also, incorporating leadership behaviors in the performance evaluation of the leaders may help motivate leaders, especially Machiavellian leaders, to engage in servant leadership behaviors and consequently enhance their leadership effectiveness.

On the other hand, we find that the cooperative TCM style mediates the relationship between servant leadership behaviors and leadership effectiveness in teams with low-Machiavellian leaders but not high-Machiavellian leaders. Organizations with a strong focus on building a cooperative conflict management climate may need to be careful in choosing team leaders and, if possible, avoid appointing high-Machiavellian leaders to these teams.

Limitations and future research

Like most research, our study has limitations that warrant discussion. First, while our study collected data at two-time points (i.e. one month apart), it is still cross-sectional and uses self-report as the dependent variable. Some managers may respond in a socially desirable manner to Machiavellianism items and underestimate the extent to which they are Machiavellian. Future studies that collect data on Machiavellian traits from both leaders and followers would help shed light on this issue.

Second, the study was performed in China in Mandarin Chinese, and as such, the influence of culture cannot be ruled out. We took great care while translating the items to maintain their core meaning as best as possible. A recent servant leadership meta-analysis by McCune Stein *et al.* (2020) showed no significant differences in effect sizes between employees in China and Anglo-Saxon countries (the US, Canada, the UK and New Zealand) concerning a broad range of dependent variables such as job performance, creative behavior and job satisfaction. Therefore, we are confident that the results presented here, to some extent, can be generalized among these cultures. However, it is important to acknowledge that findings in this study are based on data from one country. Future researchers need to be aware that the results might be affected by the social and cultural contexts where the research was conducted.

Third, our study found that the cooperative TCM strategy provides a pathway that positively associates servant leadership behaviors with leader effectiveness. Even though the indirect effect decreased as leaders' Machiavellianism increased, the total effect of servant leadership behaviors on leader effectiveness remained significant and even increased. A lingering question, then, is which other mechanisms better explain the effects of servant leadership behaviors on leader effectiveness as leaders' Machiavellian traits increase. Future research is encouraged explore other mechanisms through which servant leadership behaviors impact leadership effectiveness.

In conclusion, our study shows the interrelationships of three intriguing areas: servant leadership behaviors, leaders' Machiavellianism and TCM skills. It confirms the importance of building contingent models for a holistic understanding of servant leadership behaviors.

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Leadership style, knowledge sharing and audit quality

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Abstract

Purpose – This paper aims to examine how leadership style in audit firms influences audit quality. The paper further explores the mediating role of knowledge sharing in the relationship between leadership style and audit quality.

Design/methodology/approach – The present paper studies the effects of transformational and servant leadership styles on audit quality through knowledge sharing. Data are collected from 396 Iranian external auditors via a questionnaire.

Findings – The results show that both transformational and servant leadership style significantly influence audit quality through knowledge sharing. Moreover, the impact of transformational leadership style is stronger than the impact of servant leadership style.

Originality/value – In audit quality literature, little attention has been devoted to both leadership style and knowledge sharing. This paper develops a parsimonious model which shows how leadership style improves audit quality, and how knowledge sharing strengthens the impact of leadership style on audit quality. The results have important implications particularly for audit industry.

Keywords Transformational leadership, Servant leadership, Knowledge sharing, Audit quality

Paper type Research paper

1. Introduction

Auditing plays an important role as an external corporate governance mechanism, which is directly reflected in audit quality (Xiao *et al*., 2020). According to Khudhair *et al.* (2019), audit quality generally refers to the services provided by auditors hired by different client companies. Improving audit quality attracts more investors and reflects the audit firm performance. Therefore, stakeholders and investors will have more trust and confidence in audit firms that provide higher audit quality services. In fact, audit quality can be considered as a chain that can have different range; from low audit quality to high audit quality (Khudhair *et al*., 2019). In this respect, recent literature (e.g. Duh *et al.*, 2020) has acknowledged that knowledge sharing in the organization affects audit quality. The main source of knowledge sharing in an audit firm arises from interpersonal relationships and interactions between auditors (Sergeeva and Andreeva, 2016). Knowledge sharing in the organization involves many cases such as communicating and receiving knowledge from others by examining processes, consulting with peers, co-workers or people with different work experience, doing works in teams, holding brainstorms, training in organization and other informal communication among people (Duh *et al.*, 2020). For this reason, it is clear that

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knowledge sharing in organizations exists in many forms and can influence the firm performance and audit quality in different ways.

While knowledge sharing has become increasingly a valuable source of competitive advantage among organizations in the economical era (Yin *et al.*, 2019), the implementation of it often seems very difficult (Ruggles, 1998); since people are often tending to share and talk about their knowledge, particularly in developing countries in which organizations have poor mechanisms for the effective evaluation of organizational personnel. Knowledge management research has recently focused on identifying the vital knowledge sharing antecedents in response to the challenges of knowledge sharing (Berraies and Zine El Abidine, 2019). Particularly, recent research has revealed the substantial roles of leadership style in the implementation of knowledge sharing. For example, Yin *et al.* (2019) studied leadership styles as effective antecedents on knowledge sharing.

Previous research also shows transformational leadership (Le and Lei, 2019; Berraies and Zine El Abidine, 2019) and servant leadership (Tripathi *et al.*, 2020) can facilitate individual learning and knowledge sharing in organizations. Transformational leadership impresses followers thinking and the overall behavior in every organization. Transformational leadership style is an inspirational style, a way to motivate followers and improve their thinking ability (Avolio *et al.*, 2004). Another style of leadership is servant leadership in which leaders originally interested in serving others. In fact, servant leaders concentrate on their followers' growth and well-being. Both transformational and servant leaders are able to influence followers' participation in knowledge development and learning, although there is a difference. Servant leaders usually pay more attention to serve their followers, although transformational leaders utilize their energy to engage the followers in achieving organization's goals (Choudhary *et al.*, 2013).

Therefore, this paper examines whether and how transformational and servant leadership styles affect audit quality through knowledge sharing. For the purposes of this study, we collected data from Iranian external auditors. Our findings show that both transformational and servant leadership styles significantly influence audit quality through knowledge sharing; but the impact of transformational leadership style is stronger than the impact of servant leadership style.

This paper makes contributions to the literature. While recent research has studied the relationship between some leadership styles and service quality in non-audit industries (Ghaleb *et al.*, 2022; Buja *et al.*, 2022; Thanh *et al.*, 2022; Almuharrami and Abdul Aziz, 2022), to the best of our knowledge, the paper is the first in showing an association between leadership style and audit quality. This is consistent with the agentic perspective of social cognitive theory indicating individual agents, like organizational leaders, are important to influence human actions (Bandura, 2001). In line with this theory, we show that the leaders in audit firms can influence the behaviors of auditors and their knowledge sharing behavior, which result in higher audit quality. We develop a parsimonious model by exploring the relationships around knowledge sharing in audit firms, and discovering the missing links from leadership style to audit quality through knowledge sharing. In addition, our research is in the interest of audit firms and audit firms' partners and managers. Our results may inform the partners and managers of audit firms in their efforts for improving audit quality and with respect to the audit firms' leadership style and knowledge sharing management systems (Cepeda-Carrion *et al.*, 2018). This paper shows the importance of audit firms' leadership style and knowledge sharing in audit quality improvement.

The structure of this paper proceeds as follows. Second section reviews the prior literature and develops research hypotheses. Third section describes the research design, including the sample, variable measurement, and empirical models. Fourth section reports the results; and finally fifth section explains our conclusion with existed limitations and routes for future research.

2. Literature review

2.1 Audit quality

The Importance of "quality" has increased in every aspect, especially in the field of auditing and accounting; since human recognized quality as a weapon for fighting in competitive world and gain advantages by improving quality (Beck *et al.*, 2019). Audit quality is considered as a very important topic in the academic and professional research (Carp and Istrate, 2021; Athavale *et al.*, 2022; Samagaio and Felício, 2022). Audit quality means the identification and reporting of material misstatement by external auditors (DeAngelo, 1981). According to DeAngelo (1981), the quality of audit services is defined as a market assessment in which a particular auditor discovers (1) a breach in the client's accounting system; and (2) reports violations. The probability that a particular auditor will detect a breach depends on the auditor's technological capabilities, the audit methods used in that audit procedures, the amount of sampling, and so on. Probability of conditionally reporting detected violations is a measure of the auditor's independence from the client in conducting an audit. Audit quality reflects a challenge, because information is observable, but it is difficult to focus. Moreover, researchers and experts can only describe the high quality of an audit; which possible by the explanation of errors or shortcomings that lead to a decline in audit quality (Knechel *et al.*, 2013).

2.2 Knowledge sharing

Nonaka (1994) defined knowledge as "a valid belief that increases the ability of individuals to act effectively in an organization" and is classified as one of the most important strategic resources in the organizations (Grant, 1997; Singh *et al.*, 2021). Knowledge can be generally divided into two categories: tacit and explicit knowledge. Tacit knowledge is temporary, personal and subjective knowledge that is difficult to document and exchange. Explicit knowledge is expressed in a formal and structured language and can be passed on to others. Knowledge sharing is the act of sharing knowledge with others in an organization. Knowledge sharing between people is a process through which peoples' knowledge becomes comprehensible, absorbed and used by other people (Ipe, 2003; Ahmad and Karim, 2019). Employees' external motivations such as organizational rewards (Bartol and Srivastava, 2002), as well as intrinsic motivations such as enjoying helping others and self-efficacy of knowledge, are known as two main determinants of knowledge sharing behavior in organizations. On the other hand, Ardichvili *et al.* (2003) showed that employees' fear of criticism and misleading others thwart their intention to help and share knowledge with organizational members and communities. Knowledge sharing can be horizontal or vertical in the nature, for example, among peers in the same rank or between people with different ranks. Both types of sharing Knowledge deepen the employee's understanding the present condition and the circumstances surrounding decision-making (Duh *et al.*, 2020).

2.3 Transformational leadership

Leadership is a process of social influence, in which a leader seeks the subordinates' voluntary participations in an effort to achieve the organizational goals (Budur, 2020). A leader can be defined as a person who allows or influences the subordinates to act in a way to acquire the organizational goals (Mullins, 2007). There are different leadership styles, one of which is transformational leadership style (Omolayo, 2007). There has been a scientific debate about the nature and effectiveness of transformational leadership since the 1970s. Dow and Downton (1974) first talked about transformational leadership style. Transformational leadership then developed by Bass. According to Bass (1990), transformational leadership occurs when leaders expand and enhance the interests of their employees, when employees become aware of and accept the group's goals and mission, and when managers motivate employees to go beyond personal interests for the group to

cooperate (Budur, 2020; Qadri *et al.*, 2021). According to Abu-Rumman (2021), transformational leaders interact more with their followers, focus on higher intrinsic needs, and raise awareness of the importance of specific outcomes and new ways in which goals can be achieved. Transformational leaders lead people from lower levels of need (according to Maslow's hierarchy) to higher levels (Kelly, 2003). They may also motivate followers to go beyond their own interests for the sake of groups' aims (Feinberg *et al.*, 2005); But they usually help followers achieve inner satisfaction as well. Transformational leaders build trust, admiration, loyalty, and respect among their followers (Ariyani and Hidayati, 2018; Barbuto and Wheeler, 2006; Cao and Le, 2022).

2.4 Servant leadership

Leadership style is a relatively fixed pattern of a leader's behavior (Xie *et al.*, 2018). According to Xie *et al.* (2018), the success or failure of organizations, nations and other social units is largely attributed to their leadership style. Leadership is defined as an effective process between the influential leader and the followers (Bourdieu, 2002; Razak *et al.*, 2018). According to Omolayo (2007), servant leadership is one of the different leadership styles. Greenleaf (1977) proposed the of servant leadership idea for first time in his article "Servant as Leaders" and acknowledged that leaders must first see themselves as servants. Servant leadership is primarily seen as a conceptual structure (Barbuto and Hayden, 2011; Brown *et al.*, 2020). Servant leadership broadly defined as "a desire in the leaders to guide, motivate, provide hope for followers and provide a good caring experience via establishing a high quality relationship with both followers and subordinates" (Spears and Greenleaf, 2002). Brown *et al.* (2020) said that service leaders dedicate themselves to the growth and well-being of the people. Barbuto and Wheeler (2006) identified and validated five dimensions of servant leadership; these five dimensions include altruism, emotion healing, wisdom, persuasion and organizational service (Gandolfi and Stone, 2018). The basic motivation for servant leadership is the desire to serve. It is not the leader's interest to serve him, but his privilege of serving others. Servant leaders value human beings equally and seek the promotion, development and professional participation of all members of the organization. Servant leaders waive their personal rights because they have found greatness in serving others (Gregory Stone *et al.*, 2004; Rabiul and Yean, 2021).

2.5 Research gap

As discussed above, on the one hand, prior research, based on the social cognitive theory as well as contingency and situational theories of leadership, suggests that knowledge sharing can be influenced by leadership style. On the other hand, past studies indicate that knowledge sharing may affect audit quality (Duh *et al.*, 2020). Hence, we can theoretically assume that changes in knowledge sharing behavior of auditors caused by taking different leadership styles of audit managers can affect audit quality. In other words, due to positive effect of knowledge sharing on audit quality, and positive effects of transformational and servant leadership on knowledge sharing, taking this leadership styles by audit managers probably results in higher audit quality. Nevertheless, prior empirical or survey research do not provide any direct evidence this theoretical connection. We extend the literature by examine whether or not leadership styles through knowledge sharing lead to an increase in audit quality.

2.6 Institutional background

The study is conducted at the auditing firms in Iran. Iran is a nation of more than 84 million people [1], is located in west Asia, which commonly referred to the Middle East. From geographically perspective, Iran's surface area is 1,648,195 km. While Iran is rich with

resources such as oil, gas and other natural reserves, it is considered a developing country. Iranians' ancient documents are the evidences that all public incomes and costs were recorded and kept, soundly and punctually. The Iranian Expert Accountants Association has registered in 1974 and still operating (Mashayekhi and Mashayekh, 2008).

Iranian governmental structure reform programs with many measures were introduced; one of which was international accounting standards with modifications. These allowed private audit firms to verify financial statements of listed companies to improve financial reporting quality and credibility. Unlike other developing countries, Iran has not allowed international accounting firms to operate in the country. It has classified audit firms into four categories (A, B, C and D from high to low ranked) to differentiate audit firms (MohammadRezaei *et al.*, 2018). The current paper concentrates on discussing and analyzing the effect of leadership styles on audit quality through the knowledge sharing. Hence, hypotheses are developed that link some specific aspects of leadership style to audit quality.

2.7 Indirect effect of transformational leadership on audit quality through knowledge sharing

Based on the theory of transformational leadership, leadership style has four important dimensions including idealized influence, inspirational motivation, intellectual stimulation and individual consideration (Longshore and Bass, 1987; Budur, 2020; Santoso *et al.*, 2022). Idealized influence means creating high expectations about the mission and goals of the group or taking on a charismatic role that brings praise to employees. Motivation inspiration includes explaining the organization's vision to employees and creating optimism about achieving goals. Intellectual stimulation means encouraging employees to challenge existing approaches and assumptions, as well as re-examining existing problems to find new solutions. Individual consideration includes paying attention to the individual needs and strengths of employees and meeting their demands and developing their abilities (Hay, 2006; Bakti and Hartono, 2022). According to the research literature, transformational leadership has an undeniable role in enhancing knowledge sharing (Berraies and Zine El Abidine, 2019; Yin *et al.*, 2019; Anselmann and Mulder, 2020). On the other hand, knowledge sharing can have a significant impact on audit quality. For example, research by Javadi *et al.* (2012) state that knowledge sharing among auditors can create an environment for consultation, brainstorming and training by preventing the repetition of past mistakes and rework. Therefore, considering the impact of transformational leadership style on knowledge sharing and the impact of knowledge sharing on audit quality, we expect that transformational leadership increases the audit quality by knowledge sharing. Accordingly, the following hypothesis is proposed:

H1. Transformational leadership through knowledge sharing leads to an increase in audit quality.

2.8 Indirect effect of servant leadership on audit quality through knowledge sharing

Greenleaf (1977) pointed out that leaders should consider themselves primarily as servants (Gui *et al.*, 2021). Among the knowledge sharing various antecedents, leadership is a major factor (Park and Kim, 2018; Singh *et al.*, 2021); because leaders enable communication, collaboration, and trust between employees that lead to knowledge sharing as a good source of competitive advantage for the organization. Bou Reslan *et al.* (2021) suggest that leaders create an open and transparent work environment in which members can share experiences, information and knowledge through transparent communication. By providing knowledge and guidance to employees, leaders are able to create an appropriate organizational environment for knowledge sharing (Winarno and Hermana, 2021). Tuan and Thao (2018)

assumed that servant leaders show great sense of empathy, care for all employees and act in their favor, encouraging employees to participate in sharing information and knowledge for others' advancement. In addition, employees passionately mimic the leaders' behaviors and participate in other servant behaviors such as sharing. Tripathi *et al.* (2020) also highlighted the importance of servant leadership in knowledge sharing. Audit quality and efficiency can be increased by reducing rework that is possible with knowledge sharing (McCracken and Kaynak, 1996; Krishnan *et al.*, 2000; Duh *et al.*, 2020). In addition, knowledge sharing can increase knowledge and expertise in the industry and thus increases the professional competence of auditors, which is considered as a factor influencing the quality of auditing (International Auditing and Assurance Standards Board (IAASB), 2021). Knowledge sharing including learning and interactions in the audit process that increase the accuracy of auditors, improve consensus between them, increase the stability of interactions, and bring new knowledge to the decision-making process, are all important in audit quality (Duh *et al.*, 2020). Therefore, we propose the following hypothesis:

H2. Servant leadership through knowledge sharing leads to an increase in audit quality.

2.9 The effect of transformational leadership versus servant leadership

Transformational leadership is a dominant concept in leadership research (Dvir *et al.*, 2002); however, recent studies have focused more on servant leadership (Ehrhart, 2004; Hoch *et al.*, 2016; Sendjaya *et al.*, 2008; Van Dierendonck, 2011). In studies comparing leadership styles, transformational leadership is usually compared with servant leadership (Van Dierendonck, 2011; Choudhary *et al.*, 2013; Andersen, 2018). Scholars have identified some major differences between transformational and servant leadership styles. As formulated by Gregory Stone *et al.* (2004) 'The extent to which the leader is able to shift the primary focus of leadership from the organization to the follower is the distinguishing factor in classifying leaders as either transformational or servant leader'. Barbuto and Wheeler (2006) recommended that another important difference between servant leadership and transformational leadership is that servant leadership focuses on a desire to serve, whereas transformational leadership emphasizes a desire to lead and inspiring followers to perform well.

Graham (1991) specifically argued that the primary allegiance of transformational leaders is to the organization rather than to follower autonomy or universal moral principles. Parolini *et al.* (2009) also concluded that transformational leadership is unique in terms of its strategic role toward organizational goals whereas servant leadership is focused on individual autonomy. Servant leaders usually pay more attentions to serve their followers, although transformational leaders utilize their energy to engage the followers in achieving organization's goals (Choudhary *et al.*, 2013). For these differences, there is a consensus that transformational and servant leadership cannot be used interchangeably (Hoch *et al.*, 2016).

Although, in terms of promoting knowledge sharing, both servant leadership and transformational leadership have a positive impact (Tripathi *et al.*, 2020; Yin *et al.*, 2019; Liu and DeFrank, 2013), due to their differences, it is not probable that the effect of both of them on audit quality through knowledge sharing be equal.

Since transformational leadership is a more dominant leadership style in knowledge sharing, and it focuses on organization goals rather than individuals, and it helps employees reach collective goals (Bass, 2000; Graham, 1991; Gregory Stone *et al.*, 2004), it seems to be a better match for increasing audit quality than servant leadership. Therefore, the third hypothesis of this research is as below:

H3. The impact of transformational leadership on audit quality is stronger than servant leadership.

3. Methodology

3.1 Data and sample selection

This study uses a questionnaire to collect data on the impact of leadership styles on audit quality through knowledge sharing in audit firms. According to informal statistic, there are around 300 audit firms in Iran; all of which are classified in four rate A, B, C and D according to their competencies. Statistical population in this research involves all active auditors in Iranian auditing firms, which are not calculable. In order to expedite data collection, we collected data in both forms of online and offline.

We sent the link of online questionnaires to the firms on March 15th through emails. We sent reminder emails to the firms to maximize the response rate after three weeks, and follow-up phone calls was made two weeks after sending the reminder emails. Dou to Iranian holidays, we had to distribute the paper-questionnaire from April 10th. After three weeks we made the first follow-up, and two weeks later we made the second follow-up by phone calls. The data collection process took about 90 days. We gathered 196 online responses, all valid. We also gathered 216 offline responses, 16 responses were invalid. At last, we had 200 offline and 196 online valid responses to analysis.

3.2 Measurement

The development of the measurement model includes phases of theoretical modeling, statistical testing and refinement. Indicators were mainly adopted from a comprehensive review of the literature and their wording was modified to adjust to our context by reflecting expert opinions. To measure transformational leadership style, this study follows literature (e.g. Chandrasekara, 2019) and used the Bass and Avolio (2000) questionnaire, which consists of 21 questions. This questionnaire measures four important aspects of transformational leadership. This study follows literature (e.g. Xie, 2020) and Jacobs (2006) research questionnaire which was also adopted to measure servant leadership style, consisting of eight questions. To measure knowledge sharing, this study follows literature (e.g. Anwar *et al.*, 2019) and five questions of Carmeli *et al.* (2013) research questionnaire were used.

This study used the research of Knechel *et al.* (2013) to measure the quality of auditing. Knechel *et al.* (2013) identifies and classifies the basic characteristics and various aspects of audit quality. The various aspects of audit quality according to this classification include the four categories of inputs, process, outputs and context. This classification was introduced in 2014 by IAASB as a framework for audit quality by adding key interaction aspects. The framework presented by this committee identifies and presents factors at the level of the audit team, the company and the country that can lead to the quality of the audit. This research has also adopted the items stated in the IAASB for inputs and processing at the level of the institution and the team as items and indicators for measuring audit quality. All variables except demographic questions were measured using a five-point Likert scale.

4. Results

4.1 Measurement model

This part of research dedicated to presenting the results of statistical analysis of field data, consists of two main parts, descriptive and inferential statistics. These analyzes were performed on data obtained from 396 respondents in SPSS software with regression models. It is worthy to note that all research hypotheses were tested at 95% confidence level.

As shown in Table 1, the majority of respondents, around 60%, are men. 50% of respondents are under 30 years old. The respondents are mostly master graduates, all working as auditors. Respondents mostly work in B audit firms, and their job position is auditor. Most of respondents work at least in two audit firms. The majority of collected responses are offline (nearly %51). In similar research in Taiwan, most of respondents were

	N	Percent
Gender		
Man	237	59.8
Woman	159	40.2
Age		
<25	104	26.3
26–30	91	23.0
31–35	97	24.5
36–40	46	11.6
41–45	28	7.1
>45	30	7.6
Education		
Bachelor	157	39.7
Master	174	43.9
PH. D	11	2.8
Bachelor student	27	6.8
Master student	27	6.8
PH. D student	0	0.0
Type of response		
Online	196	49.5
Offline	200	50.5
Field of activity		
Auditor	380	96.0
Other	13	3.3
No answer	3	0.7
Institutional rating		
A	167	42.2
B	169	42.7
C	37	9.3
D	23	5.8
Position		
Auditor	234	59.1
Senior auditor	57	14.4
Supervisor	24	6.1
Senior supervisor	24	6.1
Manager	32	8.1
Partner	25	6.3
Employment history in audit firms		
1	138	36.8
2	142	35.9
3	43	10.9
4	53	13.4
5 Or More	20	5.1

Note(s): It refers to the numbers of audit firms that a respondents have worked from the beginning
Source(s): Authors' calculations

Table 1.
Descriptive statistics

women, bachelor, and senior (Duh *et al.*, 2020). Table 1 shows the respondents' profile in details.

The reliability and construct validities of our measurement model were firstly assessed. The summary of reliability, validity for each construct and correlation between constructs is visible in Table 2.

For examining the reliability, all test statistic values of Cronbach's alpha and composite reliability exceed the recommended threshold values, 0.70. Moreover, all factor loadings for own constructs are above 0.7 and average variance extracted (AVE) for each construct exceeded 0.3, thus demonstrating convergent validity (Hair *et al.*, 2011). Variables have a distance scale in this research and their normality is confirmed, their correlation with Pearson coefficient is calculated. The correlation study of variables in this section is a descriptive study and has not been used to test hypotheses. Table 2 demonstrate the variables' mean and standard deviation along with their correlation coefficients. The highest correlation coefficient is related to the relationship between transformational leadership and audit quality (0.76) and the smallest coefficient is related to the relationship between servant leadership and knowledge sharing (0.12). Meanwhile, the knowledge sharing variable has the highest mean (4.25) and the lowest standard deviation (0.473) simultaneously.

4.2 Hypotheses testing

To test our hypotheses, SPSS software is employed. To check the preference of a mediating effect, Sobel test was adopted. Sobel test examines whether the inclusion of a mediator (M) in the regression analysis considerably reduces the effect of the independent variable (X) on the dependent variable (Y) (Abu-Bader and Jones, 2021). The results of the model analysis are visible in Table 3. The indirect effect coefficient of transformational leadership on audit quality is 0.17, which is obtained by multiplying direct effects on each other (0.36×0.48). Based on the Sobel test, the significance level of this coefficient is greater than 1.96. Therefore, the first hypothesis that knowledge sharing mediates the relationship between transformational leadership and audit quality has confirmed. Moreover, the indirect effect

Variable	Mean	SD	1	2	3	Cronbach's alpha	AVE
1. Transformational leadership	4.026	0.535	1			0.923	%39.88
2. Servant leadership	3.648	0.749	0.450 (99%)	1		0.898	%54.94
3. Knowledge sharing	4.251	0.437	0.360 (99%)	0.128 (95%)	1	0.719	%44.15
4. Audit quality	4.042	0.510	0.764 (99%)	0.422 (99%)	0.566 (99%)	0.994	%38.17

Source(s): Authors' calculations

Table 2. Correlation matrix, reliability and validity

Effects	Beta	*t*-value	*p*-value	Result
Hypothesized paths				
TL→KS→AQ	0.360	6.489	0.000	Supported
SL→KS→AQ	0.128	2.508	0.011	Supported
Control measures				
Gender→AQ	0.187	2.195	0.000	Supported
Age→AQ	0.135	−2.046	0.000	Supported
Education→AQ	0.055	−2.025	0.016	Unsupported
Field of activity→AQ	0.137	−0.391	0.151	Supported
Position→AQ	0.218	2.069	0.000	Supported
Institutional rating→AQ	0.044	2.026	0.000	Unsupported
Employment history→AQ	0.344	0.148	0.249	Supported
Type of response→AQ	0.149	−2.153	0.000	Supported

Source(s): Authors' calculations

Table 3. Analysis results

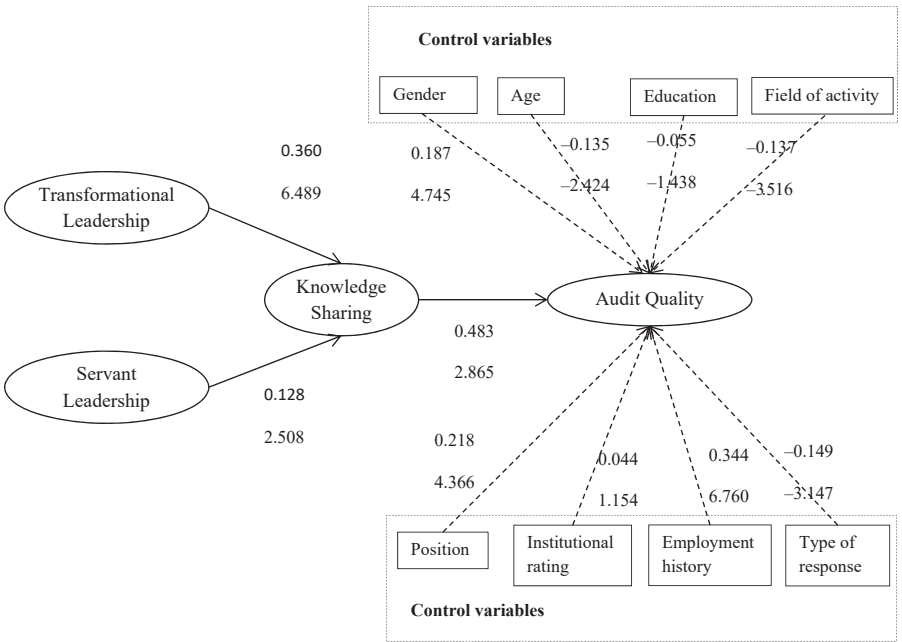
coefficient of servant leadership on audit quality is 0.06, which is obtained by multiplying direct effects on each other (0.12 × 0.48). Based on the Sobel test, the significance number of this coefficient is calculated to be greater than 1.96. Therefore, the second hypothesis that knowledge sharing mediates the relationship between servant leadership and audit quality is also confirmed. Finally, transformational leadership has an estimated coefficient of 0.360, while servant leadership has an estimated coefficient of 0.128. Thus, that transformational leadership and servant leadership have positive impacts on audit quality, but transformational leadership has stronger impact than servant leadership, confirming the third hypothesis.

As shown in Table 3, gender, age, education, field of activity, position, institutional rating, employment history and type of response are controlled. Analysis shows that gender, age, field of activity, position, employment history and type of response are significant variables and their effect are controlled to extract the effect of the predictor variable (knowledge sharing) on dependent variable (audit quality).

To improve the presentation of the different associations, we have included Figure 1 which displays all the associations between variables.

4.3 Robustness check

As a robustness check, this paper also employs structural equation modeling (SEM). Consistent with Figure 2, our SEM shows that our main results are remained unchanged as similar to main results, both transformational and servant leadership style significantly influence audit quality through knowledge sharing. Moreover, the impact of transformational



Note(s): Adjusted R squared for Knowledge Sharing and Audit Quality equals 61% and 82%, rtespectively

Source(s): Authors' calculations

Figure 1.
Empirical model

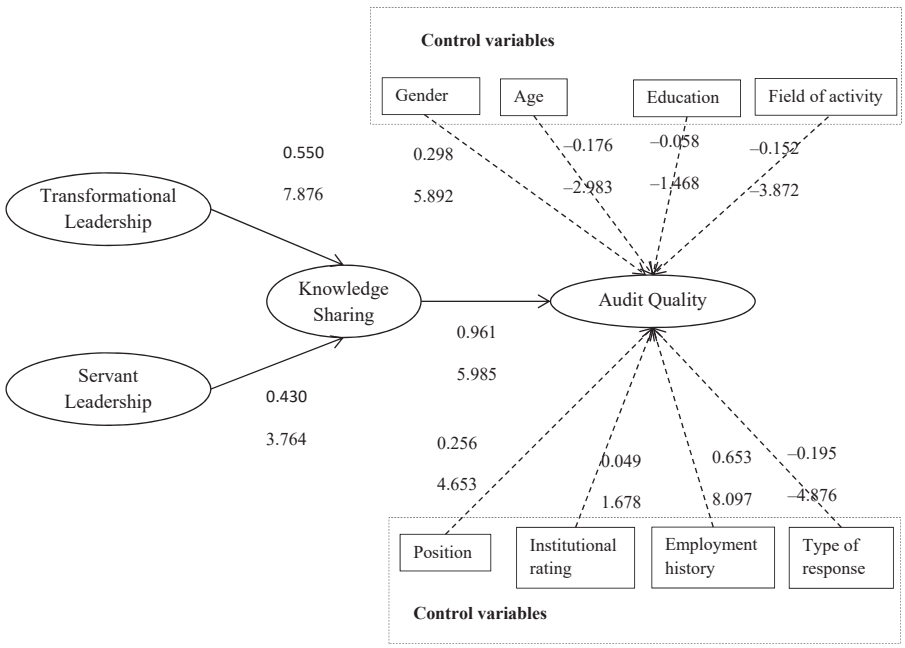


Figure 2.
Robustness check

Note(s): RMSEA = 0.04; GFI = 0.95; CFI = 0.67; NFI = 0.91; SRMR = 0.05
Source(s): Authors' calculations

leadership style is stronger than the impact of servant leadership style. In addition, the indexes regarding the goodness of fit show that the model has generally acceptable fit for the data. For example, root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) is lower than 0.05 and 0.08, respectively, indicating that our model is appropriate and parsimonious.

5. Discussion

We developed an empirical model of the effects of leadership style on audit quality through knowledge sharing and tested the model with 396 auditors. Several points are important of note. Primarily, the results of this study indicate major role of knowledge sharing in leading transformational and servant leadership style to audit quality. This study provides a better understanding of the importance of leadership style in audit firms since it relates two leadership styles to audit quality. Both servant and transformational leadership have many facets in common and exhibit wonderful leadership. Through this research it has been acknowledged that through knowledge sharing, transformational leadership has more impact on audit quality than servant leadership. As audit firms with transformational and servant leadership likely to achieve greater quality, the results imply high knowledge sharing is associated with improved audit quality. Previous studies that focus on a direct relationship between knowledge sharing and audit quality (Duh *et al.*, 2020). According to Francis and Krishnan (1999), reaching better audit quality is accessible via moving beyond our current knowledge in academic area and sharing the acquired knowledge among employees in auditing firms.

Previous studies show direct effects of transformational on knowledge sharing (Park and Kim, 2018). Yin *et al.* (2019) report the indirect effect of transformational leadership on knowledge sharing mediated by psychological security and team productivity, and Anselmann and Mulder (2020) also support the indirect effect of transformational leadership style on knowledge sharing mediated by team safe environment. According to Yin *et al.* (2019), knowledge sharing has gained more importance for firms' success in knowledge economy era. Transformational leaders monitor followers and help them to keep at a very high level of facilitating knowledge sharing among organizational staff.

Previous studies also show direct effects of servant leadership on knowledge sharing (Tripathi *et al.*, 2020). Some researchers have supported the impact of servant leadership on knowledge sharing. Tuan and Thao (2018) reported the indirect impact of service leadership on knowledge sharing through public service motivation and corporate social responsibility adjustment. Therefore, by employing knowledge sharing as a mediator, we verify the postulation that real usage is the significant link from leadership style to audit quality. The result shows that knowledge sharing fully mediates the relationship between transformational and servant leadership style to audit quality. According to Tripathi *et al.* (2020) servant leaders inspire staff to engage in serving behaviors and knowledge sharing with others. Knowledge mutual exchange results in the co-production of knowledge that promotes efficient resources use to achieve complex organizational goals.

In case of demographic information, meaningful differences are observed. To clarify, transformational leadership style, knowledge sharing and audit quality are greater in woman; while gender has no meaningful difference in servant leadership style. Transformational leadership, knowledge sharing, and audit quality are higher in partners' point of view; while servant leadership is greater in senior supervisors. Servant leadership is more in audit firms' rank B in comparison to others; while there is no significant difference in audit firms' rank A, C and D.

This study finally offers a few areas for further refinement. First, we examine the mediating role of knowledge sharing in relationship between transformational, and servant leadership style with audit quality in Iran and with limitations, this study cannot be generalized for all the audit firms. This study undertook a limited sample size; future research can enhance the generalizability of the findings by considering cross-national or multinational survey. Second, the applied approach in this paper has some limitations; we point out the importance of knowledge sharing, but the specific practices and mechanisms of knowledge sharing are not pointed out, we focus on knowledge sharing as a whole concept rather than special procedures (using information technology like webcasts, internal databases, and online training to facilitate knowledge sharing). Future research should consider various knowledge sharing mechanisms and compare the outcomes. Third, our research is conducted in the individual level data; while our model is applicable to the firm level. In future studies, firms-based data should be considered to test the model applicability. Forth, we only examine the effects of two leadership styles; future research can study multiple leadership styles. Fifth, the result of control variable show that audit firms with certain employees' gender, age, field of activity, position, employment history in audit firms apply knowledge sharing more than other employees do. This way, future research can focus on certain employees' gender, age, field of activity, position, employment history in audit firms that can result in providing deeper findings with usage of knowledge sharing.

This study has clear practical implications, particularly in audit quality that covers a range of low to high quality. We provide useful guidance to partners and senior managers on how audit firms can improve audit quality by applying a specific leadership style through the knowledge sharing. Both transformational and servant leadership style influence the audit quality through knowledge sharing; therefore, we strongly suggest the audit companies' partners and senior managers to choose one of these leadership style in their firms.

In addition to, the impacts of transformational leadership style are more than servant leadership style on the audit quality, we thus recommend to the audit companies' owners and senior managers to apply transformational leadership style in their companies. Moreover, this research can lead to important implications for auditing firms in developing countries like Iran. Unfortunately, there is no strong and efficient leadership style in audit firms in developing countries, therefore, this study clears the importance of having a specific leadership style that contribute to increase audit quality by enhanced knowledge sharing.

Note

1. http://datatopics.worldbank.org/world-development-indicators

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Genetic algorithm modeling of European Union firms' competitive advantage

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Abstract

Purpose – This research aims to identify the optimal configuration of investment which leads firms to their best competitive positions, considering the degree of concentration in the market.

Design/methodology/approach – The methodology was quantitative and based on secondary data with samples of 124, 106 and 90 firms from competitive environment classified as perfect competition, monopolistic competition and oligopoly, respectively. Proposed models' parameters were estimated by means of genetic algorithms.

Findings – Adjustments on firm's investment are contingent on the degree of competition they face. Results are in line with existing academic research affirmation that the purpose of investments is to create and exploit opportunities for positive economic rents and that investments allow firms to protect from rivals' competitive actions and reinforce the need for investment decision makers to consider the environment in which the firm is competing, when defining the amount of investment that must be done to achieve and maintain a favorable competitive advantage position.

Originality/value – This research brings two main original contributions. The first one is the identification of the optimal amount of capital and R&D investments which leads firms to their best competitive positions, contingent to the degree of concentration of the competitive environment in which they operate, and the size of the firm. The second one is related to the use of genetic algorithms to estimate optimization models that considers the three competitive environments studied (perfect competition, monopolistic competition and oligopoly) and the investment variables in the linear and quadratic forms.

Keywords Competitive position, Investment, Competitive environment, Genetic algorithms

Paper type Research paper

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1. Introduction

The effects that firms' investment exert on firms' competitive position, considered the degree of competition, have been approached by several authors, mainly with the identification of linear effects, but none of them proposed the identification of the optimal configuration of investments that leads firms to achieve competitive advantage. This research aims to identify the optimal configuration of Capex and R&D investments which leads firms to the best competitive positions, considering the degree of concentration in the markets in which they operate.

This research brings two main contributions. The first one is the identification of the optimal amount of capital and R&D investments which lead firms to their best competitive positions, contingent to the degree of concentration of the competitive environment in which they operate, and the size of the firm (control variable). The second one is related to the use of genetic algorithms to estimate optimization models that consider the three competitive environments studied (perfect competition, monopolistic competition and oligopoly) and the investment variables in the linear and quadratic forms.

Competition could be approached under two contexts. The first one, worldwide economics, considers that countries and economic groups compete for greater capacity to accumulate resources, to generate jobs and to have access to technologies. The best the nation's economy competitive position, the best the population quality of life (Bazoobandi and Nugent, 2017; Bazoobandi and Alexander, 2020), and the greater the nation's politic and economic influence in the decisions of the economic group to which they belong (Xiaotong and Keith, 2017).

In the second one, the context of firms, which is the focus of this research, the most competitive tend to be those firms with the highest internal capacity to create value (Ma, 1999) by means of product and process-innovation (Arrow, 1962; Boone, 2000; Agustia *et al.*, 2022; O'Leary *et al.*, 2022) and those located in industries, countries, or regions with competitive environments conducive to good results (Peneder, 2009; Wu *et al.*, 2017). Thus, competitive advantage is built through the interaction between internal and environmental factors (Ringov, 2017), and firms are considered effective and competitive when they manage to create superior value to their competitors (Ghemawat and Rivkin, 1998), in terms of growth and profitability (Ştefan and Coca, 2011; Brito and Brito, 2014). The possibility of combining profitability and growth strategies to achieve a better competitive position means that there must be a balance between them (Dias *et al.*, 2019a, b).

Thus, a firm is competitive when it optimizes its resources and opportunities to gain a medium and long-term advantage over its rivals (Gradinaru *et al.*, 2017; Machokoto *et al.*, 2021; Agustia *et al.*, 2022). Therefore, expertise is needed to realize that efforts to use high technologies could create competitive advantages in environments where technology evolves rapidly, but not in environments where technology is slowly advancing. In circumstances where resources are limited, managers should consider the influence of environmental contexts. Therefore, they should consider the competitive position of the firm in the market, in the process of resources allocation (Yang and Tu, 2020; Dias *et al.*, 2022).

The competitive advantage needs to be sustained for the perpetuation of firms in the market. However, the context of competition is characterized by transitory competitive advantages (Kanuri and Mcleod, 2016) and, to achieve the best competitive positions, firms constantly adjust their strategies, considering internal and external factors (Wilden *et al.*, 2016; Fainshmidt *et al.*, 2019; Agustia *et al.*, 2022; Dias *et al.*, 2022). These adjustments involve directing investment strategies and decisions to place greater emphasis on growth, profitability, or both (Brito and Brito, 2012, 2014; Dias *et al.*, 2019b). Thus, factors such as competitive environment, investment strategies decisions and firm's competitive position are in constant interaction (Dias *et al.*, 2020).

This study presents relevant contributions to the empirical literature. First, the analysis of the relationship between firms' investment and competitive advantage under three different competitive environments is approached by means of genetic algorithm models, using data from

firms located in countries that are members from European Union. Second, the identification of different results, conditioned by degree of competition, contributes to better understanding of the dynamics of the firms' investments and its relations to competitive environments.

2. Theory

Research on business strategies focuses mainly on understanding the factors that make a firm most competitive in the environment in which it operates, as well as the processes responsible for achieving this competitive position (Håkansson and Snehota, 1989). Generally, firms are considered effective and competitive when they accumulate resources throughout their existence, interacting with the environment in which they compete, and the resource accumulation is fundamental to its existence (Håkansson and Snehota, 1989). In this context, Håkansson and Snehota (1989) stated that "[n]o business is an island", suggesting that every organization needs to consider the business environment where it is inserted, because, regardless of its location, most businesses are affected by global competition.

Investments made by firms may focus on the creation, extension, upgrade, protection, or maintenance of the firm's unique asset base. Investment decision-making is related to the ability to detect opportunities and threats, seize opportunities and maintain competitiveness through improvement, combination, protection and, when necessary, reconfiguration of the firm's assets. However, detecting opportunities and threats astutely is necessary, but not enough, to succeed when surprises occur in a business environment. The firm should also seize opportunities in a timely manner by successfully innovating and implementing new systems that take advantage of external changes (Stewart, 1998; Perez and Famá, 2006; Teece, 2007; Teece *et al.*, 2016; Schoemaker *et al.*, 2018; Peng *et al.*, 2021).

Firms that have the greatest capacity to generate economic value tend to gain competitive advantage over their competitors. Thus, the competitive advantage of a firm corresponds to the economic value that it can create, through its investments (Barney and Hesterly, 2011; Santos *et al.*, 2017; Afonso *et al.*, 2018; Karmarkar and Plassmann, 2019; Pallant *et al.*, 2020; Machokoto *et al.*, 2021).

The investment decision-making capacity is necessary to promote the organizational agility necessary to deal with the uncertainties and demands imposed by innovation and dynamic competition, associated with the context of the organizational environment (Teece *et al.*, 2016; Tell *et al.*, 2016; Pascucci, 2018; Schoemaker *et al.*, 2018; Karmarkar and Plassmann, 2019; Pallant *et al.*, 2020; Peng *et al.*, 2021). Innovation is considered a strategic factor for the survival and growth of firms, especially in the face of great competitive pressure, directly affecting their competitive position (Pascucci, 2018). This capacity for innovation refers to the capacity of firms to react or cause changes in the business environment, in search of the maintenance or acquisition of a better competitive position (Teece *et al.*, 1997; Teece, 2018).

The more competitive and dominant the firm, the more value it will offer to the market, compared to its competitors, through the transformation of raw materials into products and services (Wernerfelt, 1984; Porter, 1986, 1999; Håkansson and Snehota, 1989; Camisón *et al.*, 2016; Wilden *et al.*, 2016; Ringov, 2017; Wu *et al.*, 2017; Namada, 2018 Yuan *et al.*, 2018 Fainshmidt *et al.*, 2019). In this sense, firms seek to increase their competitive position, but can converge to a position of parity, due to restrictions imposed by technology, economy, regulations, labor processes, market concentration and other characteristic factors of the industry where they are in (Eisenhardt and Martin, 2000; Goudarzi, 2013; Kumar and Ranjani, 2018; Machokoto *et al.*, 2021). Industry also affects the firm's competitive position through the ability of other competitors, as the industry operates with a constant cycle of innovation and imitation, in which firms seek innovative capabilities to gain an advantage over the firms that are in the same industry. To the extent that they are successful, other firms follow suit, adapting and improving what their competitors are doing (Lampel and Shamsie, 2003; Santos *et al.*, 2017; Dias *et al.*, 2019b; Alam *et al.*, 2020; Peng *et al.*, 2021).

Thus, firms also differ in their competitive position in the market, which can not only be influenced by their own operating characteristics and internal capacity (Porter, 1980; Håkansson and Snehota, 1989; Teece *et al.*, 1997; Namada, 2018), but also by the environment in which they operate (Porter, 1980; Håkansson and Snehota, 1989; Sener, 2012; Camisón *et al.*, 2016; Wilden *et al.*, 2016; Ringov, 2017; Santos *et al.*, 2017; Wu *et al.*, 2017; Yuan *et al.*, 2018; Dias *et al.*, 2019b; Fainshmidt *et al.*, 2019; Alam *et al.*, 2020). It should be considered that the firm's competitive position, in addition to being influenced by its capabilities, is also influenced by the external competitive environment configuration, whether it is industry, country or region to which it is linked.

The effects of firms' investments on competitive position have been approached by many authors with different results. Some of them concluded that firm growth by investment positively influences firm's competitive advantage (Kulatilaka and Perotti, 1998; del Sol and Ghemawat, 1999; Tsai and Wang, 2004); that firms investment have a positive effect on firms' performance, which is commonly used as a proxy to competitive advantage (Brailsford and Yeoh, 2004; Amir *et al.*, 2007; Gupta and Banga, 2009; Fang Yang, 2014; Pandya, 2017; Zuoza and Pilinkienė, 2019; Kim *et al.*, 2021); that the effects of R&D investments on competitive advantage are contingent on the degree of competition faced by firms (Miller *et al.*, 2005; Tubbs, 2007; Ravšelj and Aristovnik, 2020), and that firms adjust their investment in R&D and in Capex when facing financial constraints in times of crisis (Flammer and Ioannou, 2021).

Based on the presented theoretical approaches, we propose that,

Proposition. Firms should increase the amount of investment in both Capex and R&D to increase the competitive position, the less concentrated the competitive environment.

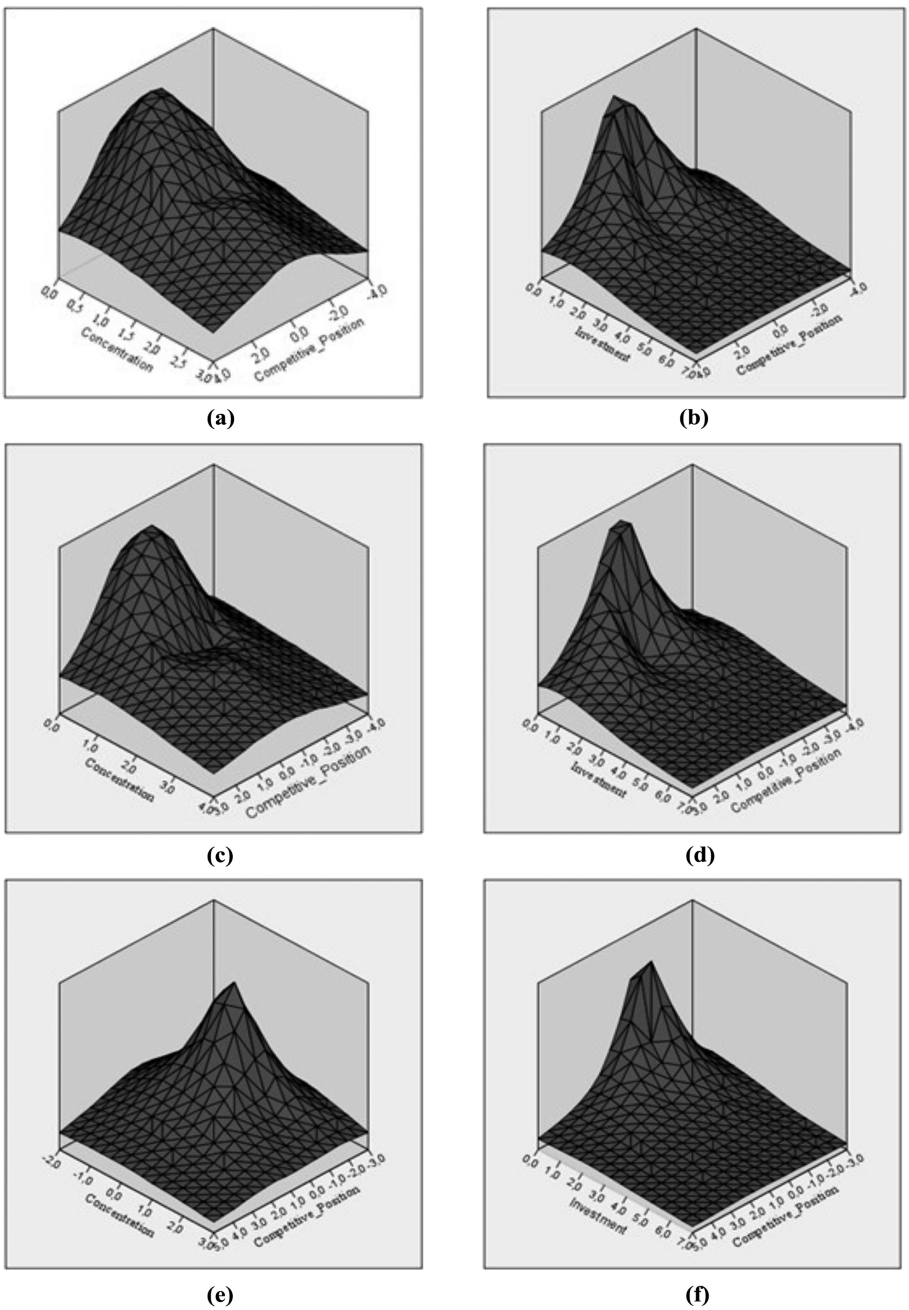
3. Methods

In this section we present the path and procedures chosen to carry out the research, as well as the variables that were used to measure the constructs that make up the model and its operationalization for data generation.

The genetic algorithms method was used to identify the optimal configuration of strategic factors (investments in Capex and R&D) that leads to the best competitive position of firms, considered the degree of concentration in the industry. According to Lee *et al.* (2002) the genetic algorithm is a computational tool that provides mechanisms to understand competition from the evolutionary perspective. One of these mechanisms is known as selection, and it can identify winners and losers over time (Lee *et al.*, 2002). In this way, Lee *et al.* (2002) points out that genetic algorithms are composed of mathematical structures and therefore allow the conduction of an economic analysis without the need to resort to assumption.

3.1 Research model

When processing genetic algorithms through Evolver software®, version 7.5, values were estimated for the construct competitive position, according to Equation (1), elaborated with reference in the hypothetical model that was tested through the processing of a structural equation model. The parameters of the model were established as: population size equal to the number of cases in each competitive environment; crossover rate of 0.500; and mutation rate equal to 0.100. Squared effects of competitive environment (concentration) and Investment were included in the model after the analysis of the graphs presented in Figure 1, which represents the relationships between competitive environment's degree of concentration and firms competitive position, and between firms investments and firms competitive position.



(a) (b) (c) (d) (e) (f)

Figure 1.
Relationship between concentration, investment and competitive position

Source(s): Figure by authors

$$CP = \beta_1 CE + \beta_2 CE^2 + \beta_3 IN + \beta_4 IN^2 + \beta_5 SIZE + \beta_6 (CExIN) + \beta_7 (SIZExIN) + \varepsilon \quad (1)$$

Where:

CP = Competitive position.

CE = Competitive environment.

CE^2 = Squared Competitive environment.

IN = Investment.

IN^2 = Squared investment.

SIZE = Firm's size (control variable);

CE × IN = Interaction between CE and IN (moderating effect of CE on the influence of IN on CP).

SIZE × IN = Interaction between SIZE and IN (moderating effect of SIZE on the influence of IN on CP).

The genetic algorithm model was elaborated with the objective of identifying which amount of investment (Capex and R&D - Equation (2)) maximize the mean value of the estimated competitive position. The indicators' coefficients were estimated by structural equations modeling, for each one of the three competitive environments considered in the analysis and for the most recent available year (2017) in the samples.

$$IN = \beta_3 Capex + \beta_4 R\&D + \varepsilon \quad (2)$$

Where:

IN = Investment.

Capex = Investment in capital.

R&D = Investment in research and development.

The increase in firms' competitive position that will be achieved as a consequence of the increase or the decrease on Capex and R&D investments, is obtained by the difference between competitive position estimated (Equation (1)), and the original competitive position values (Equation (3)), for each one of the firms in the samples.

$$CPo = \beta_5 MS + \beta_6 ROA + \varepsilon \quad (3)$$

Where:

CPo = Competitive position - original.

MS = Market share.

ROA = Return on assets.

The operationalization of the dependent and independent variables in Equations (1) through (3) is presented in Table 1.

4. Results

4.1 Samples

Data was collected from Thomson Reuters Datastream®, and samples are composed of 124 cases representing firms in competitive environment classified as perfect competition, at the year

Category	Variable	Calculation method	References
Competitive Environment (CE)			
Degree of industry concentration	Herfindahl-Hirschman (relative)	$HHIRel = (\sum_{i}^{n} S_i^2) : \frac{1}{n}$	Brezina *et al.* (2016), Dai *et al.* (2019), Jošić *et al.* (2019), Powers and Topper (2019), Zhang *et al.* (2020)
Investment (IN)			
Investment in capital	Capex	$\ln(Capex)$	Dias *et al.* (2019a), Curtis *et al.* (2020), Lai *et al.* (2020), Nguyen and Nguyen (2020)
Investment in research and development	R&D	$\ln(R\&D)$	Dias *et al.* (2019a), Rocha *et al.* (2019), Alam *et al.* (2020), Curtis *et al.* (2020)
Competitive position (CP)			
Market Share	MS - (firm's market share compared to the average market share of the industry's firms)	Z-score (firm's market share)	Brito and Brito (2012), Fontoura and Serôdio (2017), Aghion *et al.* (2019), Dias *et al.* (2019a), Yi *et al.* (2019), Dias *et al.* (2020), Wang (2020)
Profitability	ROA – (firm's Return on Assets (ROA) compared to the average ROA of the industry's firms)	Z-score (firm's ROA)	Brito and Brito (2012), Erica *et al.* (2018), Dias *et al.* (2019a), Zapata *et al.* (2019), Dias *et al.* (2020), Zhong and Wu (2020)
Firm Size (SIZE)			
Firm's size	SIZE – (firm's size measured with reference on total assets)	$\ln(Total\ Assets)$	Saliha and Abdessatar (2011), John and Adebayo (2013), Kartikasari and Merianti (2016), Kumar and Kaur (2016), Dinali Viglioni and Leal Calegario (2021), Wijayaningsih and Yulianto (2021)

Source(s): Table by authors (2021)

Table 1.
Operationalization of the variables

of 2017, 106 cases representing firms in competitive environment classified as monopolistic competition, and 90 cases representing firms in competitive environment classified as Oligopoly, according to the classification presented by Djolov (2013), presented in Table 2. The number of firms in the sample per industry, per competitive environment is presented in Table 3.

The samples were above the minimum of 57 cases estimated for a test power of 0.950, effect size of 0.500 and significance bi-caudal test at 5% for the verification of differences between the means of paired groups, through the Wilcoxon test. G*Power 3.1.9.2 software (Faul *et al.*, 2009) was used to calculate the minimum sample size.

As one can see in Table 3, 50% of the firms in perfect competition competitive environment (62 from 124) are in the top 1,000 ranking of R&D investment elaborated by the European Commission for the year of 2017, and above 29% are in the top 500 (35 from 124). A total of 59% of the firms in monopolistic competition competitive environment are in the top 1,000 (63 from 106), and 43% are in the top 500 (46 from 106). A total of 55% of the firms in oligopoly are in the top 1,000 ranking of R&D investment (50 from 90) and 28% are in the top 500 ranking (26 from 90) (European Commission, 2022).

The year of 2017 was chosen for the study because it represents the maximum growth in European Union's GDP in the after 2008 crisis and before the Brexit period (growth of 2.2% in

2010; growth of 1.9% in 2011; reduction of 0.7% in 2012; neither growth or reduction in 2013; growth of 1.6% in 2014; growth of 2.3% in 2015; growth of 2.0% in 2016, growth of 2.8% in 2017; growth of 2.1% in 2018; and growth of 1.8% in 2019) (The World Bank, 2022).

4.2 Genetic algorithms models results

Equations (4)–(6) were used as references to the estimation of the values of competitive position, for the environments perfect competition, monopolistic competition and oligopoly,

HHI in percentage range	Concentration	Competitive environment
0.00 < HHI =< 0.20	Low	Perfect competition
0.20 < HHI =< 0.40	Slight	Monopolistic competition
0.40 < HHI =< 0.70	Elevated	Oligopoly

Source(s): Adapted by authors from Djolov (2013)

Table 2. Economic view of HHI

Industry	Number of firms	Top 1,000	Top 500
Perfect competition			
Chemicals	27	16	11
Computer services	22	5	3
Electrical equipment	19	10	6
Electronic equipment	19	13	7
Foods	22	9	4
Telecommunication equipment	15	9	4
Total	124	62	35
Monopolistic Competition			
Industry	*Number of cases*	*Top 1,000*	*Top 500*
Biotechnology	11	9	6
Building material	17	8	3
Chemical inputs	7	4	4
Medical equipment	16	9	7
Medical supplies	8	4	3
Pharmaceuticals	25	18	16
Semiconductor	14	8	7
Storage	8	3	0
Total	106	63	46
Oligopoly			
Industry	*Number of cases*	*Top 1,000*	*Top 500*
Clothing and accessories	10	2	2
Computers	7	1	1
Heavy construction	5	3	1
Industrial products	7	4	3
Iron and steel	7	7	4
Media agencies	4	1	0
Mining	2	2	2
Personal products	4	2	2
Software	44	28	11
Total	90	50	26

Source(s): Table by authors based on data processing results and on data from European Commission (2022)

Table 3. Number of cases per industry, per competitive environment and investment ranking

respectively. All the coefficients were obtained with reference in a hypothetical model that was tested through the processing of a structural equation model.

$$CPe = 0.058CE + 0.218CE^2 + 0.530IN - 0.041IN^2 + 0.918SIZE - 0.064(CExIN) - 0.036(SIZExIN) \quad (4)$$

$$CPe = 0.146CE - 0.340CE^2 + 0.324IN - 0.006IN^2 + 0.988SIZE - 0.074(CExIN) + 0.074(SIZExIN) \quad (5)$$

$$CPe = 0.656CE - 0.471CE^2 + 0.288IN + 0.060IN^2 + 1.105SIZE + 0.116(CExIN) + 0.176(SIZExIN) \quad (6)$$

Taking Equation (2) as reference, the coefficients of the Investment construct's indicators are presented in Equations (7)–(9), for perfect competition, monopolistic competition and oligopoly competitive environments, respectively. All the weights were obtained with reference in a measurement model that was tested through the processing of a structural equation model.

$$IN = 0.600Capex + 0.490R\&D \quad (7)$$

$$IN = 0.689Capex + 0.360R\&D \quad (8)$$

$$IN = 0.538Capex + 0.566R\&D \quad (9)$$

The original competitive position of the firm was calculated with reference on Equation (3), and the weights of the construct's indicators are presented in Equations (10)–(12), for perfect competition, monopolistic competition and oligopoly competitive environments, respectively. All the weights were obtained with reference in a measurement model that was tested through the processing of a structural equation model.

$$CPo = 0.999MS - 0.021ROA \quad (10)$$

$$CPo = 1.000MS - 0.024ROA \quad (11)$$

$$CPo = 1.011MS - 0.058ROA \quad (12)$$

As can be seen in Table 4, the differences between means for the competitive position construct, in the three competitive environments addressed in the research, are statistically significant, as well as the differences between the means for the Capex and R&D indicators, which were used to measure the investment construct. The significance of the difference between means was ascertained by Wilcoxon's nonparametric test.

Variables	Perfect Competition Difference[a]		Std deviation	Monopolistic Competition Difference[a]		Std deviation	Oligopoly Difference[a]		Std deviation
CP	0.926	***	0.745	−0.287	***	0.449	0.880	***	0.472
Capex	1.734	***	1.425	2.447	***	1.081	1.531	***	1.274
R&D	1.763	***	1.419	2.304	***	1.142	2.200	***	1.768

Note(s): *** significant at 5.00%
[a] –Difference = calculated mean minus original mean
Source(s): Table by authors based on data processing results

Table 4. Differences between means

The positive value of the difference and the standard deviation values lower than the differences point to the increase in competitive position, with a tendency to the position of competitive advantage, due to the variation in investment in capital (Capex) and research and development (R&D), for the perfect competition and oligopoly competitive environments, according to the data presented in Table 4. As for the monopolistic competition environment, for the firms in the sample to achieve an advantageous competitive position, it will be necessary to avoid the negative variation of the competitive position by up to about 50.00% of a standard deviation, ideally the variation of the competitive position above a standard deviation – Table 4.

In fulfillment of the objective established for this research, was identified the optimal investment configuration in Capex equal to 1.790 and R&D of 1.990, both expressed in their logarithmic form, to obtain a value of competitive position equal to a maximum of 1.892, in the perfect competition environment. These figures represent a 147.66% increase in Capex investment and 101.19% in R&D investment, leading to 50.81% increase in the competitive position – Table 5.

For the monopolistic competition environment, as can be seen in Table 5, the optimal configuration of Capex investment equal to 1.068 and R&D of −0.095 was identified, both expressed in their logarithmic form, to obtain a competitive position equal to the maximum of 2.796. These figures represent a 56.97% reduction in Capex investments and a 104.03% reduction in R&D investment, leading to a 32.78% increase in the competitive position – Table 5.

As for the oligopoly environment, the optimal configuration of Capex investment equal to 1.856 and R&D of 2.030 was identified, both expressed in their logarithmic form, for the competitive position range equal to 3.199 – Table 5. These values would be achieved with an increase of 174.31% of investments in Capex and of 16.76% in R&D, leading to a 24.51% increase in the competitive position.

5. Conclusions

This research aims to identify the optimal configuration of Capex and R&D investments which leads firms to the best competitive positions, considering the degree of concentration of the markets in which they operate, and firm size as control variable. For this, we built a data sample of European Union firms from several industries, that were active in three competitive environments, namely perfect competition, monopolistic competition, and oligopoly, during the 2017 year.

Overall, we show that the adjustments on firm's investment is contingent on the degree of competition they face, leading them do achieve on competitive advantage goals. Results are in line with existing academic research affirmation that the purpose of investments is to create

Original value			Calculated value		
Capex	R&D	Competitive position	Capex	R&D	Competitive position
Perfect competition					
0.723	−0.190	1.255	1.790	1.990	1.892
Monopolistic competition					
2.481	2.360	2.106	1.068	−0.095	2.796
Oligopoly					
0.676	1.738	2.569	1.856	2.030	3.199

Source(s): Table by authors based on data processing results

Table 5. Original and calculated values for Capex, R&D and competitive position

and exploit opportunities for positive economic rents and that investments allow firms to protect from rivals competitive actions, and reinforce the need for investment decision makers to consider the environment in which the firm is competing, in terms of degree of concentration and investment capacity of competitors, when defining the amount of investment that must be done to achieve and maintain a favorable competitive advantage position. These results are in line with the findings of Tsai and Wang (2004), Zuoza and Pilinkienė (2019), Kim *et al.* (2021), Peng *et al.* (2021), and O'Leary *et al.* (2022), who identified a positive effect of firms' investment on competitive advantage, and also with the findings of Miller *et al.* (2005), Tubbs (2007), Ravšelj and Aristovnik (2020), Machokoto *et al.* (2021), who identified that the effects of firm's investment on competitive advantage are contingent on the degree of competition faced by firms, and with the findings of Dias *et al.* (2022), who identified a positive effect of task environment on firm's competitive advantage.

Based on the results obtained by genetic algorithms models processing, it is possible to conclude that firms in the perfect competition environment operate with values below the ideal investment in both Capex and R&D. This investment behavior indicates a tendency to risk avoiding by firms that faces low degree of market concentration and, consequently, higher levels of competition, leading to a less than ideal competitive position of competitive parity. Efforts must be made to increase the competitive capacity of the firms that are aimed in achieving and maintaining market leadership, by increasing investments in Capex and R&D.

The model estimation results for firms in the monopolistic competition environment, point to the need for reduction in both Capex and R&D investments, which means that firms invest above the ideal to increase their competitive advantage. These results could be counterintuitive, but one must consider the negative effect of the degree of market concentration on the competitive position of the firms, leading firms that are not in a competitive advantage position to make investments with the objective of creating barriers to avoid aggressive behavior by powerful firms.

Firms in the oligopoly environment operate with R&D investments close to the ideal, while there is a greater discrepancy in relation to investment in Capex. To face the degree of concentration in the industry and to achieve a favorable competitive position (i. e. competitive advantage), firms must increase their investment in Capex, expanding the capacity of production and creating scale conditions to attend customers and, thus, increasing their market share.

The present study brings relevant theoretical contributions. First, previous studies have approached the effects exerted by firms' investment on performance and competitive position, and also the effects exerted by competitive environment on firms' investment. Therefore, the present study contributes to the theory field by using theories that considerers the interaction between competitive environment and firms' investments, and its relationships with firms' achievement, in terms of competitive position. Second, prior research has focused on the effects exerted by competition on firms' investment decisions and performance. This research extends this theoretical framework when fulfill the existing gap related to the identification of the optimal amount of investment that allows firms to achieve and sustain competitive advantage, considering the degree of concentration and competition in the competitive environment.

The results of the study have relevant implications for executives who decides on firm's investment to achieve a competitive position that is favorable to the firm. They show that the adjustment in the financial resources that should be allocated in R&D activities and Capex must be estimated under a nonlinear perspective instead of a predominantly linear perspective. Another contribution of the research to decision making is that managers should consider the degree of competition the firm face in the competitive environment, when

forecasting the results of the implementation of resources allocation strategies, in conjunction with the firm's capacity of deploying financial resources.

Policy makers should consider the results of the study when defining programs focused on the development of a set of conditions that promotes innovation and allow firms to have access to resources to be allocated and used to achieve and keep a favorable competitive position.

We suggest considering the inclusion of proxies that represents dimensions of firms' sustainability, mainly under the economic, financial and social dimensions, in the model, and the expansion of the time length. This research presents the limitations of using only public traded firms' data to calculate industry concentration measures, and of only considering one year period.

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Machine learning algorithms applied to the estimation of liquidity: the 10-year United States treasury bond

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Abstract

Purpose – Having defined liquidity, the aim is to assess the predictive capacity of its representative variables, so that economic fluctuations may be better understood.

Design/methodology/approach – Conceptual variables that are representative of liquidity will be used to formulate the predictions. The results of various machine learning models will be compared, leading to some reflections on the predictive value of the liquidity variables, with a view to defining their selection.

Findings – The predictive capacity of the model was also found to vary depending on the source of the liquidity, in so far as the data on liquidity within the private sector contributed more than the data on public sector liquidity to the prediction of economic fluctuations. International liquidity was seen as a more diffuse concept, and the standardization of its definition could be the focus of future studies. A benchmarking process was also performed when applying the state-of-the-art machine learning models.

Originality/value – Better understanding of these variables might help us toward a deeper understanding of the operation of financial markets. Liquidity, one of the key financial market variables, is neither well-defined nor standardized in the existing literature, which calls for further study. Hence, the novelty of an applied study employing modern data science techniques can provide a fresh perspective on financial markets.

Keywords Data science, Finance, International markets, Machine learning liquidity, Treasury bond

Paper type Research paper

1. Introduction

The foundation of the present study is the concept of liquidity as a key financial indicator with which to predict the behavior of financial markets.

Liquidity is the flow of capital and credit within the global financial system. A concept that both the Bank for International Settlements and the Federal Reserve System apply, as well as many other financial institutions, as is reflected in the Fed Financial Stability Report. The concept of liquidity is approached in this study, so as to analyze financial stability, to anticipate systemic risk and particularly to analyze capital management among certain private sector investors.

The area of greatest economic significance in relation to liquidity is the central banking community, in which the term "Financial conditions" is also used. This concept is equivalent to the underlying idea behind liquidity. The capability to anticipate financial instability helps policymakers to make decisions on monetary policy, and it is likewise decisive for capital management among certain investors.

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Alessi and Detken (2011) used liquidity as a predictive indicator to study asset prices during boom/bust cycles that can have serious economic consequences. Chen *et al.* (2012) recognized the importance of decision-making and explored the significance of liquidity for the global economy and for policymakers through multiple sets of liquidity indicators.

The researchers attempted to model the global financial cycle in terms of the interaction of monetary policy and financial stability in markets and they emphasized its relevance to central bank interest rate hikes and quantitative easing policies (Miranda-Agrippino and Rey, 2020, May). They also studied the importance of capital inflows and outflows (international liquidity) to manage the implications of the global financial cycle in emerging markets (Jeanne and Sandri, 2020). Bernanke *et al.* (2011) likewise investigated the effects of capital inflows into the United States on U.S. longer-term interest rates.

The objective that is pursued here is to offer predictions of safe asset prices, through the application of data science techniques, in particular machine learning, identifying the models that yield the most promising results. To do so, the 10-year US treasury bond, considered to be the most representative variable within a typical portfolio of safe assets is used. These predictions are advanced using certain proxy variables, which are considered representative of the concept of liquidity. Various machine learning models are compared with stationary and nonstationary variables.

It is not only that these predictions are of intrinsic value, as they may also serve either to support or to refute the notion that liquidity fluctuations are in some way responsible for the fluctuations of other types of assets, specifically the 10-year US treasury bond and, by extension, economic fluctuations. This can help us to benchmark when working on prediction exercises with liquidity variables.

The use of machine learning techniques to guide monetary policymaking is a novelty with growing interest not only from the perspective of central banks themselves but also from the perspective of academia and, to a lesser extent, independent investors (Guerra *et al.*, 2022).

Despite the widespread use of machine learning, Guerra *et al.* (2022) reiterated that the combination of such factors as risk, safe assets, liquidity and the field of artificial intelligence have rarely been studied together, and in even fewer studies models have been used to forecast economic flows through liquidity variables, Galindo and Tamayo (2000) and Abellán and Castellano (2017) have demonstrated the suitability of machine learning algorithms for such tasks.

Authors such as Hellwig (2021) defend the improvement in predictions of complex financial concepts such as liquidity and the different dimensions by which we model it, that machine learning methods *(i.e. random forest or gradient boosted three)* attain compared to other traditional econometric approaches. These improvements in predictions are generally obtained due to the limits present in the machine learning models when fitting the data which allow them to explore relationships of variables with a lower risk of overfitting and the increase in precision that ensemble models tend to achieve by averaging the predictions of other models.

One practical reason for using the 10-year US bond is its global importance as a reference price with which many different assets are linked and valued. According to Goda *et al.* (2013), long-term Treasury yields are used as a proxy of safe assets and the same authors also referred to the strong linkages between the Treasury yield and non-Treasury bond yields.

In summary, the state of the art of the liquidity concept is reviewed in Section 2. The different machine learning techniques and the theory behind the algorithms are treated in the same way. Subsequently and arising from that review, a series of research questions are proposed. In the fourth section, the methodological aspects are explained. In the data analysis section, the indicators that are common to the different algorithms are presented to

facilitate their analysis, discussion and comparison. Finally, the conclusions that respond to the research questions are set out, indicating the implications for management and for investors and institutional decision-making.

2. State of the art

2.1 Liquidity and its different classes

The concept of liquidity has been broadly investigated and discussed, especially since the global financial crisis of 2008. In particular, it has been and continues to be the business and the concern of the BIS and the IMF. Both financial institutions gather extremely useful macroeconomic data from reliable sources through surveys administered to central and commercial banks. The BIS analyzes liquidity from the point of view of financial stability, in order to minimize systemic risk and vulnerabilities. Its methodology is centered on two basic variables: banking assets and currency-based credits to the nonfinancial private sector.

Borio *et al.* (2011) highlighted the ambiguity of the above definition and laid the foundations of both key concepts to arrive at a standardized definition: separate types of liquidity, *i.e.* public or private, and their application within a context of financial stability. From a macro perspective, they presented the empirical characteristics of the financial cycle and the implications for monetary policy. In effect, significant movements of liquidity are associated with systemic banking crises, hence his proposal for the implementation of mechanisms to anticipate these events, lessening financial distress.

Howell (2020) presented one of the most up-to-date analyses of liquidity. The main ideas within this field are the classification of liquidity according to the type of source, the cyclic nature of liquidity, and its implications for financial stability. Its principal contribution emphasized the shadow banks (institutions not subject to banking regulation) and how they affect the whole system, especially through collateralized operations and safe assets. Indicators that seek to capture these operations will be taken into consideration in the analysis that is completed in this paper.

To Bruno and Shin (2015a, b), the modeling of global credit flows to anticipate financial distress is the principal example for any study of international liquidity. The works upon which predictive models are constructed on the basis of banking capital and currency flows are used to study the transmission of liquidity between different countries.

On the other hand, Stanley Druckenmiller (Barrow, 2017) based his investment strategy on the analysis of liquidity. "Earnings don't move the overall market; it's the Federal Reserve Board . . . focus on the central banks and focus on the movement of liquidity . . . Most people in the market are looking for earnings and conventional measures. It's liquidity that moves markets".

Liquidity may be defined as the total quantity of capital and credit existing within the system for use in the real economy (of products and services) and in the financial markets (assets). It is a gross financing concept that represents the overall balance of entities supplying money and credit to the system.

With regard to its source, liquidity may be classified as follows:

(1) Private liquidity or within the private sector (endogenous according to the literature) covers both financial banking and nonbanking (shadow banks, institutions, large investors, *etc.*) sectors, including data on family credit, growth rate in the volume of financial savings/private credit, and interannual change in consultations of personal credit and small firms.

(2) Public (or exogenous) liquidity is associated with governmental institutions relating to the source of official liquidity or the set of tools that the central bank can use, principally reference interest rates and operations on the open market (asset purchase

programs), the monetary base (core of the passive monetary policy of the central issuing bank), money in circulation and credits assigned to commercial banks, among others.

(3) International liquidity or all financial resources available to the monetary authorities of each country that will be used to finance the deficits in their international balance of payments when all the other sources supplying foreign funds are insufficient to ensure a balance in international payments.

There is support in the literature for these dimensions of liquidity, particularly Howell (2020). In it, liquidity was broken down into three sub-components, then explanatory variables were leveraged to explore each one and finally machine learning modeling was applied to the data. The same methodology was also applied, although in a different way, in Hatzius *et al.* (2010), where the exploratory variables were aggregated and a financial conditions index was constructed.

Liquidity constitutes a time series, *i.e.* a set of observations recorded over a particular time span (Brockwell and Davis, 2009). What is now proposed is the prediction of multivariant time series, such as metric variables, that measure the different predicted versions within which we will itemize liquidity based on the ideas discussed in the above-mentioned literature.

The choice of the explanatory variables is endorsed in the literature, and the approach toward the measurement of liquidity, and the division between public and private sector entities is based on the work of Landau (2011). He proposed the separation of public and private factors when analyzing liquidity and the inclusion of both price and balance sheet quantities. Caruana (2013) also raised the inclusion of stock variables (*i.e.* amount of debt outstanding) and flow variables (*i.e.* bank credit growth) in the analysis of liquidity. Chung *et al.* (2014) examined the relationship between financial conditions and the money aggregates. Shin and Shin (2011) explored the link between monetary aggregates and the financial cycle.

Lane and McQuade (2014) suggested the inclusion of an international liquidity component, so as to shed light on financial stability within the domestic financial system. Three determining factors related to liquidity conditions were described in the work of Eickmeier *et al.* (2014): global monetary policy, global credit supply and global credit demand. Finally, Cesa-Bianchi *et al.* (2015) utilized bank-to-bank cross-border credit to examine international liquidity.

Given the above definitions of liquidity, we searched for variables representing different forms of capital and credit. We then proposed monetary aggregates as variables for capital and types of loans as variables for credit. The reference interest rate of monetary policy was used as an explanatory variable, because it is at the most fundamental level the price of money, it influences liquidity, and the economy, and it is under government control.

2.2 Machine learning

Machine learning models perform iterative processes on a dataset (divided into a training and a validation or test dataset) that refers to a specific context (in this case, liquidity). On that basis, predictions of the future values of the dependent variable are advanced (in this case, the 10-year US treasury bond), which are tested and validated with both the training and the validation datasets. The results are compared with a reference or benchmarked model.

2.2.1 Models with nonstationary variables. Nonstationary variables follow temporal trends, as they show no constant average or variance over time. In general, the models with nonstationary variables usually present worse results than the models with stationary variables. Overfitting affects these models more than the models with stationary variables, despite applying methods for its reduction that are recommended in the literature.

Bayesian Ridge Model uses probability distributors rather than point estimates. The output Y is extracted from a probability distribution, instead of its estimation as a unique value. In this way, good functioning is guaranteed even with insufficient or poorly distributed data.

2.2.2 Models with stationary variables. It is far easier to model a stationary than a nonstationary series. Having transformed nonstationary into stationary variables, the differences can be compared with the earlier models. That transformation is applied to the nonstationary variables that are identified with the Augmented Dickey–Fuller tests, operating in the following manner.

If $\boldsymbol{z}$ is a set of differentiated predictions and $\mathbf{Y}$ is the value of the original dependent variable, then

$$Y_{t+1} = Y_t + z^{t+1}$$

$$Y_{t+2} = Y_{t+1} + z^{t+2} = Y_t + z^{t+1} + z^{t+2}$$

The *Orthogonal Matching Pursuit* (OMP) algorithm, as with other "greedy algorithms", constructs a sequential solution $X_0, X_1, X_2, \ldots, X_k$. In this way, it includes an atom that is most closely correlated with the actual residual at each step and, unlike Matching Pursuit, the residual is calculated once again after each iteration using an orthogonal projection within the space of the previously chosen elements. In essence, the algorithm processes all n possibilities to identify a Column, A, that shows the highest correlation with the observations of y in the first step (hence the term "matching"), *i.e.* the best fit of Ax to b. Subsequently, it identifies Column A in each iteration that shows the highest correlation with the actual residual. It therefore seeks the atom with the best fit of Ax to b, on the basis of those selected earlier. In each iteration, the estimation of the vector sign is updated through the most highly correlated column with Column A (Khosravy *et al.*, 2020). The solution at each step is selected in such a way that the new residual is "orthogonal" to all the atoms selected in A.

The *CatBoost Regressor algorithm* is based on the theory behind other algorithms such as Decision Trees and Gradient Boosting. The principal concept of "boosting" involves sequential combinations of multiple models that perform slightly better than random chance. The algorithm is used to create a solid, predictive and competitive model, by applying a "greedy" search (a mathematical process that tests simple solutions to complex problems, through the choice of the subsequent step that provides the most obvious benefit).

In the same way as "gradient boosting" adjusts the decision trees in a sequential manner, the adjusted trees will learn from the errors of the earlier trees and the errors will therefore be minimized. The process continues until the selected loss function can no longer be minimized.

In the growth process of the decision trees, the algorithm produces "unconscious" trees, which means that the trees grow, under the rule that all the nodes at the same level test the same predictor under the same condition. This "unconscious" tree procedure permits simple adjustments and improves computational efficiency, while the structure of the tree operates as a means of regularization to identify an optimal solution and to avoid overfitting (Thiesen, 2020).

The *AdaBoost Regressor Model* has the objective of fitting a sequence of "weak learners" (models that are slightly better than a random estimation) to versions of the data that are repeatedly modified. The predictions of all these "weak learners" are combined through weighted majority voting, *i.e.* a sum in which equal account is taken of the weights, in order to estimate the final predictions.

The data modifications for each "boosting" iteration consist of applying weights $\mathbf{w_1}, \mathbf{w_2}, \ldots, \mathbf{w_n}$ to each training sample. Initially, all these weights are established through $\mathbf{w_i} = 1/\mathbf{n}$, in such a way that a "weak learner" is trained with the initial data in the first step of the

process. The weights of the sample are individually modified for each iteration that is successively performed and the algorithm is once again applied to the newly modified data.

According to this method, the weights attached to the observations of the training sample that are incorrectly predicted are increased, whereas those that are correctly predicted are, on the contrary, decreased. In doing so, far greater influence is attached to those observations that the model can only predict with difficulty as the iterations continue. Each subsequent "weak learner" is therefore obliged to center on the observations that other "weak learners" had mistakenly predicted earlier on (Wang, 2012).

The *Extreme Gradient Boosting Model* (XGBoost) provides computational rapidity and performance levels that are difficult to equal. This algorithm functions in the same way as other models that use the ensemble methods, in which new models are successively generated from a training set to correct the errors of the earlier models, in a similar way to the above-mentioned AdaBoost algorithm.

The concept of Gradient Boosting entails the design of new models that predict the residuals or errors of earlier models, which are then added together to arrive at a final prediction. It is referred to as Gradient Boosting, because it uses a reduced gradient algorithm to minimize the loss function when adding new models (Brownlee, 2016a).

Extremely Randomized Trees Model (ET) uses an ensemble decision tree method that usually yields better results than those based on simple decision trees.

The Extremely Randomized Trees or Extra Trees (ET) algorithm generates a large number of unpruned decision trees (without removing small-sized branches), based on the training dataset data, fitting each decision tree to the complete training dataset.

In summary, the principal differences that this algorithm has over other decision tree ensembles are as follows: the use of the whole training dataset (instead of a bootstrap replica) to start the growth of the trees as mentioned earlier; the other difference is that ET divides the nodes, randomly selecting the cutoff points (Geurts *et al.*, 2006). At each cutoff point, the algorithm activates a random selection of the different features.

The predictions advanced in a regression problem are prepared through the average of all the decision trees, while a majority voting method among the different decision trees is used for the classification problems (Geurts *et al.*, 2006). In the case of regression, these averages are used to improve the predictions and to check for overfitting.

The choice of this algorithm for the completion of the model was due to the problems with overfitting observed when using the other models, because the random selection of the cutoff points meant fewer correlations between the decision trees (although this random selection increased the variance of the algorithm, increasing the number of trees used in the ensemble can counteract that effect) and the level of overfitting may therefore be reduced in comparison with the levels of other models.

The *Random Forest* (RF) algorithm is a decision tree ensemble method similar to ET. Both are very similar algorithms composed of a large number of decision trees that will influence the final prediction.

The main differences are, on the one hand, that subsamples generated with the bootstrapping method are used in Random Forest, *i.e.* a resampling technique that generates datasets by continuously repeating the sampling of the available data (James *et al.*, 2013). In contrast, the overall sample is used in the et algorithm. On the other hand, the cutoff points were established in the most optimum form in Random Forest, unlike ET in which a higher randomness component was added to its decision-making.

The above-mentioned greedy algorithms have not been widely discussed in the literature on similar liquidity problems, so we wish to delve further into their performance in this area of study. On the other hand, there is ample support for the suitability of both decision tree algorithms and ensemble methods (Galindo and Tamayo, 2000; Abellán and Castellano, 2017; Sahin, 2020), which perform better than conventional approaches and other machine learning

algorithms applied to liquidity-related classification and prediction problems (Guerra *et al.*, 2022).

2.2.3 Models used with both types of variables. The Voting Model consists of combining different sorts of automatic learning algorithms and generating final predictions, through an estimator consensus method (average probabilities when processing a regression problem). The results are intended to yield separate improvements to the predictions of the original method. The aim is therefore to improve the predictions of certain individual models through their combination and by averaging their values.

3. Research questions

The importance is evident in both the concept of liquidity and the differentiation of types of liquidity. A variety of indicators are used to measure the different types. Besides, automatic learning offers a broad range of possibilities to make predictions, for which reason the general objective is to predict liquidity through different machine learning algorithms, comparing the results that are provided, in order to identify the best models. In this case, the price of the 10-year US treasury bond is taken as a reference and the following research questions are proposed:

RQ1. Will the estimation of the price of the 10-year US treasury bond with machine learning models improve upon the estimations of traditional models?

RQ2. Will the best predictions of the 10-year US treasury bond be dependent upon predictions with either stationary or nonstationary variables?

RQ3. Which machine learning algorithms will yield better estimations of the 10-year US treasury bond?

RQ4. Which voting models will improve upon the estimations of other models?

RQ5. Which models will present more problems of overlearning in their predictions?

RQ6. Which variables will determine more than any others the price of the 10-year US treasury bond? Will the private, the public or the international liquidity variables be the most decisive?

4. Methodological aspects

4.1 Variables and data sources

The dependent variable is the price of the 10-year US treasury bond. It is the most widely tracked debt indicator and price instrument in the field of financing, being used as a reference benchmark to calculate different values. It is usually perceived as the "safe" asset by antonomasia, attracting large quantities of liquidity especially during times of crisis and uncertainty, in what are referred to as safe havens (Zucchi, 2021).

The contents described in Tables 1–3 were used as the independent variables of private, public and international liquidity. In Table 1, the variables used to describe money and credit circulating between private agents are described. In Table 2, the variables used to describe money and credit circulating between public agents are described and likewise, in Table 3, the variables used to describe money and credit circulating between international agents are described.

In Table 4, the variables used to describe different financial markets (bond market, foreign exchange market, developed economies stock market and emerging economies stock markets) are described. Quantity and price (market-dependent prices or rates) indicators are used.

Variable	Notation in graphs	Definition
Total consumer credit & Change in the total consumer credit	Total_ConsumerCredit & Change_Total_ ConsumerCredit	Total consumer credit in property and securitized, nonstationary flows
Total monetary base (M_0)	Total_Monetary_Base	Total quantity of money (in this case, the US Dollar) that is in general circulation in the hands of the public or in the form of commercial banking deposits maintained in the US central banking reserve (M_0)
M_1 for the USA	M1_USA	Monetary aggregate resulting from the sum of i) money in circulation in USD; ii) private sector deposits at commercial banks and iii) other liquid and savings deposits
M_2 for the USA	M2_USA	Monetary aggregate resulting from the sum of i) M_1 aggregate; ii) savings deposits (<100K) in commercial banks and iii) liquid funds from the money market
M_3 for the USA	M3_USA	Monetary aggregate resulting from the sum of i) M_2 aggregate and ii) savings deposits (>100K) in commercial banks
Private credit for the USA	Private_Credit_USA	Total credit (banking and nonbanking) to the nonfinancial private sector for the USA
M1 for the EU	M1_EU	Monetary aggregate resulting from the sum of i) money in circulation in Euros; ii) private sector deposits held in commercial banks and ii) other liquid and savings deposits
M_2 for the EU	M2_EU	Monetary aggregate resulting from the sum of i) M_1 aggregate; ii) savings deposits (<100K) at commercial banks and iii) liquid funds from the money market
M_3 for the EU	M3_EU	Monetary aggregate resulting from the sum of i) M_2 aggregate and ii) savings deposits (>100K) at commercial banks
Private credit for the EU	Private_Credit_EU	Total credit (banking and nonbanking) to the private sector for the Eurozone

Table 1.
List of variables relating to private liquidity

Note(s): In all cases, on a monthly basis. Data preprocessing converted the quarterly variables into monthly figures
Source(s): Table by authors

Variable	Notation in graphs	Definition
Bank credit of US commercial banks	Bank_Credit_ Comercial_Banks	Credit in the (asset) balance of US commercial banks
Currency in circulation in the USA	Currency_in_ Circulation_USA	Physical amount of money (Dollars) in circulation within the monetary system of the USA
Deposits in US commercial banks	Deposits_ Commercial_Banks_ USA	Consumer deposits held at US commercial banks
Federal fund rate	FEDFUNDS_%	The federal fund rate is the reference interest rate for the implementation of monetary policy
Reference rate of the ECB (European Central Bank)	Reference_Rate_BCE	The rate that commercial banks and financial institutions receive for placing short-term investments with the ECB

Table 2.
List of variables relating to public liquidity

Source(s): Table by authors

4.2 Data preprocessing

The data were limited to between January 1, 2000 and December 1, 2020, although 2019 and 2020 were reserved to make predictions with "unknown" future dates.

Python was used for the processing work. In order to palliate the effect of outliers 2.5% of the values on each side of the tail of the distribution were removed.

Interpolation was used to standardize the quarterly data on a single monthly timescale. To do so, the Python programming language was used to establish the date (frequency in quarters in this case) as the data frame index. We then applied the resample function of the Pandas package to change the frequency to monthly, and we filled in the NA values (or missing data) obtained through the interpolation function of the same package, using a linear method. Finally, the data was converted into a column instead of an index format, so that the data could be merged with the other Pandas DataFrames.

The daily frequency data in the case of the "European Central Bank reference rate" variable were added in months using the average interest rate of that variable throughout the month.

It is necessary to analyze the specific characteristics of the series referring to autocorrelation: seasonality and stationarity (Chhugani, 2020). A moving average was applied, in order to analyze these tendencies with a temporal window of 12 months, within which the rolling average was calculated, and exponential softening was also applied, the results of which are shown in Figure 1.

The US bond, as may be observed, followed a descending trend. The Augmented Dickey–Fuller test was applied to each variable to test for stationarity. The transformation of the first difference was applied to the nonstationary variables (the preceding observation was

Variable	Notation in graphs	Definition
Global liquidity	Global_ Liquidity(%)	BIS Indicators of global liquidity. Index composed of two indicators: a) international banking assets, essentially bank loans throughout the work, both from other banks and firms and consumers and b) credit to firms and consumers by denomination of currency (USD, EUR, JPY)
DXY index	DXY_Index	DXY (US Dollar) index v. a basket of currencies (EURO, YEN, POUND STERLING, *etc.*). The DXY is a weighted geometric measure

Note(s): Monthly frequency except for the global liquidity indicators that were presented quarterly and were preprocessed for the monthly figures
Source(s): Table by authors

Table 3.
List of variables relating to international liquidity

Variable	Notation in graphs	Definition
Price of the 10-year German bond	Price_Bond_German _10Y	10-year German government bond
Exchange rate Euro against Dollar	Variation_EU_VS_USD	Rate of variation of exchange rate with regard to the US Dollar
Rate of variation of S&P 500	Variation_SP_500	Rate of variation of the US S&P 500 share index
Closing price of the VEIEX	Closing_Price_ VEIEX	Vanguard Emerging Markets Stock Index Fund Investor Shares (VEIEX), monthly prices of the index of emerging economy shares

Source(s): Table by authors

Table 4.
List of variables relating to financial markets used as predictors

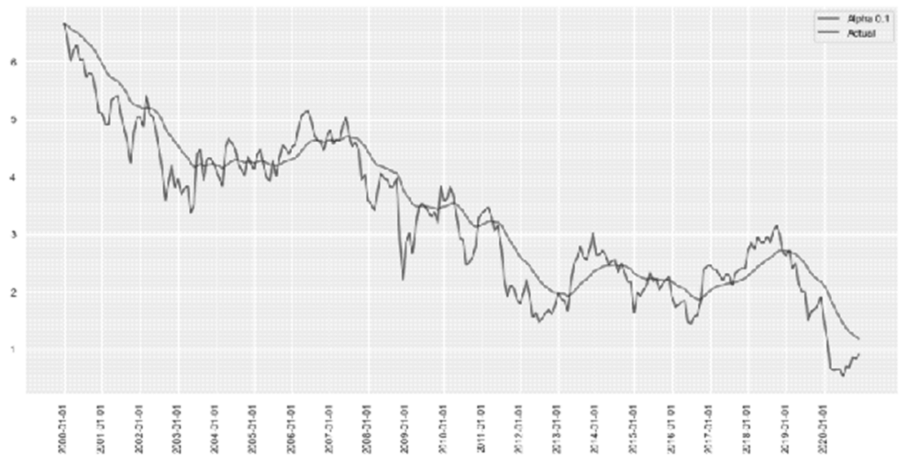

Figure 1.
Softened exponential of the dependent variable

Source(s): Figure by authors

subtracted from the current observation over time) converting all the variables that were not stationary into stationary variables, as shown in Figure 2. Having obtained the predictions of the model, this transformation was reversed for proper interpretation of the results.

4.3 Modeling

(1) *Data selection.* The observations from 2019 to 2020 were set aside to make predictions. Although the extraordinary circumstances of 2020, due to COVID-19, complicated the predictions, the training dataset extended from January 2000 until December 2011, while the validation or test dataset extended from January 2012 until December 2018.

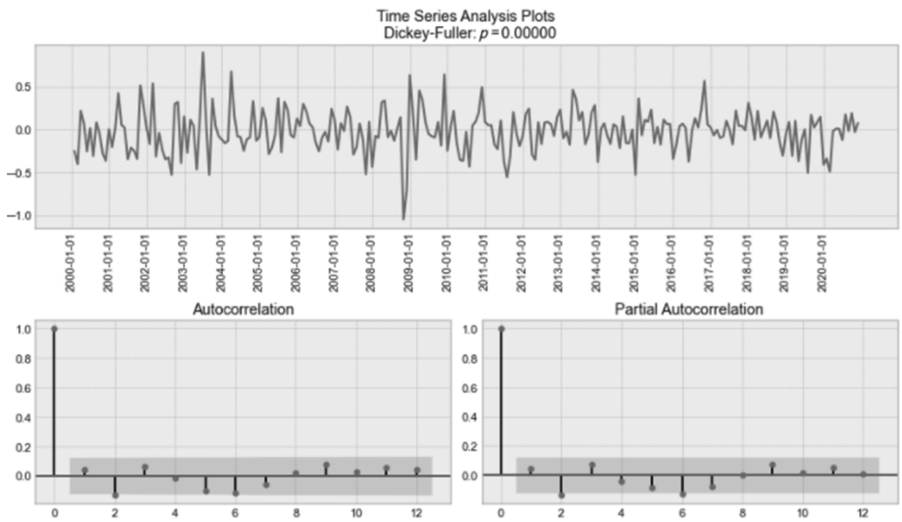

Figure 2.
Dickey–Fuller test, autocorrelation and partial autocorrelation of the dependent variable with transformation of the first differences

Source(s): Figure by authors

(2) *Cross-validation* strategy. The time series cross-validator, a variation of the k-fold, was used. It returns the first **k**-folds within the **k** subsample as a training set and the **k-fold + 1** as the validation dataset. The successive training datasets are supersets of the previous datasets. In this way, problems of data leakage and overfitting are avoided. Data leakage occurs when the data used to train an algorithm hold the information that the algorithm is attempting to predict (Gutierrez, 2014), in other words, when the model is trained with data that it is meant to predict and that should not be available to it. Overfitting occurs when the model memorizes the noise or the random fluctuations in the training data, which implies a negative impact when generalizing (Brownlee, 2016b). After different tests, it was concluded that the ideal number of folds was $\mathbf{k} = 10$.

(3) Normalization. The most widely used option in the literature for the normalization of temporal series, minmax, was applied.

(4) Multicollinearity. There is no reason for high correlations to affect the model in a negative way. Although some indications pointed to the liquidity-related variables as a factor in the price variations of the assets that were considered to be safe, the predictions were based on correlations rather than causality. Underlying causes (liquidity) within the financial markets for the variation in the price of safe assets can be intuitively guessed.

In general, a threshold is established to avoid multicollinearity, according to which if the correlation between two variables is higher or equal to a particular value, one of them is removed to minimize problems.

(1) Evaluation of the models. The goodness of the model predictions is usually evaluated through a comparison with a series of base models (linear regression), rather than with metrics that are dependent on such scales as the Root Mean Square Error (RMSE) and the Measure of Absolute Percentage Error (MAPE). It could therefore be verified that the most complex models contributed greater value to the predictions than the simpler and more easily interpretable metrics such as MAPE, mentioned above, and the Mean Absolute Error (MAE).

5. Data analysis

The results were expressed with standard measurement metrics, in order to compare the different algorithms, following the same evaluation process for each algorithm. The individual performance of each model is graphically represented for a clearer understanding, commenting on the differences between the selected metrics, the adjustments of the models and, in certain cases, the distribution of errors to study the aforementioned adjustments. The set of results of the models with both stationary and nonstationary variables are summarized and compared in Table 6.

Two linear regression models were prepared with the previously explained predictors. Their hyperparameters were adjusted through a Random Grid Search, which was the benchmark with which other more advanced models were compared. One with nonstationary variables and another with variables converted into stationary values. Metrics were obtained from the stationary model that improved upon those of the nonstationary model, as can be observed in Table 5.

A variety of machine learning models with different regression algorithms were applied. The R^2 statistic, considered of little or no use in the literature (Dunn, 2021) in the context of prediction-centered automated learning, was not applied. Instead, metrics that were not

dependent on the scale were principally used, in this case RMSE. The models whose metrics improved upon the pre-established base models may be highlighted.

5.1 Models with nonstationary variables

The *Bayesian Ridge Model* yielded the best results when using the initial variables: MAE = 0.2751, RMSE = 0.3338 and MAPE = 0.0783. It was the only one of its type that improved upon the base linear regression model that had been proposed.

This model also improved upon the MSE/RMSE obtained with a persistence model (MSE = 0.167, RMSE = 0.4086) that predicted the price of the 10-year US treasury bond at t+1 through the value of **t (**Figure 3). This particular model therefore contributed value with respect to the two naïve models, thereby ensuring that work with temporal series was not merely a random walk.

The results of the *Voting Model* were very similar. They yielded slightly lower results: MAE = 0.2781, RMSE = 0.3386 and MAPE = 0.0782 (Figure 4). Nonetheless, the overfitting of these models is easily appreciated.

5.2 Models with stationary variables

The results of the base reference model were improved through the use of various algorithms. The metrics of the stationary models are shown in detail in Table 6.

The *OMP Model* is among those that yielded the best results, improving on the base Linear Regression model and most of the other models (Figure 5). After the changes

Table 5. Characteristics of the linear regression models

	MAE		RMSE		MAPE	
Variables	Mean	SD	Mean	SD	Mean	SD
Nonstationary	0.3451	0.1482	0.4018	0.1615	0.0866	0.0363
Stationary	0.3116	0.2323	0.3816	0.3816	5.3768	9.4791

Source(s): Table by authors

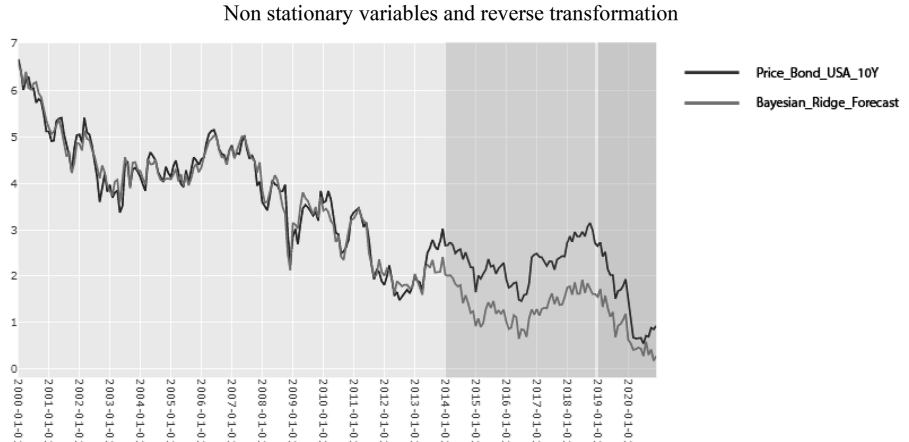

Figure 3. Bayesian Ridge model applying nonstationary and reverse transformation variables

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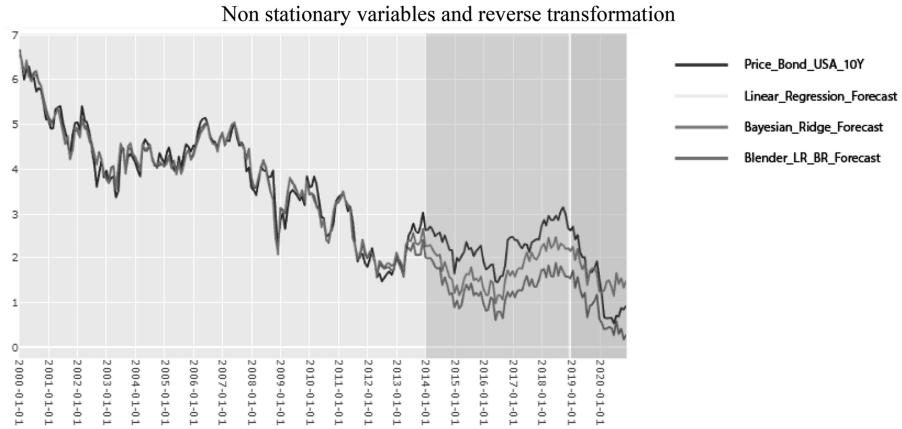

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Figure 4.
Comparison of models applying nonstationary variables and reverse transformation

Model	RMSE	MAE	MAPE	Variables	Overfitting
Second Voting (OMP/RF/ET)	0.1715	0.1312	1.4816	Stationary	No
First Voting (OMP/CatBoost/AdaBoost/ XGBoost)	0.1759	0.1360	1.3781	Stationary	Yes
ET	0.1782	0.1358	1.3479	Stationary	No
OMP	0.1786	0.1418	1.558	Stationary	No
Random Forest	0.1858	0.1464	1.5869	Stationary	No
CatBoost	0.1860	0.1456	1.5149	Stationary	Yes
Adaboost	0.1889	0.1499	1.6574	Stationary	Yes
XGBoost	0.1899	0.1509	1.4860	Stationary	Yes
Voting (BR/RL)	0.3336	0.2781	0.0782	Nonstationary	Yes
Bayesian Ridge	0.3338	0.2751	0.0783	Nonstationary	Yes
Stationary Base Linear Regression	0.3816	0.3116	5.3768	Stationary	No
Non-Stationary Base Linear Regression	0.4018	0.3451	0.0866	Nonstationary	No

Source(s): Table by authors

Table 6.
Metrics obtained by each model ordered from lowest to highest RMSE

introduced to reduce overfitting, the most relevant predictors for the dependent variable were the interbank interest rate of the US Federal Reserve (FedFunds), the reference interest rate of the BCE, the price of the German government bond and, finally, the variation of the Euro with respect to the Dollar.

The *CatBoost Model* performance was not poor overall, although it was seriously affected by overfitting, as often happens with "greedy algorithm" based models. Despite having taken this factor into account and having taken the necessary measures, the R^2 values of the training and the test dataset were 0.934 and 0.501, respectively, which points to a large gap; the sign of an overfitted model (Figures 6 and 7).

The most important features of the CatBoost model were as follows: M_1 monetary aggregate of both the European Union and the US, the price of the German government bond, the closing price of VEIEX, the variation of the Euro with respect to the Dollar, the total of the monetary base, the change of consumer credit, the S&P 500 price and private European credit.

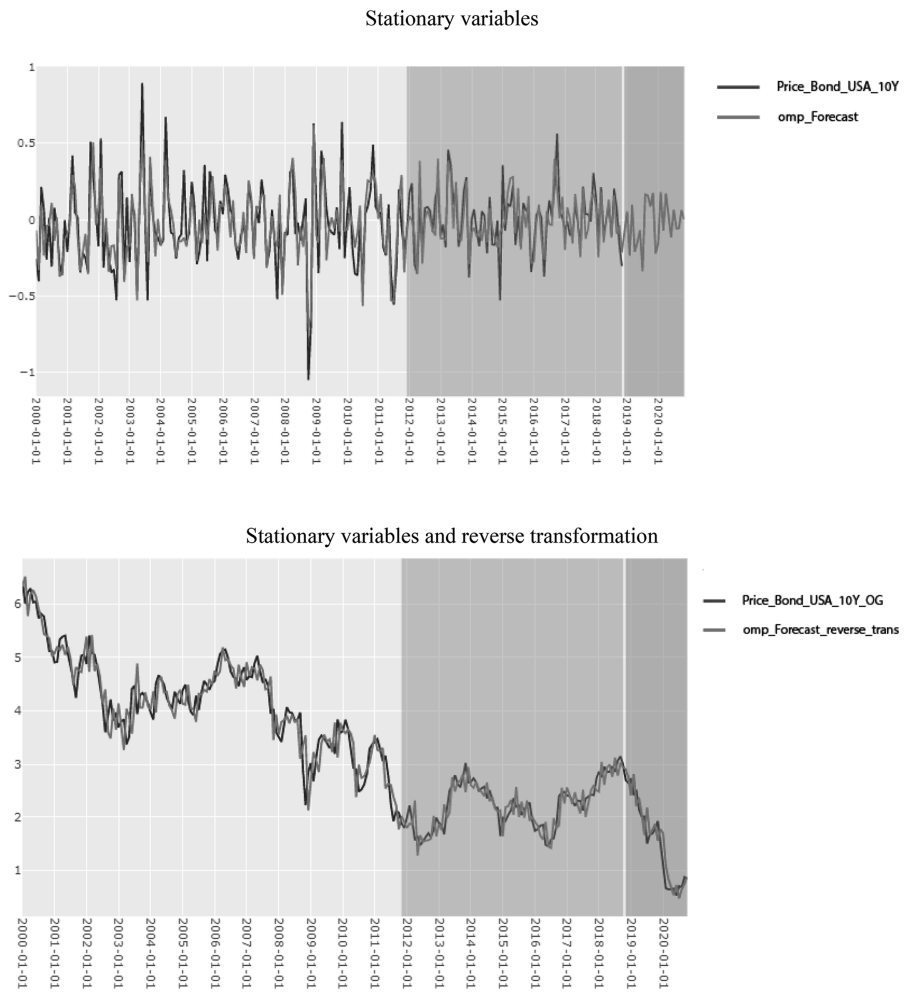

Figure 5.
OMP model

Source(s): Figure by authors

The most influential independent variables of *AdaBoost Model* were as follows: the price of the German government bond (which is the norm for the majority of models), followed by the M_1 monetary aggregate of the European Union, the variable year, the variation of the Euro with regard to the Dollar, the closing price of the VEIEX, private US and European credit and, finally, the total monetary base.

When we look at the distribution of the residuals of this model, a certain degree of overfitting can be seen. The R^2 squared of the training dataset was 0.862 while that of the test dataset was 0.468 (Figure 8).

The metrics obtained with the *XGBoost* model were as follows: MAE = 0.1509, RMSE = 0.1899 and MAPE = 1.4860 (Figure 9).

The results of the Feature importance model measured the degree to which one variable influenced the results based on the predictions of a particular model (Oh, 2019). We can see

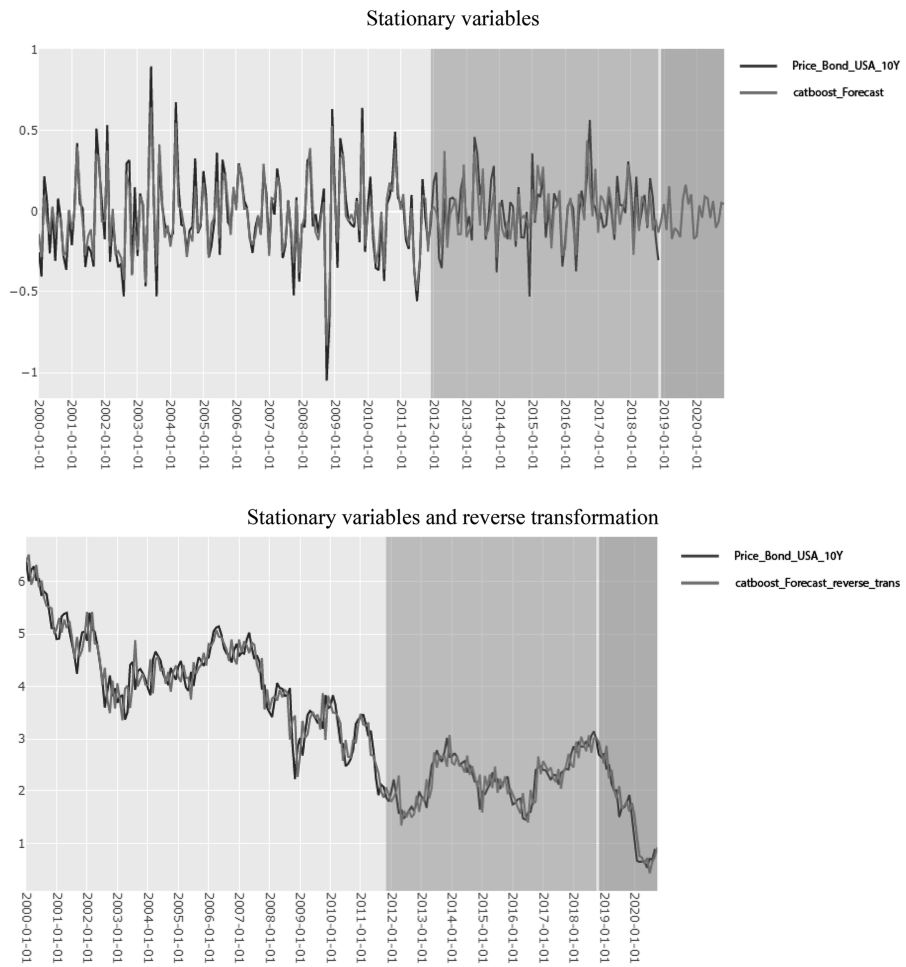

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Figure 6.
CatBoost model

that the most relevant variables were the credit of all commercial banks, the price of the 10-year German bond and the closing price of the VEIEX. Followed to a lesser degree, but even so with a notable influence, the variables M1 EU and Total Monetary Base.

The overfitting was high in this model, obtaining an R^2 in the training and in the test datasets of 0.869 and 0.485, respectively.

The *ET Model* presented very good results, better than those of the base Linear Regression model and the majority of the other models that were prepared (Figure 10).

With regard to overfitting, the principal reason for the selection of this algorithm was understood to be somewhat less than in other models that were prepared. The R^2 of the training dataset was 0.613, while the test dataset had an R^2 of 0.543, which is an acceptable difference.

The predictions of this model were principally influenced by the price of the 10-year German government bond and private credit, both in the EU and in the USA.

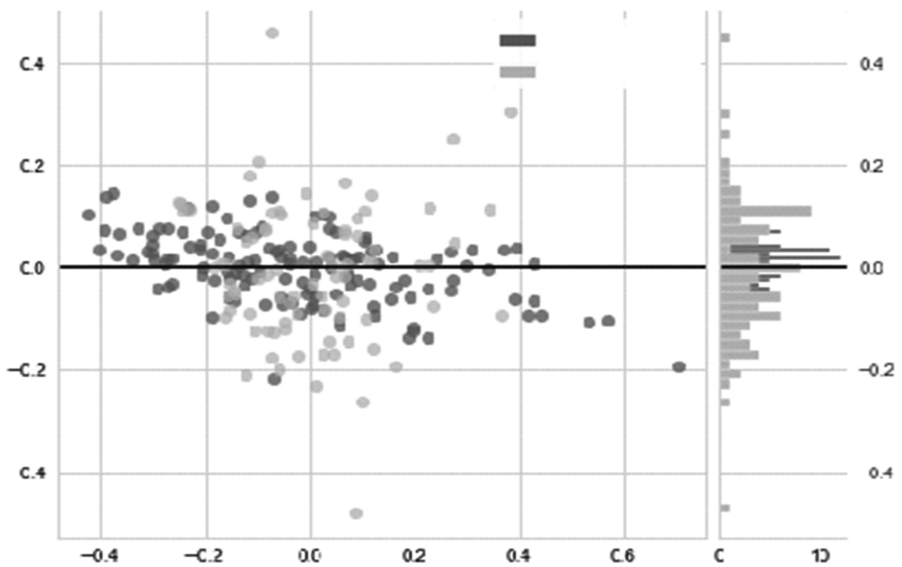

Figure 7.
Distribution of residuals in the CatBoost model with stationary variables

Source(s): Figure by authors

The results of the *Random Forest Model* were somewhat less accurate than the results of ET: Likewise, the computing time was shorter (Figure 11).

Random Forest presented no overlearning problems, with R^2 values for the training and for the test datasets of 0.583 and 0.517, respectively.

The independent variable which had markedly greater importance when making predictions for this model was once again the 10-year German bond, followed to a lesser extent by the total monetary base, the variable FedFunds and private credit both in Europe and the USA.

Two voting models were developed that yielded some of the best results this time with the stationary variables.

The first model in which OMP–CatBoost–AdaBoost–XGBoost were combined and that generated new predictions through consensus between estimators (majority voting average probabilities). The metrics resulting from this combination were very encouraging.

The voting model yielded: MAE = 0.1360, RMSE = 0.1759 and MAPE = 1.3781 (Figure 12).

The second voting model included those models that not only improved the base model but also presented less overfitting: OMP–Random Forest–Extra Trees.

The metrics of this new model yielded the best results of the study: MAE = 0.1312, RMSE = 0.1715 and MAPE = 1.4816.

The principal objective of this latter model was to improve the metrics that had previously been obtained without committing the error of increasing the overfitting. This objective was satisfactorily achieved through the design of the voting model. The R^2 values of the training and the test datasets were 0.647 and 0.552, respectively, revealing a difference of only 0.095, which can be attributed to what is known as the generalization gap.

6. Analysis and discussion of the results

According to the results of each algorithm and the metrics with which they are comparable, we now focus on Table 6, which summarizes the indicators of the models, among which the

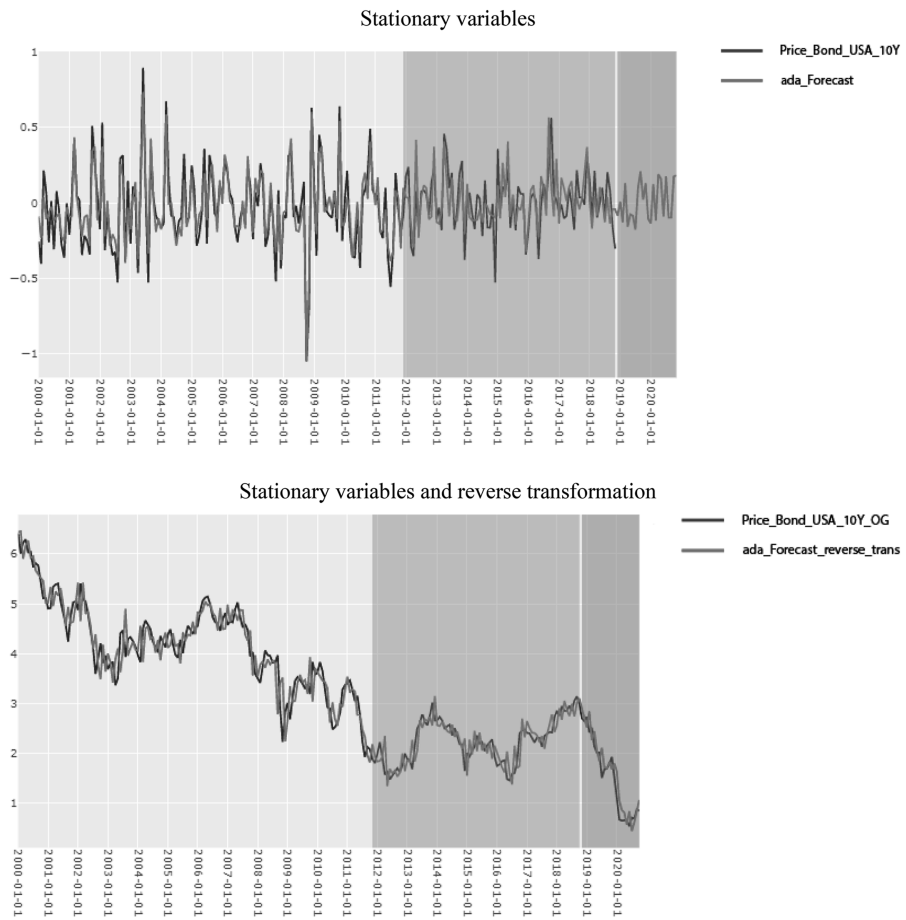

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Figure 8.
AdaBoost model

RMSE may be highlighted to consider the goodness of fit of these models and whether there is a considerable presence of overfitting in the model.

The low performance of the models with nonstationary variables is evident (in accordance with the literature), showing problems of overfitting and the worst metrics among all the models. Only the Bayesian Ridge and the Voting model, prepared with a linear regression model and the earlier Bayesian Ridge model, managed to overcome the benchmark model with stationary variables among all the models that were tested.

The machine learning models based on stationary variables presented better RMSE values, as well as the other metrics under observation.

The CatBoost, AdaBoost and XGBoost models and the first voting model, prepared with the OMP, CatBoost, AdaBoost and XGBoost models, presented strong overfitting that represents a major limitation, despite their exceptional results.

On the other hand, the OMP, RF and ET models, and the second voting model (prepared with those three models) yielded exceptional RMSE values of 0.1786, 0.1858, 0.1782 and

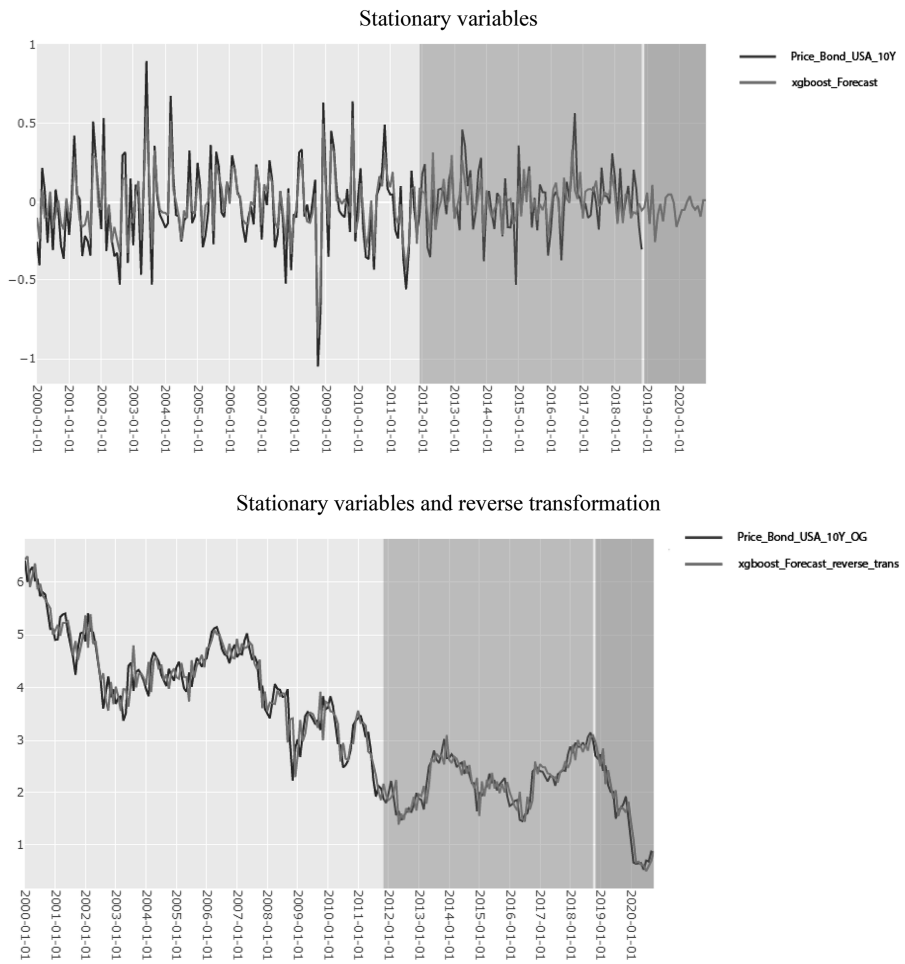

Figure 9.
XGBoost model with stationary variables

Source(s): Figure by authors

0.1715, respectively. The presence of overfitting in each of these models was disregarded, so it was concluded that these four machine learning models with stationary variables yielded the best results. The second voting model with stationary variables was the one that yielded the best metrics, followed by the ET, the OMP and, finally, the RF models.

It must be noted that some variables were removed from some of the models, either because they only contributed to background noise or because their removal alleviated overfitting, helping to determine which variables had been the most important in the models.

The variable that had the most obvious relevance when predicting the dependent variable was the price of the 10-year German government bond, as its nature and behavior were very similar to the dependent variable, with which it showed a very high correlation (0.89). This correlation points to the presence of multicollinearity, although the value of 0.89 was below the threshold that is usually employed in the literature of 0.9.

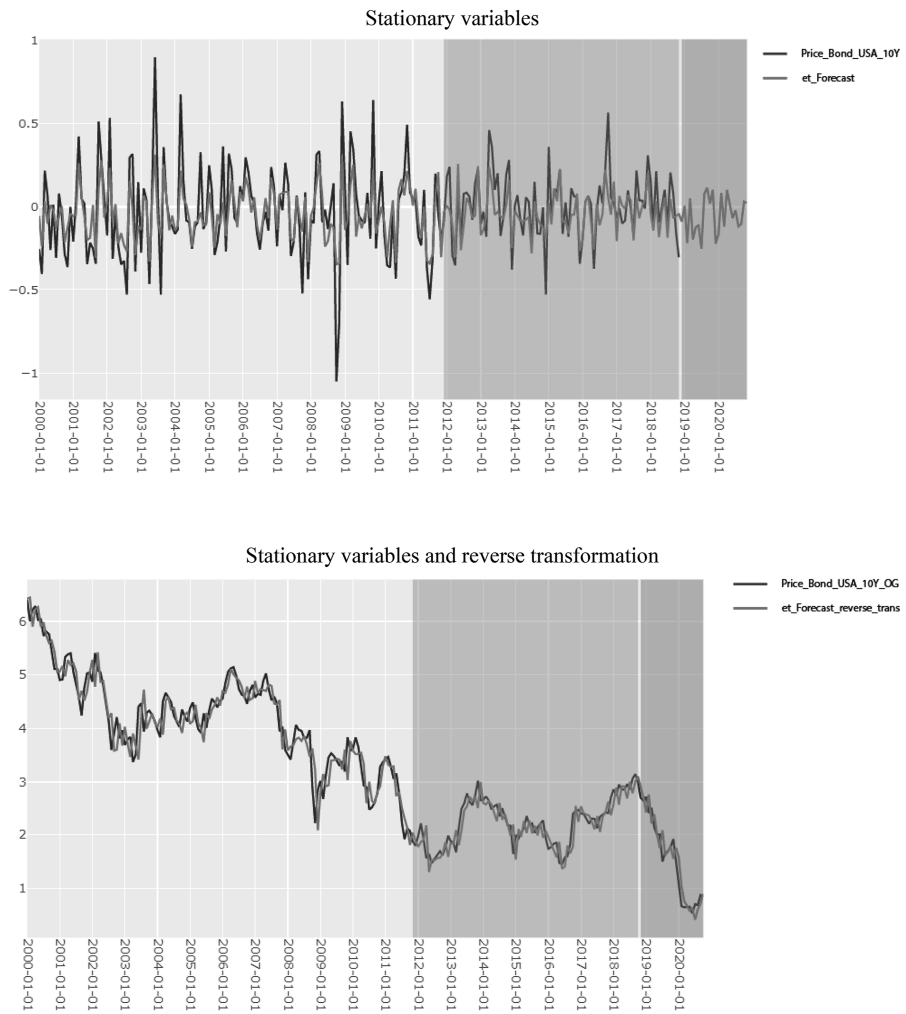

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Figure 10.
ET model

When testing other models in which this threshold was lower, there were significant losses of predictive capability. Maintaining the aforementioned variable, which to a great extent helped to predict the price of the US bond, when considering these circumstances, was therefore recommendable.

The representative variables of public liquidity had no high impact on the models. Among the variables of this group, the reference interest rate of the Central European Bank and the FedFunds (Federal Funds Rate) variables stood out most of all, having a relative relevance in models such as Random Forest, XGBoost and OMP.

The representative variables of private liquidity were the variables that more than any others helped the predictions of the different models (second only to the safe assets used as predictors). The variables of this group that may be highlighted because of their importance

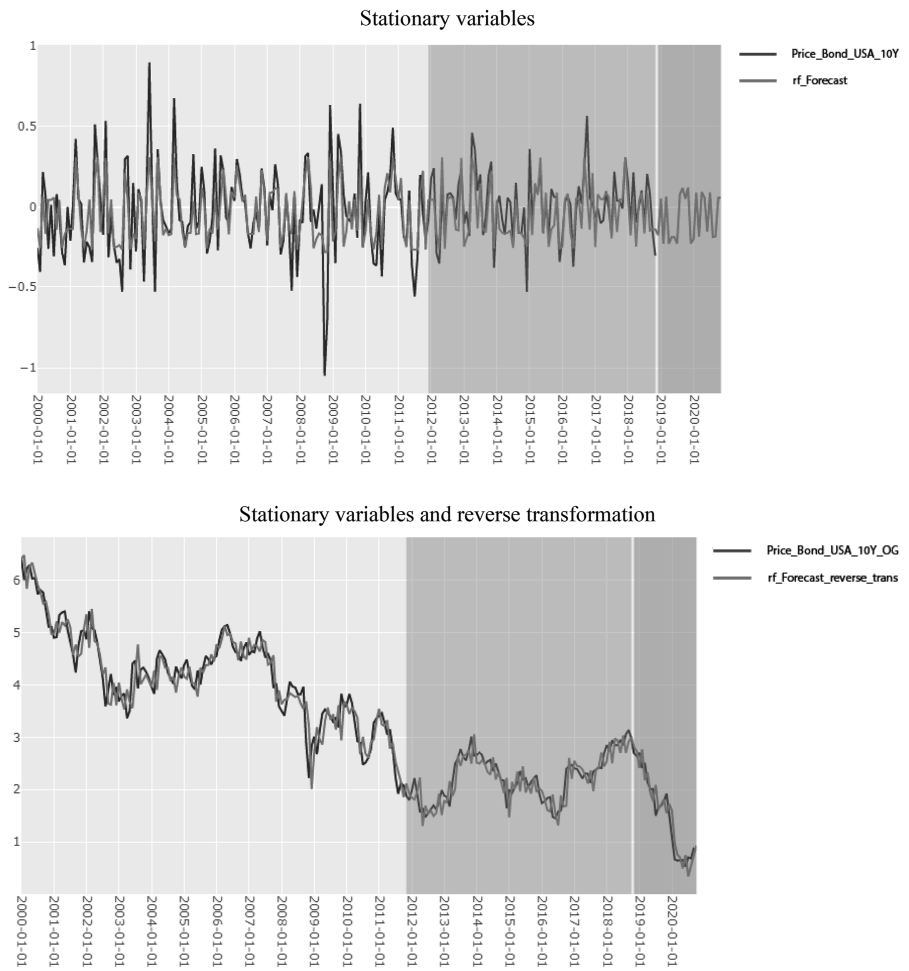

Figure 11.
Random forest model

Source(s): Figure by authors

were principally the M_1 monetary aggregate (for Europe and the USA), the M_0 monetary aggregate and the total monetary base (for the USA), closely followed by credit to the private nonfinancial sector (for Europe and the USA) and, to a lesser extent, the percentile change in consumer credit.

International liquidity is, outstandingly, the type of liquidity with the vaguest of definitions and it is especially difficult to measure with precision, consequently, the majority of its representative variables have been converted into background noise in the models. In the feature selection step, both the index of global liquidity prepared with BIS indicators and the DXY indicator of the Dollar versus the basket of currencies (the variables employed as proxies of international liquidity) were removed from the majority of the models. In general, it contributed to noise and could have generated overfitting in the models that maintained it.

The price of the 10-year German bond was not the only variable to have substantial influence on the results of the models. Other variables grouped as safe assets and used as

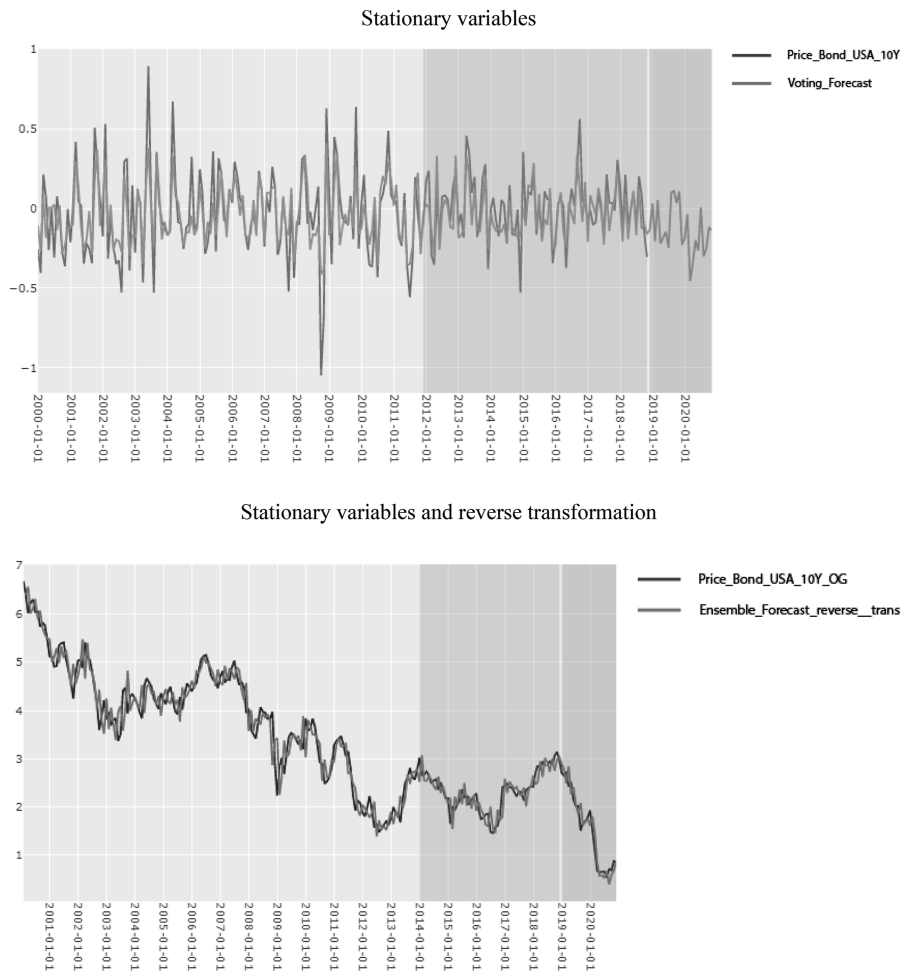

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Figure 12.
First voting model

predictors also turned out to be useful for predicting the dependent variable, especially the variation of the Euro with regard to the Dollar, followed by the closing price of the VEIEX and to a lesser degree the variation of the S&P 500.

7. Conclusions, recommendations and limitations

On the basis of the above discussion, the following conclusions can now be presented.

The two models that yielded the best results, both in terms of their RMSE and their quality of fit, were based on decision tree algorithms: the Extra Trees model and the Random Forest model. There was also one model based on the OMP greedy algorithm. (All three models employed variables that had been converted into stationary variables following their transformation into the first difference in the natural log.) These models yielded better results

than both the traditional regression base models and the nonstationary variables, as we can see in Table 6, thereby responding to research questions Q_1 and Q_2.

A series of new predictions were generated using a combination of these three best-performing models in an ensemble (second voting model with stationary variables), predictions that were better than the other results obtained in this study, with an RMSE of 0.1715. On average, their predictions of 10-year US bond prices over 2019 and 2020 only deviated 0.1715 from the real price (a deviation expressed in the same units used for the bond); results which are responses to Q_3 and Q_4.

In line with the theoretical predictions, the models with nonstationary variables presented clear overfitting as previously mentioned. Regarding the stationary models, those based on boosting and greedy algorithms presented overlearning in each case, except for the one running the OMP algorithm. Tree-based models were the best performers in this regard, especially the ET model, which was specifically selected for this specific reason as supported by the theory presented in Section 2 (State of the Art).

The second ensemble comprising OMP, ET and Random Forest models showed no overfitting either, obtaining quality results in that regard. However, the first voting model, made up of the boosting and greedy algorithm models mentioned above, presented serious overlearning problems. An expected result, considering that the models with which it was configured also presented this problem, together with the fact that the voting approach makes the models more robust, although it can also contribute to increasing the difference between the proportion of variance explained between the training set and the test set, thereby contributing to overfitting (Q_5).

Likewise, the second voting model presented fewer overlearning problems, while the nonstationary variables suffered more from this problem (Q_5).

In response to Q_6, the variables that contributed most to the formulation of the bond price predictions were the price of the 10-year German government bond, the closing price of the VEIEX, and the M_0 and M_1 monetary aggregates. The variables that represent the value of other assets considered as safe and assets that represent private liquidity have been the most useful for the preparation of the models. While the public liquidity variables that were defined contributed to a lower number of models, they nevertheless did so in a significative manner (FedFunds and reference interest rate of the BCE). In general, they generated inconvenient levels of noise when training the models, although far less so than the variables of international liquidity.

Regarding the recommendations derived from the analysis of liquidity metrics, first, the importance of tracking private liquidity metrics such as banking credit and monetary aggregates was clear, given that when those indexes descended, clear upward trends of the price of the US bonds were observed, and *vice versa*.

Likewise, the tracking of public liquidity, given that there was a strong increase in the prices of risk assets when they increased in a significative way and *vice versa* when they fell. One important fall of the FedFunds predicted future price rises of the S&P 500 index.

Theoretical implications with regard to international liquidity are focused on the need to develop variables that reflect this category of liquidity more precisely. It is one of the most difficult challenges for researchers, due to the vast breadth of this conceptual dimension, as well as its diffuse and mutable definition.

The monitoring of liquidity could facilitate the identification of systemic risks within the financial system and the consequences of economic activity, as it has already been of assistance to policymakers. In an earlier initiative, the Federal Reserve of the US (https://www.boj.or.jp/en/research/brp/fsr/index.htm) and the Bank of Japan (https://www.boj.or.jp/en/research/brp/fsr/index.htm) began to publish their respective Financial Stability Reports. The methodology followed by the Federal Reserve of the US for the monitoring of financial stability may be found in Adrian *et al.* (2015).

Our study differs, insofar as it approaches the same concept of liquidity/financial stability from a proactive viewpoint rather than from a reactive one. The predictability of the existing forecasting models could be heightened, by selecting liquidity and the corresponding key variables as the leading indicators for forecasting changes to economic cycles.

The limitations arise from the inclusion of a series of variables of little utility when advancing predictions on the dependent variable. This increase in the number of futures only caused overfitting of the model, in particular, in relation to some international and public liquidity variables.

The correlation between US bond and German bond gave rise to problems of multicollinearity, though it never passed the established threshold in normal use. Although, they never affected the predictions.

The singular events arise from the interruption of COVID-19 in 2020, adding a major difficulty to the production of accurate predictions for that year.

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Impact of social media influencers on consumers' well-being and purchase intention: a TikTok perspective

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Abstract

Purpose – Extending the elaboration likelihood model (ELM), this study investigates the impact of social media influencers (SMI) on consumer well-being (CW) as well as the influence of CW on purchase intention.
Design/methodology/approach – A between-subjects experiment (macro- vs mega-influencer) was conducted to assess the proposed hypotheses. A total of 190 consumers participated in the experiment, and SmartPLS 3.3 was used for multigroup analyses.
Findings – Overall, argument quality (AQ), source's credibility (SC) and influencer's kindness positively predict CW, and CW predicts purchase intention. It was also found that SC is more important when information comes from a mega-influencer, whilst kindness is essential for a macro-influencer.
Practical implications – The results of this study imply that CW should be an essential component of influencer marketing strategy. Marketing managers should hire credible and kind influencers who can produce quality arguments. Additionally, the selection of SMI (macro- vs mega-influencer) should be aligned with the marketing objective and type of persuasion required.
Originality/value – This is one of the early attempts to extend ELM by introducing influencer kindness as a peripheral cue. Moreover, the study offers novelty by examining the effects of influencer characteristics (AQ, SC and kindness) on CW and comparing these effects across macro- and mega-influencers.

Keywords Social media influencer, Argument quality, Source's credibility, Kindness, Consumer well-being, Elaboration likelihood model

Paper type Research paper

1. Introduction

Social media influencers are the consumers on social media who (1) regularly post content on social media, (2) have a large fan base and (3) are used by brands for marketing communications (Reinikainen *et al.*, 2020). The SMIs embody an inexpensive third-party advocate (Malik *et al.*, 2023) and are more accessible and enticing due to social media's persuasiveness (Appel *et al.*, 2020). Recent statistics show that fifty per cent of consumers on social media trust SMI's recommendations, whilst 40% of them go on to purchase the product (DigitalMarketingInstitute, 2021). Therefore, marketers invest in SMIs to develop favourable consumer attitudes towards their brands (Cheung *et al.*, 2022). In this regard, studies have been conducted on Facebook (Winter, 2020), Twitter (Britt *et al.*, 2020), Instagram (Janssen *et al.*, 2022) and YouTube influencers (Jamil and Qayyum, 2021). Whether these findings and

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theories hold similarly across other platforms like TikTok? The question remains primarily unanswered (Vrontis *et al.*, 2021).

Despite researchers' focus on SMIs, influencer marketing literature has theoretical gaps. For example, previous studies heavily utilised credibility theory, attribution theory, persuasion knowledge and social comparison theory, neglecting dual-process models (Jamil and Qayyum, 2021; Vrontis *et al.*, 2021). Dual-process theories explain that individuals process information through two routes. Motivated individuals opt for the central/systematic route, whilst non-motivated ones choose the peripheral/heuristic route (Xiao *et al.*, 2018). The elaboration likelihood model (ELM) (Petty and Cacioppo, 1986) is a key dual-process theory that states that consumers process information through central or peripheral routes. The central route resides on careful information quality assessment, whereas the peripheral route relies on positive or negative cues. Dual-process theories are more suitable in the influencer marketing context as they can uncover consumers' emotional and attitudinal reactions (Jamil and Qayyum, 2021).

The present study extends ELM to elaborate on the SMIs' persuasion. The majority of previous studies employed argument quality (AQ) as a fundamental cue (central) and the source's credibility (SC) as a peripheral cue (Bhattacherjee and Sanford, 2006; Jamil and Qayyum, 2021; Leong *et al.*, 2019). In contrast, the impact of social media influencers' (SMIs) kindness on consumer attitudes and behaviours has been ignored by researchers (Vrontis *et al.*, 2021). Kindness is an important trait resulting in well-being, happiness, cognitive functioning and positive intentions (Ciocarlan *et al.*, 2018; Erdinger, 2019; Jasielska, 2020; Jin *et al.*, 2021). Therefore, this study provides a novel contribution to the SMI and ELM literature by empirically validating influencer kindness as a peripheral cue to information persuasion.

Building upon the dual-process models, studies on influencer marketing examined numerous consumer outcomes regarding AQ and SC. For example, AQ and SC have been examined to influence information usefulness (Bhattacherjee and Sanford, 2006; Jamil and Qayyum, 2021), crowdfunding attitude (Kim and Petrick, 2021), and product usefulness evaluation (Zhu *et al.*, 2016). However, consumer well-being (CW) as an outcome of SMI persuasion has not received due attention (Vrontis *et al.*, 2021). Social media exposure to attractive influencers, luxurious lifestyles, and upward social comparison has caused health problems (Jin and Ryu, 2020; Jang *et al.*, 2016). Alternatively, SMIs can contribute to CW through congruity and familiarity (Kim and Kim, 2020). Recognising the significance of CW in the SMI context, we set to validate the impact of influencer characteristics on CW empirically.

Finally, this study employed an experimental design to compare the effects of SMI characteristics across influencer types (macro vs mega). A macro-influencer has 100,000 to 1 million followers, whilst a mega-influence has more than 1 million followers (Janssen *et al.*, 2022). Recent research claims that most findings and theories in influencer marketing literature are irrelevant (Kay *et al.*, 2020; Ladhari *et al.*, 2020) because they fail to recognise the importance of influencer categorisation (e.g. macro- and mega-influencers) (Campbell and Farrell, 2020). It is necessary to address disparities between different influencer types and understand the underlying mechanism of their influence (Boerman, 2020; Voorveld, 2019).

In response, the studies that examined effects across influencer types produced conflicting findings. For example, some studies argue that influencers with more followers are better (Alassani and Göretz, 2019; Ladhari *et al.*, 2020), whilst others support vice versa (Janssen *et al.*, 2022; Park *et al.*, 2021). On the other hand, Boerman (2020) demonstrated that the type of influencer has no bearing on the consumer response to the message or the brand. These outcomes suggest that the effectiveness of influencers (low vs high followers) depends upon their characteristics. Mixed findings and previous studies warrant further investigation

(Vrontis *et al.*, 2021). Therefore, we compared the effects of influencer characteristics on CW and purchase intention across macro- and mega-TikTokers.

Based on the above discussion, this study has identified multiple gaps in the influencer marketing literature. First, despite the numerous studies on the subject matter, theoretical underpinnings are underutilised to explain how SMIs (specifically TikTokers) affect consumers. Likewise, an influencer's kindness has not received due attention, although it could serve as a critical peripheral signal, shaping consumer attitudes. Moreover, CW has recently gained much attention from researchers, yet little is known in the context of influencer marketing. Finally, mixed findings regarding influencer type (macro vs mega) warrant further inquiry. To address these gaps, this study proposes three research questions: (1) Do characteristics (AQ, SC and kindness) of TikTok influences affect CW? (2) Does CW affect purchase intention? (3) Is there any difference in the outcomes when mega-influencers deliver messages compared to macro-influencers?

The rest of the paper is organised as follows: Section 2 reviews the literature on AQ, SC, kindness, CW and their association with purchase intention. Section 3 details the study's methodology, whilst Section 4 demonstrates the results. Finally, Section 5 discusses the findings, implications, limitations and direction for future research.

2. Literature review

2.1 Argument quality and consumer well-being

AQ is "the persuasiveness of arguments within an informational message" (Bhattacherjee and Sanford, 2006). The literature on dual-process models emphasises that AQ is one of the most critical central paths to consumer persuasion and material helpfulness (Zhu *et al.*, 2016). Additionally, it has been supported that AQ is an effective parameter of SMIs, developing consumer perception and positive attitudes (Jamil and Qayyum, 2021; Leong *et al.*, 2019).

Despite the enormous research on dual-process models, little is known about the association between AQ and CW. Castellacci and Tveito (2018) contended that access to more information on the internet boosts consumer decision satisfaction and well-being. Similarly, Tien *et al.* (2019) found that the quality of arguments during online information exchange inculcates positive consumer attitudes. The literature generally supports the positive outcomes of AQ (Cheung *et al.*, 2008; Sussman and Siegal, 2003). However, in the case of social media and influencer marketing, there are mixed findings. For example, Winter (2020) found that social media had weaker persuasiveness than websites or newspapers. Furthermore, Jamil and Qayyum (2021) added that the influence of AQ on consumer attitudes was weaker for SMIs versus electronic word of mouth. The varied findings indicate the need for more research on the impact of AQ in the influencer marketing context.

H1a. AQ has a positive effect on CW.

Extant literature supports that influencer recommendations are persuasive, fostering positive consumer attitudes (Cheung *et al.*, 2022). A comparative study on the effects of influencer type (micro vs mega) by Jin and Muqaddam (2021) yielded that consumers responded differently to each influencer alternative. In this regard, the popularity level of an influencer is also important. For example, Alassani and Göretz (2019) argued that influencers with a higher fanbase are more effective on social media than influencers with a lower fanbase. Moreover, stronger consumer perceptions are built when endorsed brands are supported by influencers with a higher fanbase (Park *et al.*, 2021).

H1b. Compared to macro-influencers, the influence of AQ of mega-influencers will be stronger on CW.

2.2 Source credibility and consumer well-being

In some cases, customers cannot absorb or process compelling information, thus indicating low elaboration likelihood. In these cases, the part of outlying signals becomes crucial (Sussman and Siegal, 2003). Literature on dual-process models shows that SC (i.e. the recipient's perception that the message source is competent, believable and trustworthy) is one of the most commonly cited peripheral cues (Bhattacherjee and Sanford, 2006). SC fosters a parasocial relationship between influencers and their followers, generating believability (Leung *et al.*, 2022; Yuan and Lou, 2020), positive attitudes (Bi and Zhang, 2022) and behaviours (Koay *et al.*, 2021).

Recently, researchers have shown interest in the relationship between SC and CW. For example, Mundel *et al.* (2022) found that credible influencer marketing lowers social media anxiety and boosts CW. Similarly, Chetioui *et al.* (2022) reported that congruity, attractiveness and credibility are precursors of consumer attitudes towards Instagram health and well-being influencers.

H2a. SC has a positive effect on CW.

The stature and popularity of SMIs are essential when they promote brands. It has been elaborated recently that the popularity of influencers determines product recommendations and purchase decisions on social media (Ladhari *et al.*, 2020). The brands often hire famous SMIs to gain popularity and boost product sales (Jin and Muqaddam, 2021). Moreover, Janssen *et al.* (2022) added that endorsers with a greater fanbase are more credible, generating positive attitudes and intentions. Hence, it can be argued that the effect of influencers with a greater fanbase (mega-influencers) will be higher than an influencer with comparatively lesser followers (macro-influencers).

H2b. Compared to macro-influencers, the influence of SC of mega-influencer will be stronger on CW.

2.3 Kindness and consumer well-being

Kindness is being warmhearted, compassionate, humane and empathetic to others (Comunian, 1998). Influencer marketing is a relatively new phenomenon, lacking sufficient literature on influencer kindness. As an exception, Vrontis *et al.* (2021) suggested that influencer kindness could be an essential determinant of influencer persuasion, fostering positive outcomes. A satisfactory experience with a service provider generally results in CW (Su *et al.*, 2022).

Contrary to influencer marketing, social and psychological research provides sufficient evidence of the relationship between kindness and well-being. Erdinger (2019) demonstrated that acts of kindness, affection and intimacy positively affect well-being. Furthermore, the kindness and generosity of information sources enhance happiness, well-being and positive intentions amongst the audiences (Ciocarlan *et al.*, 2018; Jasielska, 2020). In an experimental study, Perkins *et al.* (2022) found that kindness is a key determinant of cognitive functioning and well-being. Moreover, kindness helps maintain positivity and well-being during stressful situations (Jin *et al.*, 2021). Therefore, it can be argued that an influencer's kindness could reduce consumer online scepticism, inducing well-being and positive intentions.

H3a. Influencer kindness has a positive effect on CW.

Despite the general understanding that influencers with more followers are more effective, some contexts offer contrasting explanations. For example, micro-influencers are more authentic in generating hedonic pleasures (Park *et al.*, 2021) and hedonism predicts CW (Kumagai and Nagasawa, 2022). Micro-influencers are also better at building interpersonal and intimate connections with followers (Britt *et al.*, 2020). These findings suggest that small-

scale influencers (nano and micro) are relatively new, having most of their follower from proximity, resulting in closer personal ties. Thus, consumers trust and relate more to small-scale influencers, resulting in a devoted fan base (Janssen *et al.*, 2022).

Regarding kindness, it is an interpersonal phenomenon focussed on building reciprocal relationships, intimacy and affection (Comunian, 1998; Erdinger, 2019). Thus, we can argue that macro-influencers (having fewer devoted and closely related followers than mega-influencers) are better positioned to develop personal ties. Therefore, macro-influencer's kindness should have more influence on CW than mega-influencers.

H3b. Compared to mega-influencers, the influence of kindness of macro-influencer will be stronger on CW.

2.4 Consumer well-being and purchase intention

Recently, CW has gained popularity and importance (Sirgy, 2021), particularly in influencer marketing (Vrontis *et al.*, 2021). Broadly, adverse health consequences have been found in response to upward social comparison on social media (Jang *et al.*, 2016). Similarly, Jin and Ryu (2020) argued that exposure to attractive SMIs and their luxurious lifestyles impair CW. Browsing SMI profiles leads to materialism and compulsive buying (Jin and Muqaddam, 2021). In contrast, a sense of acquaintance and congruity with an influencer enhances consumer's well-being and commitment (Kim and Kim, 2020).

Research on the influence of CW on purchase intention is limited. However, existing knowledge regarding consumer attitudes and online shopping suggests that attitudes predict behavioural intentions (Andronie *et al.*, 2021; Musova *et al.*, 2021; Nica *et al.*, 2022). According to ELM and dual-process theories, positive consumer attitudes predict favourable intentions and behaviours (Cheung *et al.*, 2008; Jamil and Qayyum, 2021). Moreover, CW relates to loyalty, commitment (Kim and Kim, 2020) and happiness (Sirgy, 2021). At the same time, consumer happiness has been linked to purchase intention (Kim and Lee, 2020). Therefore, we argue that CW should inculcate positive outcomes, including purchase intention.

H4a. CW has a positive effect on purchase intention.

The popularity of influencers on social media significantly affects consumer purchase decisions (Ladhari *et al.*, 2020). Consumers with a mindset of material acquisition prefer product promotions from famous (high fanbase) personalities (Jin and Muqaddam, 2021). In support, Janssen *et al.* (2022) added that consumers develop positive attitudes towards the product if it is endorsed by a famous influencer (having more followers) than other types (with a lesser number of followers), comparatively.

H4b. Compared to macro-influencers, the influence of CW on purchase intention will be stronger for mega-influencers.

Table 1 summarises the recent key literature regarding the effects of SMIs on consumer attitudes and intentions.

A proposed conceptual framework has been derived from the above literature, reporting the hypothesised relationships (see Figure 1).

3. Methodology

3.1 Study platform

TikTok was selected for this experimental investigation in Pakistan for several reasons. First, TikTok has one billion active monthly users who can create and share 15-s videos on various topics. Second, Pakistan had over 18.26 million TikTok users in early 2022 (Kemp, 2022), making it a significant proportion of the international community, with Pakistanis

Study	Country/context	Key variables	Analytical approach	Key findings
Chetioui *et al.* (2022)	Instagram health and well-being influencers	Health and well-being, consumer attitudes, gender, purchase intention	Structural equation modelling	Health and well-being influencers on Instagram positively shape consumer attitudes and purchase intention. Gender moderates the outcomes such that the physical attractiveness of the influencer will likely result in stronger effects among females
Cheung *et al.* (2022)	Malaysian Instagram, Facebook, YouTube, and Weibo	Consumer brand engagement, entertainment, information seeking, social interaction, reward	PLS-SEM	Different consumer gratifications (entertainment, information seeking, social interaction, reward) affect brand engagement through observational learning
Jamil and Qayyum (2021)	Pakistani YouTube influencers	Argument quality, source credibility, information language, information usefulness, purchase decision	Co-variance based SEM	Argument quality, source credibility, and information language are key predictors of consumer decisions on YouTube
Janssen *et al.* (2022)	Dutch Instagram users	Product-influencer fit, number of followers, credibility, identification, consumer attitudes	ANOVA, Hayes PROCESS	Product-influencer fit and number of followers affect consumer attitudes mediated via credibility and identification
Leung *et al.* (2022)	General	Online influencer marketing (OIM), marketing communications	Literature review	The study endeavoured to define online influencer marketing, benefits and threats to OIM, and strategies for effective marketing communications
Malik *et al.* (2023)	USA social media users	Escapism, self-improvement, fun, glamour, connectedness, image	SEM	Consumers follow SMI for escapism and self-improvement. Moreover, glamour, fun, and connectedness influence the perceived image
Yuan and Lou (2020)	General social media users	Source credibility, fairness, parasocial relationship, product interest	Co-variance based SEM	Source credibility and fairness predict product interest mediated via parasocial relationships
Zafar *et al.* (2021)	Pakistani Facebook influencers	Authenticity, sentiment polarity, observational learning, impulse buying	PLS-SEM	Sentiment polarity and observational learning positively predicated impulse buying. The moderating role of authenticity was insignificant

(*continued*)

Table 1.
Summary of recent key literature

Study	Country/context	Key variables	Analytical approach	Key findings
Zha *et al.* (2018)	Chinese social media blogs: Sina Microblog, ScienceNet blog, and Baidu Know	Information quality, source credibility, reputation, social media usage	PLS-SEM	Reputation is a stronger predictor compared to information quality and credibility
This study	Pakistani TikTok influencers	Argument quality, source credibility, kindness, consumer well-being, purchase intention	PLS-SEM, Multigroup analysis	Argument quality, source credibility, and influencer's kindness positively influence consumer well-being, predicting purchase intention. The experimental manipulation shows that source credibility is more important when information comes from a mega-influencer, whilst kindness is essential for a macro-influencer

Table 1.

Source(s): Created by authors

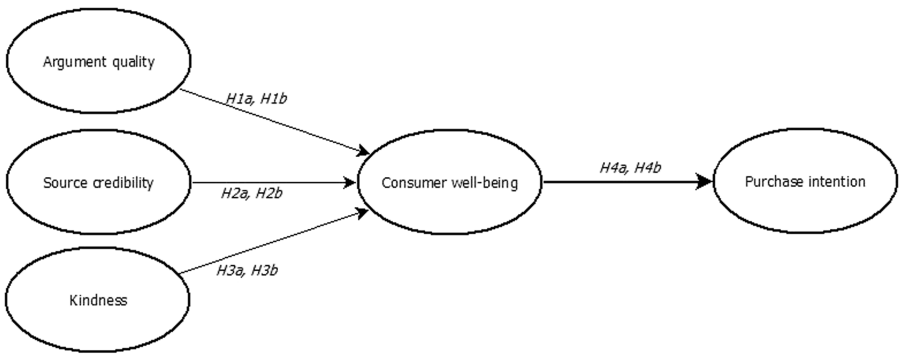


Figure 1.
Conceptual framework

Source(s): Created by authors

amongst the top 10 users of TikTok worldwide (Ecwid, 2022). Third, countries with the most social media users are typically developed economies (Dixon, 2023). Pakistan is an underdeveloped economy (Raja *et al.*, 2018) and oddly ranked amongst the top social media users. Finally, many brands in Pakistan are turning to SMIs for marketing and promotions (Zafar *et al.*, 2021). Thus, studying TikTok in the Pakistani context should offer key insights for comparing and contrasting the international literature on SMIs based on developed/underdeveloped economies.

Second, despite the platform size, researchers have paid little attention to TikTok influencers (Vrontis *et al.*, 2021), leaving knowledge voids in influencer marketing literature. Moreover, there is an apparent lack of research on TikTok, which focusses on more transient interactions (Sokolova and Kefi, 2020) and a rapidly expanding influencer marketing platform (Taylor, 2020). As a result, TikTok is a promising social media platform deserving further examination.

3.2 Preliminary focus group dialogue

A preliminary focus group dialogue (FGD) was held with university students (n = 55) to determine their favourite TikTok influencers and stimulus product. Previous experimental studies recommended conducting a preliminary FGD for stimuli and product selection (Jamil *et al.*, 2022). For the stimuli selection in an experimental inquiry, Jamil and Qayyum (2021) did a preliminary focus group discussion with individuals who were not the main study participants. We employed a similar approach to provide preliminary insights into consumer perceptions and select experimental stimuli.

We employed Janssen *et al.* (2022) criteria to categorise macro- and mega-influencers. Accordingly, the influencers having 100k–1 M followers were considered macro-influencers, whilst those with more than 1 M followers were mega-influencers. Thus, participants were initially briefed about the study and the difference between macro- and mega-influencers. Then they were asked to rate their favourite macro- and mega-influencers. The participants responded with Hira Bleeh (n = 39) as a macro-influencer and Romaisa Khan (n = 36) as a mega-influencer. In February 2022, Hira Bleech had 735.5 K, whilst Romaisa Khan had 5.5 million TikTok followers (see profile links in Appendix). Next, participants were asked about the most promoted product on TikTok; they identified that Daraz was the most commonly promoted product by these TikTokers in recent times.

To ensure ecological isomorphism between selected influencers, the researchers deliberated to find realistic, externally valid and comparable videos. The videos were deemed comparable since both influencers promoted the same product (i.e. Daraz sale of 11.11 sale event). Researchers and focus group members also agreed that both influencers' speech, facial features, voice tone and clothing (western) were similar.

3.3 Population and experimental procedure

An online experiment was performed with consumers who were TikTok users. The participants were recruited through social media platforms via an invitation link. Those who clicked the link were briefed about the study, followed by random assignment to one of two experimental manipulations. Participants were randomly assigned to watch a macro-influencer or mega-influencer promotional video (links to videos are in Appendix). Once the participants finished watching the promotional video, they were asked to complete the survey on AQ, SC, kindness, CW and purchase intention.

A total of 190 consumers volunteered for the experiment. Eighty-four participants were exposed to a macro-influencer video, whilst one hundred and six watched a mega-influencer video after a random assignment. The experimental studies that employ voluntary participation and random assignment are considered sufficient (Jin *et al.*, 2019). Data were collected during March 2022 and randomly selected participants were presented with customised gifts to boost response quality. Table 2 shows the demographic distribution of participants.

3.4 Measures

All the measures were borrowed from previous research, carefully modified to fit the needs of the present study and then validated. The measures of AQ and SC were adapted from Bhattacherjee and Sanford (2006), comprising four-item each. The kindness scale was adapted from Comunian (1998), based on three items. A three-item scale of CW was adapted from Grzeskowiak and Sirgy (2007). Finally, the three-item purchase intention scale was adapted from Dodds *et al.* (1991). All data were collected on a 5-point Likert scale.

4. Data analysis and results

Data were analysed using partial least squares structural equation modelling (PLS-SEM) through SmartPLS 3.3. Many researchers prefer the PLS-SEM method because it allows them

Variable	Cases (%)
Gender	
Male	90 (47.4%)
Female	100 (52.7 = 6%)
Age	
Less Than 20	38 (20.0%)
20–30	73 (38.4%)
31–40	60 (31.6%)
Above 40	19 (10.0%)
Education	
Bachelors	92 (48.4%)
Masters	61 (32.1%)
Doctoral	37 (19.5%)

Source(s): Created by authors

Table 2. Demographics of the participants

to estimate complex models with many constructs, indicator variables and structural routes without making assumptions about the data distribution. PLS-SEM is a causal-predictive method of statistical model estimation that emphasises prediction (Hair *et al.*, 2021). The PLS-SEM approach relies on the assessment of measurement and structural models (Hair *et al.*, 2019).

4.1 Assessment of measurement model

The study employed multiple parameters to assess the measurement model: internal consistency, convergent validity and discriminant validity (Hair *et al.*, 2019). Additionally, we examined Dijkstra–Henseler's rho_A (ρA), variance inflation factor (VIF) and standardised root mean square residual (SRMR) for model fitness.

Cronbach alpha tested internal consistency reliabilities of the measuring items, and all values were above 0.70. Convergent validity is assessed using composite reliability (CR) and average variance extracted (AVE). The CR ranges from 0 to 1, with acceptable values over 0.70 (Graciola *et al.*, 2020). For all the constructs, CR scores ranged from 0.87 to 0.95, indicating satisfactory values. Likewise, the AVE should be higher than 0.5 (Hair *et al.*, 2021). We found that AVE scores ranged from 0.64 to 0.87, hence acceptable. Collectively, CR and AVE verified the convergent validity of measures. Moreover, Dijkstra–Henseler's ρA was examined for construct reliability. For the present study, ρA values ranged from 0.77 to 0.93, above the acceptable value of 0.7 (Dijkstra and Henseler, 2015). Table 3 summarises all the details of scale refinement.

One frequently used indicator to assess the collinearity of the formative indicators is the VIF. Regarding this, Hair *et al.* (2021) guided that VIF scores should be less than 5, whilst higher values suggest serious collinearity concerns. All items had VIF scores below 5, indicating no multicollinearity concerns (see Table 3).

Discriminant validity refers to the extent to which a construct is empirically distinct from other constructs in the structural model (Hair *et al.*, 2019). The AVE of each construct should be compared to the squared inter-construct correlation of that construct and all other reflectively assessed constructs in the structural model (Fornell and Larcker, 1981). Table 4 presents the discriminant validity estimates.

In addition to the AVE-based approach, Hair *et al.* (2019) suggested using the heterotrait-monotrait (HTMT) ratio of correlations to assess discriminant validity. The HTMT is more trustworthy for assessing discriminant validity (Hair *et al.*, 2021) and values less than 1.00 are

Argument quality (AQ)	Loadings	VIF
Adapted from Bhattacherjee and Sanford (2006) $\alpha = 0.81$; CR = 0.88; AVE = 0.64; $\rho_A = 0.83$		
The information provided by Hira Bleeh/Romaisa Khan* is informative	0.75	1.71
The information provided by Hira Bleeh/Romaisa Khan* is helpful	0.78	1.79
The information provided by Hira Bleeh/Romaisa Khan* is valuable	0.88	2.14
The information provided by Hira Bleeh/Romaisa Khan* is persuasive	0.79	1.65
Source credibility (SC)		
Adapted from Bhattacherjee and Sanford (2006) $\alpha = 0.90$; CR = 0.93; AVE = 0.77; $\rho_A = 0.90$		
Hira Bleeh/Romaisa Khan* is knowledgeable on this topic	0.87	2.46
Hira Bleeh/Romaisa Khan* is trustworthy	0.90	3.29
Hira Bleeh/Romaisa Khan* is credible	0.89	2.90
Hira Bleeh/Romaisa Khan* appears to be an expert on this topic	0.84	2.06
Kindness (KN)		
Adapted from Comunian (1998) $\alpha = 0.77$; CR = 0.87; AVE = 0.69; $\rho_A = 0.77$		
The kindness of Hira Bleeh/Romaisa Khan* gives me internal satisfaction	0.82	1.53
When Hira Bleeh/Romaisa Khan* is kind, she can truly communicate	0.86	1.83
Hira Bleeh/Romaisa Khan* knows how to be properly courteous with others	0.80	1.53
Consumer well-being (CW)		
Adapted from Grzeskowiak and Sirgy (2007) $\alpha = 0.86$; CR = 0.91; AVE = 0.78; $\rho_A = 0.86$		
Hira Bleeh/Romaisa Khan* plays a very important role in my social well-being	0.86	2.15
Hira Bleeh/Romaisa Khan* plays an important role in my leisure well-being	0.92	2.91
Hira Bleeh/Romaisa Khan* plays an important role in enhancing the quality of my life	0.86	2.04
Purchase intention (PI)		
Adapted from Dodds et al. (1991) $\alpha = 0.93$; CR = 0.95; AVE = 0.87; $\rho_A = 0.93$		
I intend to buy the products at Daraz after watching the promotional video by Hira Bleeh/ Romaisa Khan*	0.93	3.63
It is likely that I will buy the products at Daraz after watching the promotional video by Hira Bleeh/Romaisa Khan*	0.96	4.77
I am willing to buy the products at Daraz after watching the promotional video by Hira Bleeh/Romaisa Khan*	0.91	3.13

Note(s): CR= Composite reliability; AVE = Average variance extracted; ρ_A = Dijkstra–Henseler consistent reliability coefficient; VIF = variance inflation factor. * Respondents saw either Hira Bleeh or Romaisa Khan subject to their randomly assigned experimental video
Source(s): Created by authors

Table 3.
Scale refinement

	Fornell-larcker criterion					HTMT ratios				
Variable	AQ	CW	KN	PI	SC	AQ	CW	KN	PI	SC
Argument quality (AQ)	0.80									
Consumer well-being (CW)	0.70	0.88				0.82				
Kindness (KN)	0.62	0.66	0.83			0.76	0.82			
Purchase intention (PI)	0.57	0.46	0.25	0.93		0.65	0.52	0.29		
Source credibility (SC)	0.79	0.77	0.70	0.46	0.88	0.91	0.87	0.83	0.51	

Source(s): Created by authors

Table 4.
Discriminant validity

deemed satisfactory (Henseler *et al.*, 2015). We did not observe discriminant validity issues in the present study since all the observed HTMT estimates were less than 1.00 (see Table 4).

Finally, the overall model fit was assessed through the SRMR criterion. To prevent model misspecification, PLS-SEM recommends employing the SRMR as a goodness-of-fit measure (Henseler *et al.*, 2015). A value less than 0.10 is considered a good fit (Ringle *et al.*, 2022). We observed an SRMR value of 0.08, indicating adequate model fit.

4.2 Assessment of structural model

When formative constructs are incorporated into the structural model, PLS-SEM is the preferable method. Hair *et al.* (2019) suggested that the relevance of the indicator weights, indicator collinearity and statistical significance are used to evaluate formative measurement models. Besides the p-value and alpha levels, it is essential to look for the effect sizes (f-square or f^2) (Graciola *et al.*, 2020). According to (Hair *et al.*, 2019), any values of f^2 above 0.35 are considered vital, whilst those above 0.02 are acceptable. Table 5 shows the f^2 scores of each hypothesised relationship.

Regarding the hypotheses testing, H1a proposed a positive effect of AQ on CW. The results show that the impact of AQ on CW was significant ($t = 2.69, p < 0.05$), supporting H1a. Similarly, H2a proposed that a positive effect of SC on CW was also supported ($t = 4.86$, $p < 0.01$). H3a proposed a positive effect of influencer kindness on CW. This hypothesis was also supported ($t = 2.84, p < 0.05$). Finally, the results also showed a positive effect of CW on purchase intention ($t = 3.21, p < 0.00$), lending support to H4a. Table 5 presents the results of hypothesis testing in response to path analysis.

Figure 2 reflects the structural model indicating hypothesised relationships and corresponding beta estimates.

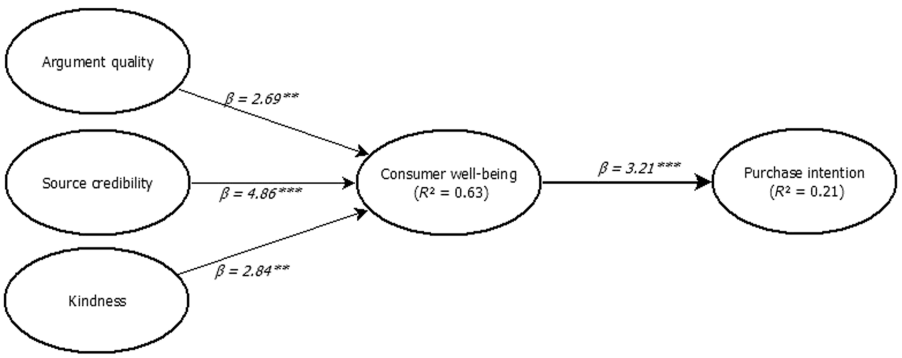
A multigroup analysis using SmartPLS was performed to investigate whether the effects were different across types of influencers (macro vs mega-influencers). In this regard, H1b proposed that compared to macro-influencers, the influence of AQ of mega-influencers will be stronger on CW. Contrary to expectations, data analysis did not support H1b (see Table 6 for details). H2b stated that compared to macro-influencers, the influence of SC of mega-influencers would be stronger on CW. Data analysis confirmed that SC's effect on CW was stronger for mega-influencers ($t = 4.76, p < 0.000$) than macro-influencers ($t = 3.10, p < 0.000$). Thus, H2b was supported. Similarly, H3b proposed that compared to mega-influencers, the influence of kindness of macro-influencers will be stronger on CW. The results showed that the effects of macro-influencers ($t = 0.24, p < 0.05$) were stronger compared to mega-influencers ($t = 0.21, p < 0.10$), supporting H3b. Finally, H4b proposed that the influence of CW on purchase intention will be stronger for macro-influencers than macro-influencers. However, it was not supported as data analysis did not show significant effects.

Paths	Standard beta	t value	f^2	p	Decision
H1a: AQ → CW	0.21	2.69	0.04	**	Supported
H2a: SC → CW	0.45	4.86	0.17	***	Supported
H3a: KN → CW	0.22	2.84	0.07	**	Supported
H4a: CW → PI	0.27	3.21	0.27	***	Supported

Note(s): **$p < 0.05$; ***$p < 0.001$; AQ = argument quality; CW = consumer well-being; KN = kindness; SC = source credibility; PI = purchase intention

Source(s): Created by authors

Table 5.
Path coefficients



Source(s): Created by authors

Figure 2.
Structural model

Paths	Path coefficients Macro	Path coefficients Mega	*t*-value Macro	*t*-value Mega	*p*-value Macro	*p*-value Mega	Decision
H1b: AQ → CW	0.30	0.05	3.01	0.42	***	0.67	Not supported
H2b: SC → CW	0.36	0.61	3.10	4.76	***	***	Supported
H3b: KN → CW	0.24	0.21	2.30	1.83	**	*	Supported
H4b: CW → PI	0.43	0.12	3.39	1.08	***	0.28	Not supported

Note(s): **$p < 0.05$; ***$p < 0.001$; AQ = argument quality; CW = consumer well-being; KN = kindness; SC = source credibility; PI = purchase intention
Source(s): Created by authors

Table 6.
Effects across macro vs mega-influencers

5. Discussion

Building upon ELM, this study examined the effects of central (AQ) and peripheral (SC and kindness) cues on CW and purchase intention. Additionally, employing the experimental design, we compared the influence of macro- and mega-TikTok influencers. Therefore, the following sections discuss the results of the overall model, followed by the findings across influencer types.

5.1 Findings of the overall model

Overall, AQ positively influenced CW (H1a). Consumers perceive high-quality messages as factually correct, inducing positive attitudes. These findings corroborate the previous studies (Jamil and Qayyum, 2021; Leong *et al.*, 2019; Zhu *et al.*, 2016) on dual-process models, confirming that influencers' AQ is an important predictor of consumer attitudes and intentions. Although there is insufficient empirical evidence on the association between AQ and CW, based on the present study's findings, we can imply that AQ inculcates positive attitudes (well-being) among consumers. Additionally, access to more information on the Internet results in greater decision satisfaction and CW (Castellacci and Tveito, 2018).

The effect of SC on CW was also significant (H2a). Consumers who lack the ability or motivation to process the information rely on peripheral cues to develop attitudes (Sussman and Siegal, 2003). The positive effect of SC on CW supports the previous studies on dual-process models (Jamil and Qayyum, 2021), affirming the significance of peripheral cues to persuasion. The intangibility and anonymity of social media create anxiety and scepticism

amongst consumers. Arguably, the credibility of influencers plays a vital role in reducing anxiety and ensuring CW (Chetioui *et al.*, 2022; Mundel *et al.*, 2022).

Kindness positively influenced CW (H3a), providing empirical evidence in an area with limited prior research. These findings align with dual-process models suggesting that peripheral cues generate positive attitudes (Xiao *et al.*, 2018). In general, kindness has been linked with reduced anxiety (Jin *et al.*, 2021), cognitive functioning (Perkins *et al.*, 2022) and well-being (Ciocarlan *et al.*, 2018). The kindness of an influencer can develop a harmonious environment on social media. Likewise, Su *et al.* (2022) demonstrated that a satisfactory experience with a service provider enhances CW. Therefore, the findings of this study support proposition of Vrontis *et al.* (2021) that influencer kindness, as a peripheral cue, fosters positive attitudes, including CW.

Finally, H4a confirmed that CW positively influences purchase intention. In this regard, ELM and other dual-process theories agree that positive consumer attitudes predict favourable intentions and behaviours (Cheung *et al.*, 2008; Jamil and Qayyum, 2021; Sussman and Siegal, 2003). Consumer health and well-being are related to reduced anxiety, better commitment, loyalty and happiness (Kim and Kim, 2020; Sirgy, 2021). At the same time, consumer happiness has been linked to purchase intention (Kim and Lee, 2020). Therefore, purchase intention as an outcome of CW is no surprise.

5.2 Findings across influencer type

In addition to overall effects, we compared the effects across influencer types (macro vs mega-influencer). Recently, numerous studies observed that findings and theories on influencer marketing are inapplicable if they ignore incorporating the influencer types (Kay *et al.*, 2020; Ladhari *et al.*, 2020). Moreover, the studies adopting the influencer categorisation generated inconclusive results. For example, some studies argue that influencers with more followers are better (Alassani and Göretz, 2019; Ladhari *et al.*, 2020), whilst others support that influencers with lesser followers are influential (Janssen *et al.*, 2022; Park *et al.*, 2021). On the other hand, Boerman (2020) found that influencer type has no difference in consumers' response to the message and brand. We concluded that rather than a general rule of thumb, the effectiveness of influencer type (low vs high follower) is subject to the influencer's characteristic under discussion.

H1b proposed that the AQ of mega-influencers will have a stronger influence on well-being compared to macro-influencers. To our surprise, there is no difference in the effects of AQ on CW for macro- and mega-influencers. These outcomes are similar to Boerman (2020) findings, showing no difference in the impact of influencer type (low vs high fanbase) on message and brand. It is essential to mention here that only the effect of the macro-influencer was significant. These outcomes could be attributed to the changing preference of consumers from mega-influencers to small-scale influencers. Regarding this, Britt *et al.* (2020) elaborated that brands are shifting towards small-scale influencers as they garner emotion-laden and interpersonal relationships.

As expected, the influence of SC on CW was stronger for mega-influencers than macro-influencers (H2b). The popularity of influencers is like a credibility signal in brand promotions. In this regard, Janssen *et al.* (2022) demonstrated that consumers consider influencers with a higher fanbase more credible, resulting in positive attitudes. Similarly, the number of likes, comments, shares and followers determine the popularity of a SMI, building trust and intentions (Ladhari *et al.*, 2020). Therefore, the findings of this study reaffirm the existing knowledge that consumers consider influencers with higher fanbases more credible.

The effect of influencer kindness on CW was stronger for macro-influencers than for mega-influencers (H3b). These outcomes are aligned with our expectations, as kindness is an

interpersonal phenomenon that fosters relationships and reciprocity. Since the small-scale influencers are usually new users having most of their followers from real-life (friends, acquaintances, or proximity), the role of kindness becomes imperative. Existing studies, such as Britt *et al.* (2020) and (Janssen *et al.*, 2022), argued that small-scale influencers are more effective when consumers want to relate to and develop interpersonal connections with influencers. Thus, macro-influencers with kind attitudes are more persuasive than mega-influencers.

In contrast to our expectations, the influence of CW on purchase was not stronger for mega-influencers than macro-influencers (H4b). These findings align with Boerman (2020), who showed no difference in outcomes based on influencer types. Like the influence of AQ on CW (H1b), the effects were significant only for macro-influencers, supporting the shift in consumer preferences towards small-scale influencers (Britt *et al.*, 2020; Park *et al.*, 2021).

6. Conclusion

In conclusion, the study contributes to discipline by illuminating the factors that influence CW and purchase intention in the context of influencer marketing. These findings offer valuable insights into AQ, SC and influencers' kindness in shaping consumer attitudes and intentions. The results also emphasise the varying roles of mega-influencers and macro-influencers. Whilst SC is crucial for information originating from mega-influencers, kindness becomes a more significant factor when considering macro-influencers. Thus, marketers can improve influencer selection strategies based on the target audience and desired outcomes. The following sections present the theoretical and practical implications. Finally, the study acknowledges major limitations and suggests future research direction.

6.1 Theoretical implications

This study offers three significant theoretical implications. First, it extends influencer marketing literature and ELM by introducing influencer kindness as a peripheral cue. With the growing popularity of SMIs, the number of consumers aspiring to become influencers is also increasing. Hence, AQ and SC characteristics might not be enough to distinguish better influencers from ordinary ones. Under these circumstances, the influencers with a kind attitude should be able to develop close bonds and intimacy with the followers, resulting in higher persuasion. In the present study, kindness as a peripheral cue was related to a positive outcome, supporting its significance in dual-process theories and influencer marketing.

Second, CW has been examined as an outcome of influencers' characteristics (AQ, SC and kindness). Although CW is closely related to influencer persuasion, it has not been investigated as a major variable in the influencer marketing domain. It has been previously noted that SMIs could adversely affect CW (Jang *et al.*, 2016; Jin and Ryu, 2020). Therefore, CW is a significant variable that should not be ignored whilst investigating the effects of SMIs. This study, therefore, extends CW to the influencer marketing field.

Third, the study highlights the role of influencer characteristics in determining the differential effects across influencer types. The researchers acknowledge that influencers' persuasion varies subject to the number of followers, yet no consensus has been achieved on whether more followers are better or vice versa. In this regard, we argued that there is no rule of thumb regarding the influence based on followers (low vs high fanbase). Instead, we proposed and empirically validated that the effects of influencer type are subject to influencer characteristics (AQ, SC and kindness) under investigation, setting a path for future inquiry.

6.2 Practical implications

The study offers important practical implications. As more consumers aspire to become influencers, brands need influencers who are credible as well as different. Even though AQ and influencer credibility are vital, the addition of kindness will be an augmented factor. For instance, most technology brands in Pakistan collaborate with Bilal Munir (an SMI, a.k.a videowalisarkar) because he is credible, tech-savvy and kind towards his followers. Likewise, Marques Brownlee (a.k.a MKBHD) is a globally famous SMI, approached by top brands since he preaches kindness and compassion towards followers. This implies that SMIs should engage in acts of kindness, such as supporting social causes or showing empathy, to influence CW positively. Likewise, online marketers should hire influencers with a kind attitude to strengthen their brand promotion strategy.

This study identifies influencers' characteristics as key drivers of CW, providing practical guidance for influencer marketing. Consequently, marketers should care about CW. Notably, in an online context, intangibility and anonymity create doubts in consumers' minds. For instance, influencers' luxurious lifestyles and attractive physical appearances create an upward social comparison, causing consumer stress and anxiety. Therefore, marketers should carefully employ influencers who can provide quality arguments and are kind and credible, resulting in better CW. In conclusion, a happy and healthy consumer is more inclined to purchase.

Regarding influencer type, marketers should carefully choose the influencers for their brand promotion. The selection of influencers should be aligned with the marketing objective and type of persuasion needed. When the objective is to build trust and positive attitudes through credibility, mega-influencers should be employed. For example, OctaFX (an online trading platform) employed Arsalan Naseer (a mega-influencer) to build trust in online trading amongst Pakistani consumers. Similarly, BOSS collaborated with Khaby Lame (The no. 1 TikToker worldwide) to generate favourable consumer responses for the newly launched clothing brand. In contrast, with their kind attitude, macro-influencers should develop closer bonds and interpersonal relationships more effectively. For instance, online communities often promote food brands and restaurants via personal recommendations. In response, many food brands are hiring Junaid Akram (a macro-influencer) for his kind attitude to encourage followers with closer personal ties. Likewise, Jennifer Messina, a well-known macro-influencer, promotes cryotherapy brands to instil well-being amongst followers. Thus, the selection of influencers should be tailored to fit the marketing strategy.

6.3 Limitations and future directions

First, the present study made a novel effort to investigate influencer kindness (as a peripheral cue) on CW. However, other influencer characteristics like intimacy, sensitivity, or humour could influence CW, opening avenues for further inquiry. Furthermore, the study was conducted in the context of TikTok and Pakistan, which may limit the generalisability. Future studies may explore other social media platforms and cross-cultural examinations to enhance understanding and generalisability.

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Appendix

Link to macro-influencer TikTok profile (Hira Bleeh)
https://www.tiktok.com/@hirableeh?lang=en

Link to mega-influencer TikTok profile (Romaisa Khan)
https://www.tiktok.com/@romaisa.khan._?lang=en

Link to macro-influencer video
https://www.youtube.com/shorts/APV3PBfQ2tU

Link to mega-influencer video
https://www.youtube.com/shorts/d8eOD-6VkaY

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