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BRIDGING THE SKILLS GAP IN BOSNIA AND HERZEGOVINA: THE ROLE OF SOFT SKILLS IN THE DIGITAL ECONOMY

ABSTRACT: *As the digital economy continues to evolve, the demand for human-centric competencies is becoming increasingly critical. This study examines the role of soft skills in bridging the skills gap in modern business environments, with a focus on communication, teamwork, adaptability, and emotional intelligence. Based on a survey of 71 senior managers and executives from diverse business sectors in Bosnia and Herzegovina, the findings indicate that communication skills are the most highly valued, followed closely by teamwork and adaptability. At the same time, emotional intelligence, though necessary, ranks comparatively lower. To contextualise these insights, the study incorporates ICT adoption data from the Agency for Statistics of Bosnia and Herzegovina to explore how digitalisation is reshaping workforce demands. The observed trends suggest that the need for problem-solving, adaptability, and interpersonal competencies could intensify as automation and digital tools become more integrated into business operations. The study highlights the growing need for interactive, feedback-driven training methods rather than traditional instructional approaches to develop these skills effectively. The findings inform strategic recommendations for human resource development, educational curricula, and organisational policies to ensure that businesses can cultivate a workforce capable of navigating the challenges of an increasingly digitalised economy.*

KEY WORDS: *soft skills, digital economy, ICT adoption, Bosnia and Herzegovina*

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1. INTRODUCTION

As businesses worldwide undergo rapid digital transformation, the skills demanded of the workforce are evolving just as swiftly. Technological advances such as automation and artificial intelligence (AI) are reshaping job requirements, and employers expect nearly 40% of workers' core skills to change by 2030 (World Economic Forum, 2025). In this context, soft skills, encompassing communication, teamwork, adaptability, and emotional intelligence, have become pivotal for maintaining productivity and innovation. They complement technical know-how and enhance the productivity of hard skills (Balcar, 2016) by enabling workers to collaborate effectively, navigate change, and solve problems creatively, qualities that automation cannot easily replicate.

The importance of soft skills is particularly pronounced in transitional economies such as Bosnia and Herzegovina (BiH), which are striving to catch up with global digitalisation trends. According to the International Labour Organisation, employers in BiH report a lack of digital competencies and soft skills, including communication abilities, among the workforce (International Labour Organisation, 2025). This gap between the skills workers have and the skills modern jobs require poses a challenge to economic growth and competitiveness. Yet, despite these challenges, empirical research on soft skills in BiH's digital transformation context is scarce, leaving a gap that this paper seeks to fill. Therefore, examining how soft skills can help bridge this skills gap in the digital economy is timely and crucial for BiH. The primary motivation of this analysis is to address this gap by exploring how soft skills development can drive workforce readiness in a digitally transforming economy, such as that of BiH.

This paper addresses the need for soft skills in the digital context by investigating the role and prioritisation of soft skills in BiH's evolving digital economy. We focus on key soft skills (communication, teamwork, adaptability, and emotional intelligence) identified from the literature as vital for digital transformation. We also analyse how local business leaders perceive their importance. In line with our research objectives, we hypothesise that business managers perceive soft skills as generally necessary. Additionally, we hypothesise that communication, teamwork, and adaptability are rated as more critical than emotional intelligence, reflecting expected differences in soft skill prioritisation. The research combines

a survey of 71 senior managers across various industries in BiH with an analysis of national information and communication technologies (ICT) adoption data, providing a contextual backdrop for understanding workforce needs. The contribution of this paper is twofold. Firstly, it provides empirical evidence on soft skill prioritisation in a Western Balkan transition economy by addressing a notable research gap in this field. Secondly, it integrates managerial insights with data on digitalisation to offer a new perspective on how human competencies and technological change intersect.

Following this introduction, we review the relevant literature on soft skills in the digital era. Next, we outline the methodology of our survey and data analysis, followed by the results integrated with insights from ICT adoption statistics and managerial perceptions of soft skills. The main implications for organisations and policymakers are presented later, along with recommendations. The conclusion underscores the importance of soft skills in bridging the workforce skills gap in the digital economy.

2. LITERATURE REVIEW

The labour market has shifted towards a competence-based approach that values the skills, knowledge, abilities, and attitudes a person needs to perform their work well (Horňáček & Zelenková, 2014, p. 65). Soft skills can be defined as interpersonal and intrapersonal abilities that facilitate effective performance in particular social contexts, without relying on technical knowledge or abstract reasoning (Hurrell et al., 2013; Stal & Paliwoda-Pękosz, 2019). These skills greatly influence career development in modern society, as they reflect the ability to respond to change, continually refine methods and ways of working, and communicate effectively with colleagues and partners. The development of these skills enables graduates to adapt easily to labour-market changes and remain competitive (Ratkovskaya, 2019).

They are qualities of an employee that characterise their work activity and do not depend on technical skills acquired through formal training (Schislyaeva & Saychenko, 2022). Yet, the labour market expects students to develop them during their education (Stal & Paliwoda-Pękosz, 2019). The employers' need for workers with soft skills will increase over time due to the shortage of such workers (Schislyaeva & Saychenko, 2022). The problems of finding high-skilled workers

in the external labour force encourage companies to provide in-house training, and their propensity to offer training shows a positive relationship with technological innovation within the company. The level of computer use at work has proven to be a significant determinant of the frequency and intensity of training provided to workers (Kupets, 2018). There is a constant need to enhance employees' skills, especially in the modern environment, where knowledge and skills may become obsolete as innovations advance (Schislyaeva et al., 2022).

In addition to formal business and soft skills, digital skills and competencies are equally important in the modern context. The most essential tools for developing digital skills and their complementary skills include critical thinking, creativity, and management (Ziomek, 2021). The current and future workforce should be able to acquire digital skills with ease (Kupets, 2018).

The World Economic Forum (2025) survey suggests that 86% of employers identify AI and information-processing technologies as the leading trends driving business transformation over the period 2025 to 2030. The critical skills in the forthcoming period are expected to be analytical thinking, creative thinking, resilience, flexibility and agility, and technological literacy. Moreover, the survey reveals that human-centric skills, including curiosity, lifelong learning, motivation, and self-awareness, remain relevant in the era of advanced technological changes.

Obermayer et al. (2023) identified critical thinking, complex problem-solving, adaptability, resilience, and creativity as prerequisites for embracing and driving digital transformation within companies. Trenerry et al. (2021) recognised similar factors necessary for digital transformation: team communication and collaboration, workplace relationships and team identification, team adaptability and resilience. However, there is limited empirical research on soft skills in the context of BiH's digital transformation. Building on the above insights, our study examines which soft skills BiH managers prioritise and how this aligns with the country's digitalisation trajectory.

Young graduates in the Western Balkans are often reported to lack the practical skills required to perform well in the labour market, underscoring the need to modernise education systems (Uvalić & Bartlett, 2022). Bartlett et al. (2016) emphasised that recent graduates do not possess sufficient interactive skills,

including problem-solving, critical thinking, communication, teamwork, IT skills, and foreign language proficiency. A recent Delphi study across several Western Balkan countries similarly highlighted that communication, adaptability, flexibility, teamwork, and critical thinking are considered essential for business success in the digital age (Anđelković et al., 2025). Entrepreneurs also consider soft skills key to success, highlighting emotional intelligence, resilience, and persistence as fundamental attributes (Almeida & Devedžić, 2022). These international comparisons show that while soft skills are universally valued in digital transformation, contextual factors influence how different regions prioritise and develop these competencies.

3. METHODOLOGY

This study utilises primary data on managerial perceptions of the importance of soft skills, complemented by official data on ICT adoption in companies in Bosnia and Herzegovina to identify the soft skills that companies seek in the digital age.

The first part of the study explores the context in which the demand for soft skills is observed. We reviewed published data on ICT adoption in Bosnia and Herzegovina from the Agency for Statistics of Bosnia and Herzegovina (BHAS, 2024) to contextualise the survey findings within broader digitalisation trends. The data on ICT adoption is used as an explanatory input to understand the wider context of demand for soft skills and includes indicators on the current state of digitalisation in Bosnia and Herzegovina, such as internet access, mobile technology use, e-commerce, the employment of ICT specialists, and AI adoption.

The second part of the study employed a cross-sectional survey design to assess managerial perceptions of soft skills in the context of the digital economy. We collected primary data through an online questionnaire distributed to senior managers and executives across diverse business sectors in Bosnia and Herzegovina. The targeted participants were those in upper-management roles involved in hiring and training. The survey invitation was disseminated via industry associations, professional networks, and referrals to reach the targeted respondents. The survey focused on evaluating the importance of selected soft skills and related competencies, and was part of the USE IPM project (2024). A total of 71 respondents, all directly involved in recruiting and onboarding at their

companies, participated in the survey. The sample included representatives from small (approximately 45%), medium (23%), and large companies (32%). These firms operated across a wide range of sectors, including retail (approximately 15%), information and communication technology (14%), finance and insurance (13%), services (10%), and smaller proportions of respondents from manufacturing, education, health, and public administration. The respondents were mainly from the Banja Luka region (about 52%), with others from regions including Doboj (18%), Mostar (7%), Derventa (4%), and Prijedor (4%). The gender distribution of the managers was roughly balanced (43.7% female and 56.3% male), ensuring diverse perspectives. It is worth noting that the Banja Luka region is overrepresented in the sample, reflecting the outreach's geographic focus. This regional skew should be considered when generalising the findings nationally.

The questionnaire was administered in the local language to ensure clarity for all respondents, and was later translated into English. The questionnaire itself was structured into multiple sections. The first section gathered demographic information about each respondent and their company. The second section asked respondents to rate the general importance of four key soft skills, namely communication skills, teamwork, adaptability, and emotional intelligence, on a five-point Likert scale (1 = not important, 5 = very important). In the third section, the importance of soft skills in the modern business environment was assessed. The respondents rated an expanded list of soft skills, introducing critical thinking alongside communication, flexibility and adaptability, and teamwork and cooperation. Finally, the survey included a section on reasons for developing soft skills in the workplace, where respondents evaluated the importance of various motives: building strong relationships, contributing to teamwork, staff motivation, opportunities for professional development, and conflict resolution.

We first conducted a descriptive analysis to determine the proportion of respondents who rated each skill as essential or very important. To compare the relative importance of the different soft skills, we used nonparametric statistical tests, as the Likert-scale data did not meet normality assumptions. The responses did not follow a normal distribution. They showed negative skewness, along with a tendency for respondents to use higher rating values, which may indicate acquiescence or extreme response bias (Pimentel, 2019). A Friedman test was

applied to detect overall differences in ratings of the soft skills, testing the hypothesis that all dependent groups have identical distributions (Wilcox, 2003). Upon finding a significant Friedman test result, we performed post-hoc pairwise comparisons using the Wilcoxon signed-rank test with a Bonferroni correction to identify which specific skills differed significantly in perceived importance (Okoye & Hosseini, 2024).

4. RESULTS

4.1. Adoption of ICT in Bosnia and Herzegovina

To contextualise the environment in which we analyse demand for soft skills, it is vital to consider the state of digitalisation and ICT adoption among companies and individuals in Bosnia and Herzegovina.

Data from the BHAS (2024) show that, for the first time, 100% of companies had internet access in 2024, after having gradually risen from 99.3% in 2018. The majority of companies had an internet speed of between 30 and 100 Mbit/s (41.8%) and between 100 and 500 Mbit/s (35.7%). Internet sales, measured as a percentage of total sales, remained relatively modest: 27.9% of large enterprises, 26.1% of medium, and 19.9% of small enterprises. The enterprises mostly used a third-party e-commerce marketplace to sell their goods. This gap illustrates that smaller businesses in BiH are less likely to capitalise on digital sales channels, potentially due to resource constraints or lack of know-how. In contrast, larger companies are leading the way in digital market integration.

A large majority of firms have equipped their workforce with mobile technology: by 2024, about 77.2% of enterprises provided portable devices with mobile internet access for business purposes (BHAS, 2024). This indicates that most companies enable mobile or remote work to some extent and are investing in hardware and connectivity to keep employees digitally linked. However, the adoption of remote collaboration practices appears to be more limited, with roughly 31.3% of enterprises holding online meetings in 2024. This relatively low figure suggests that, while the internet and devices are widespread, many organisations in BiH have not fully embraced such practices as video conferencing or regular remote teamwork.

The use of business software is still relatively uncommon in companies in Bosnia and Herzegovina: 21.2% use enterprise resource planning (ERP) software, 16.8% use customer relationship management (CRM) software, and 7.7% use business intelligence (BI) software (BHAS, 2024).

In terms of workforce and ICT-related skills, the data reveal some challenges: only 18.5% of companies employ IT experts, with 66.1% of large companies, 30.5% of medium, and 13.3% of small companies having IT experts in their employment. The ICT services in large companies were provided mainly by in-house staff (69.1% of enterprises), followed by outsourcing (65.3% of enterprises). Medium and small enterprises rely mostly on outsourcing for ICT services (68.6% and 71.9%, respectively), with fewer enterprises using in-house solutions (40.7% and 28.6%, respectively). The shortage of in-house ICT professionals may limit how effectively companies can implement and maintain advanced technologies, placing the onus on general staff to handle day-to-day technical issues.

Notably, large enterprises were the most active in organising ICT training programmes, both for their IT experts (68.3% of enterprises) and for other employees (44.2% of enterprises), indicating that larger firms recognise the value of continually upgrading skills to keep pace with technology. Medium and small enterprises mainly focused on training IT experts (51.1% and 51.8% of enterprises, respectively), while IT training for other staff is lagging, with 24% of medium and 11.4% of small enterprises providing training to other employees. Small and medium enterprises, conversely, may lack the resources or awareness to provide regular ICT training, which could hinder their long-term digital productivity. These findings suggest a potential skills gap: while technology use is widespread, formal training and expert support are lagging, possibly leaving employees to learn through informal self-training.

When it comes to cutting-edge technologies such as AI, adoption among BiH firms is nascent. According to the survey, a mere 6.4% of enterprises reported using AI technologies (BHAS, 2024). The few companies engaging with AI are likely industry leaders or those in technology-related sectors, while the vast majority have yet to explore these innovations. It is worth noting that AI usage was somewhat more common in large enterprises (around 12.3% of large firms use AI, compared to under 5% in medium and 6.5% in small firms), underscoring

the role of scale and resources in adopting complex technologies. The low uptake of AI in BiH is not unusual for a developing economy in 2024. However, as global trends push towards data-driven decision-making and AI-assisted processes, BiH firms may need to catch up to remain competitive.

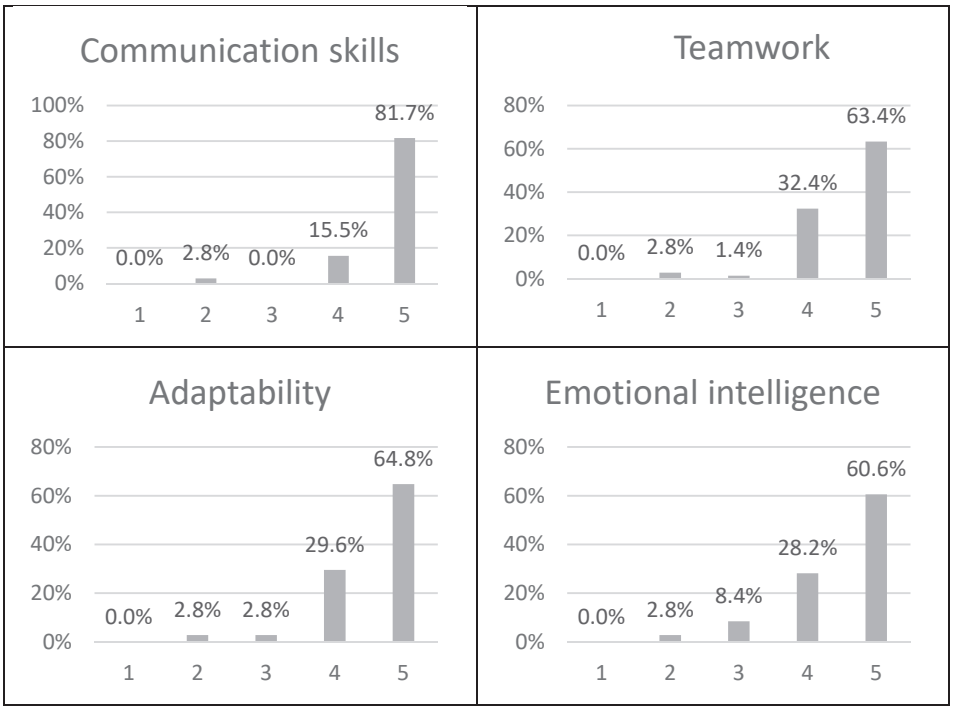
In summary, the digitalisation landscape in Bosnia and Herzegovina's enterprises is characterised by near-universal basic ICT usage (internet and mobile technologies), moderate but growing adoption of e-commerce, and minimal engagement with frontier technologies such as AI. Larger companies are generally further along in this digital transformation journey, while smaller firms lag in areas that require specialised skills or investment. Crucially, across the board, there is a notable lack of ICT specialists and formal digital skills training in businesses. This context provides the essential background for understanding the soft skills priorities identified in our survey. The fact that most companies do not have dedicated IT personnel and rely on their general workforce to implement and use new technologies means that employees at all levels are increasingly expected to be adaptable, quick learners, and good communicators to make effective use of digital tools. The following section will delve into how these digital trends shape the demand for specific soft skills and why managers' perceptions of soft skills align with the needs of a digital economy.

4.2. The importance of soft skills in the digital era

The first question asked respondents to rate the importance of the following soft skills: communication skills, teamwork, adaptability, and emotional intelligence. The respondents rated the importance on a scale from 1 to 5, and the distribution of their responses is shown in Figure 1.

Communication skills received the highest ranking among all the skills, with 81.7% of respondents rating them as very important and 15.5% as important. Only 2.8% rated them as not important. Teamwork and adaptability received similar scores, with 95.8% and 94.4% of the respondents rating them as very important or important, respectively. Emotional intelligence received the lowest scores among the analysed skills, as 88.8% rated it as very important or important.

Figure 1: The importance of soft skills



Source: Authors' calculation

Overall, the respondents deem communication skills the most important soft skill, followed by teamwork and adaptability, and, lastly, emotional intelligence. It should also be emphasised that all the skills received relatively high scores and are seen as relatively important.

Although communication skills are overwhelmingly seen as the most critical, teamwork and adaptability follow closely, indicating their substantial role in collaborative and dynamic work environments. The results concerning emotional intelligence suggest it may be seen as a complementary skill rather than a core priority. It is possible that the concept of emotional intelligence was less familiar or tangible to some respondents, leading some managers to undervalue it despite acknowledging its general importance.

These findings suggest that organisations should focus their training programmes on communication and teamwork skills while integrating adaptability and emotional intelligence as secondary yet essential components.

A Friedman test was conducted to examine whether the distributions of the responses differ significantly among the soft skills. The responses do not follow a normal distribution, as shown in the distribution charts, so a non-parametric test is used. The null hypothesis is that the distributions of ratings for communication skills, teamwork, adaptability, and emotional intelligence are identical. The obtained *p*-value of 0.003345 suggests sufficient evidence against the null hypothesis and that the distribution of responses differs significantly across specific skills.

The next step is to explore the differences identified by the Friedman test. We use the Wilcoxon signed-rank test with the Bonferroni correction to perform post-hoc pairwise comparisons and identify where differences are present.

Table 1: Wilcoxon signed-rank test for importance of soft skills

Comparison	Test statistic	*p*-value	Bonferroni-adjusted *p*-value	Adjusted significance
Adaptability vs communication skills	52.5	0.009	0.052	ns
Adaptability vs emotional intelligence	174.5	0.240	1.000	ns
Adaptability vs teamwork	85.5	1.000	1.000	ns
Communication skills vs emotional intelligence	275.0	0.001	0.009	**
Communication skills vs teamwork	136.0	0.002	0.011	*
Emotional intelligence vs teamwork	122.5	0.252	1.000	ns

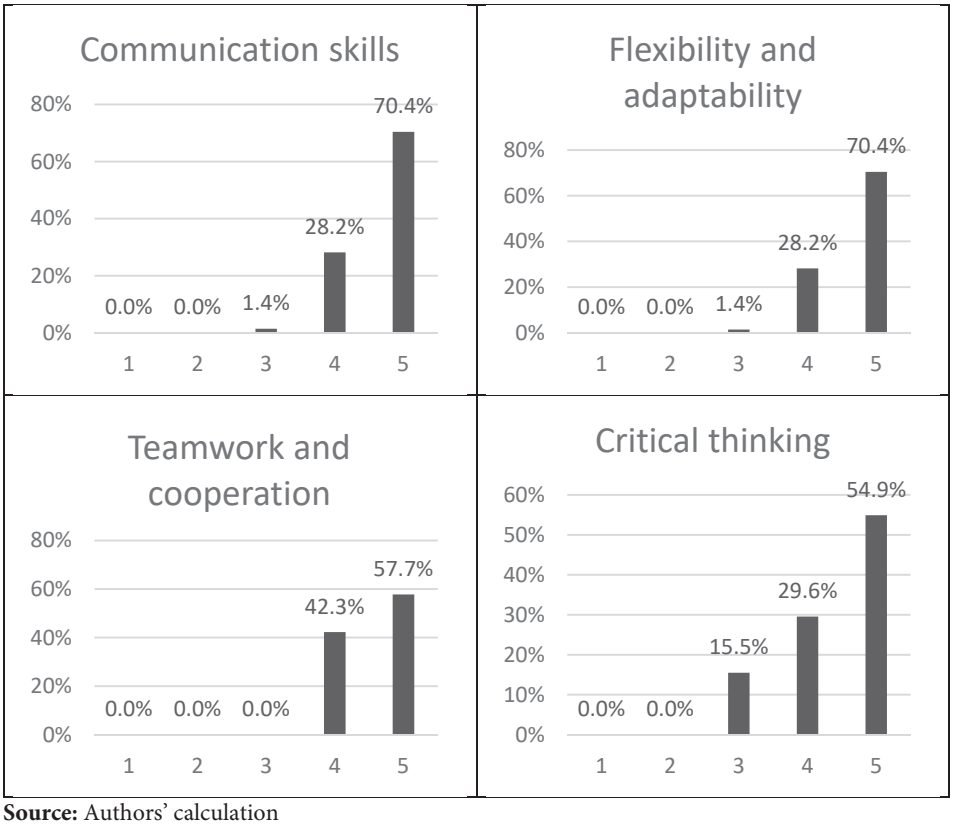
Note: Bonferroni-adjusted significance levels: * $p < 0.05$; ** $p < 0.01$; ns = not significant.
Source: Authors' calculation

Significant differences appear in communication and teamwork skills ($p \leq 0.05$), and the difference between communication skills and emotional intelligence is highly significant ($p \leq 0.01$). The test of communication skills and adaptability yielded a p-value of 0.052, which is borderline insignificant and suggests potential differences between the two skills.

The findings of the Friedman and Wilcoxon signed-rank tests confirm that respondents value communication skills more than other skills.

The second question asked the respondents to rate the importance of the following soft skills in the modern business environment: communication skills, flexibility and adaptability, teamwork and cooperation, and critical thinking.

Figure 2: Importance of soft skills in modern business environment



Source: Authors' calculation

The respondents found that communication skills, flexibility, and adaptability are the most critical soft skills in the modern business environment. 70.4% of the respondents rated these skills as very important. Teamwork and cooperation skills are seen as important or very important by all respondents, with slightly more (57.7%) rating them as very important. Critical thinking is perceived as the least important of the analysed skills, as 84.5% rated it as important or very important, while the rest rated it somewhat important.

The Friedman test rendered a *p*-value of 0.000748, suggesting that the distribution of responses differs significantly among the soft skills. The Wilcoxon signed-rank test with Bonferroni correction identifies the differences in Table 2.

Table 2: Wilcoxon signed-rank test for the importance of soft skills in the modern business environment

Comparison	Test statistic	*p*-value	Bonferroni-adjusted *p*-value	Adjusted significance
Flexibility and adaptability vs communication skills	85.5	1.000000	1.000	ns
Flexibility and adaptability vs critical thinking	381.0	0.000813	0.005	**
Flexibility and adaptability vs teamwork and cooperation	172.5	0.092000	0.550	ns
Communication skills vs critical thinking	441.0	0.002000	0.011	*
Communication skills vs teamwork and cooperation	147.0	0.077000	0.463	ns
Critical thinking vs teamwork and cooperation	108.0	0.036000	0.218	ns

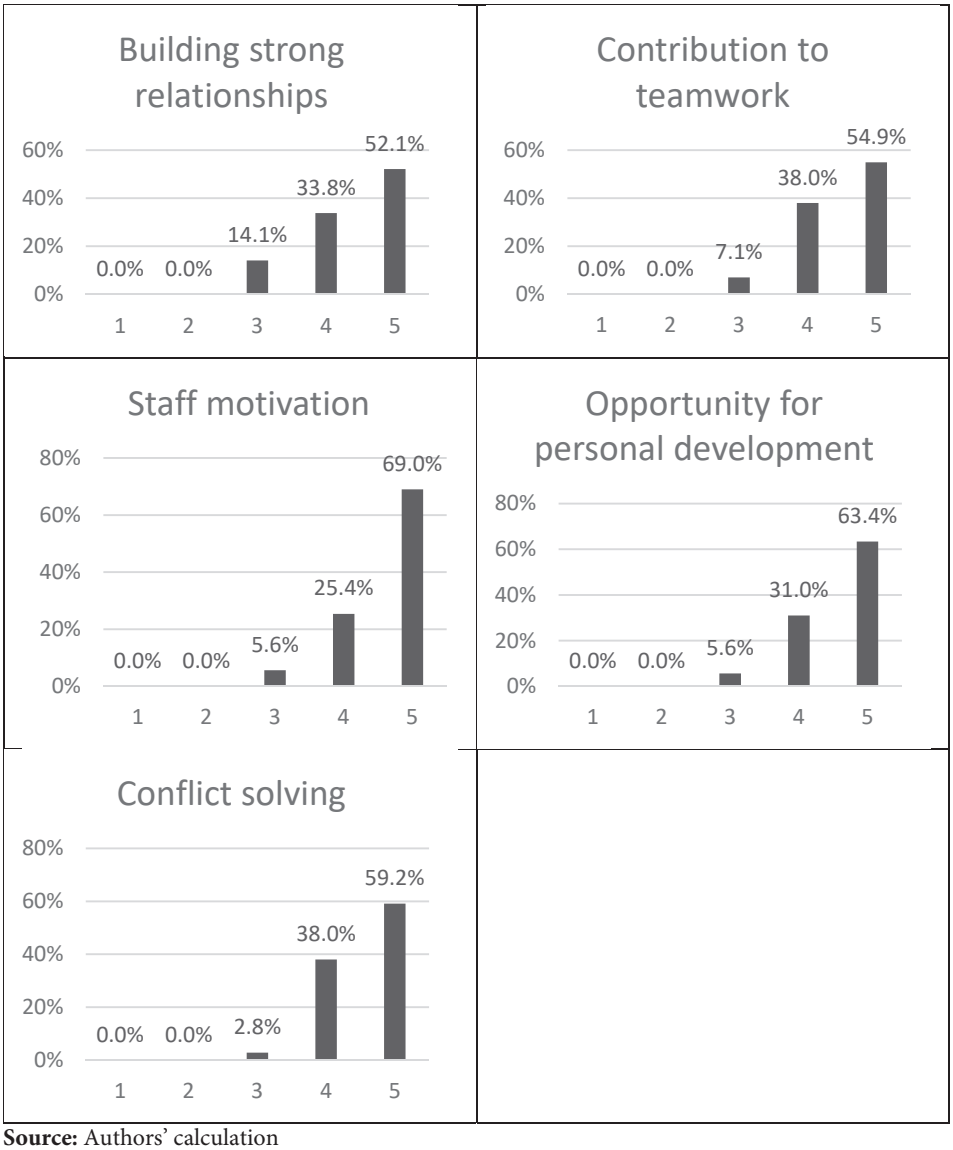
Note: Bonferroni-adjusted significance levels: * $p < 0.05$; ** $p < 0.01$; ns = not significant.
Source: Authors' calculation

The distribution for critical thinking differs significantly from that for flexibility and adaptability, while considerable differences are again found between critical thinking and communication skills. This suggests that, in the current BiH business context, managers place less emphasis on critical thinking than on more immediately practical skills such as communication and adaptability. One possible interpretation is that while strategic problem-solving ability is appreciated, employers might assume a baseline of analytical thinking or might be more urgently focused on day-to-day collaborative and adaptive skills. It may also reflect that critical thinking is more complex to observe or develop directly than teamwork and communication, or that it is sometimes taken for granted until it is lacking. Additionally, this pattern could be influenced by a wording effect, in which the term critical thinking may not resonate strongly or be interpreted narrowly by respondents, leading some managers to underrate its importance. Such cultural and semantic nuances might have contributed to the lower relative emphasis on critical thinking.

The third question involved identifying the reasons for developing soft skills in the workplace. The respondents rated the importance of the following reasons: building strong relationships, contributing to teamwork, staff motivation, opportunities for professional development, and conflict resolution. The results are depicted in Figure 3.

The results show that employers in our sample see staff motivation as the most important reason to develop soft skills, with 84.4% of respondents rating it as very important or important, making it the top-ranked reason. The next in line is opportunity for personal development, which is seen as very important by 63.4% of the respondents, followed by conflict solving (59.2% find it very important), contribution to teamwork (54.9% find it very important), and lastly building strong relationships (52.1% find it very important).

Figure 3: Reasons for developing soft skills in the workplace



Source: Authors' calculation

The Friedman test yields a *p*-value of 0.01142, confirming differences in the distributions. The Wilcoxon signed-rank test with Bonferroni correction identifies the following differences:

Table 3: Wilcoxon signed-rank test for reasons for developing soft skills in the workplace

Comparison	Test statistic	*p*-value	Bonferroni-adjusted *p*-value	Adjusted significance
Conflict resolution vs opportunity for professional development	132.5	0.867	1.000	ns
Conflict resolution vs building strong relationships	288.0	0.035	0.348	ns
Conflict resolution vs staff motivation	63.0	0.286	1.000	ns
Conflict resolution vs contribution to teamwork	170.0	0.298	1.000	ns
Opportunity for professional development vs building strong relationships	278.0	0.020	0.199	ns
Opportunity for professional development vs staff motivation	103.5	0.404	1.000	ns
Opportunity for professional development vs contribution to teamwork	180.0	0.149	1.000	ns
Building strong relationships vs staff motivation	62.5	0.002	0.016	*
Building strong relationships vs contribution to teamwork	110.0	0.229	1.000	ns
Staff motivation vs contribution to teamwork	150.0	0.012	0.124	ns

Note: Bonferroni-adjusted significance levels: * $p < 0.05$; ** $p < 0.01$; ns = not significant.
Source: Authors' calculation

The only significant difference was observed between building strong relationships and staff motivation, with the former perceived as a less important reason for soft skills development. This suggests that while good relationships are valued, BiH managers are primarily focused on the internal benefits of soft skills, particularly their role in boosting employee motivation and growth. In sum, the

findings highlight that employers believe soft skills training pays off primarily through increased employee motivation, better teamwork, and improved conflict resolution, all of which can lead to higher productivity and lower turnover. These perceived benefits align with the needs of a rapidly changing, high-pressure digital business environment, where engaged, adaptable, and collaborative teams can give companies a competitive edge.

5. DISCUSSION

The convergence of our survey findings with the Agency for Statistics of Bosnia and Herzegovina's ICT adoption data offers valuable insights into how digital transformation is shaping the demand for soft skills in Bosnia and Herzegovina. Overall, the evidence points to a reinforcing dynamic. As technology becomes more embedded in business operations, the human skills that enable organisations to adapt and thrive alongside technology are becoming ever more critical. In this discussion, we examine several key themes emerging from the comparison of the importance of soft skills in the context of the digital economy and consider their implications for the workforce and organisational strategies in the digital age.

One of the most explicit messages from the data is that technical skills do not eclipse soft skills. They are complementary and, in many cases, amplified by the march of digitalisation. The results support the findings of Poláková et al. (2023) that individuals must develop both soft and digital skills to thrive in the digital era. In the talent selection process, companies focus more on candidates' creative thinking, open-mindedness, and collaboration than on technical skills alone (Guinan et al., 2019). The near-universal importance that BiH managers attribute to communication, teamwork, and adaptability closely aligns with the digital context of their companies. With 100% of enterprises online and a majority equipping employees with mobile internet devices, work in many industries is now mediated through digital platforms such as email, messaging apps, video calls, and collaborative software. Practical communication skills are thus fundamental as employees must be able to clearly articulate ideas, instructions, and feedback across digital channels to avoid misunderstandings in an environment where face-to-face interaction may be less frequent.

Perhaps most directly connected to technology is the importance of adaptability and flexibility. In a business world where software updates, market platforms, and even entire business models change rapidly, an employee's ability to learn and adjust continuously is indispensable. BiH companies, as evidenced by their rates of AI adoption and incremental moves into e-commerce, are adapting gradually. They need employees who can smoothly transition to new processes without a loss in productivity. Our finding that adaptability was nearly as highly valued as communication resonates with the reality that digital transformation is an ongoing process, not a one-time event, and thus requires a workforce comfortable with ongoing change. Notably, the BHAS data showed that only around 18% of companies offer formal ICT training, so much of the learning happens informally on the job. This further underscores why adaptability and self-driven learning are prized, as employees often must learn new systems or technologies on their own or with minimal guidance. In essence, digital tools have a steep learning curve, and those who can climb it quickly give their organisations a competitive edge. The World Economic Forum (2025) also expects increased demand for creative and analytical thinking, resilience, flexibility, and agility skills in the labour market, highlighting skill gaps as the biggest obstacles to business transformation.

One somewhat paradoxical finding is that critical thinking was ranked the least important soft skill by our respondents. However, other research, such as Cacciolatti et al. (2017), suggests that employers constantly seek candidates with critical and analytical thinking abilities and consider them crucial to productivity and innovation. This may reflect a current underestimation among BiH managers of the importance of analytical and problem-solving skills as technology advances. Alternatively, critical thinking is seen as a more specialised skill relevant to specific roles rather than a core skill for every employee. One insight for organisations is not to overlook critical thinking in their training programmes or hiring simply because it seems less immediately relevant today. Forward-looking businesses might start nurturing this competency now in preparation for more data-centric operations soon. Notably, the World Economic Forum (2025) projects that complex problem-solving and critical thinking will be among the most crucial workforce skills in the near future. This suggests that BiH's current low emphasis on critical thinking could be a blind spot. To stay competitive, companies in BiH may need to align with international standards and place greater weight on developing employees' analytical and critical thinking abilities.

Emotional intelligence is another skill that, while rated slightly lower than communication or adaptability, remains important, especially when considering leadership and change management. Our survey indicated that large companies, in particular, value leadership skills more strongly, which often include emotional intelligence. Leadership and emotional intelligence thus become the essential soft skills in harmonising technical skills and the transformation with interpersonal talents such as adaptability, critical thinking, and change management (Musaigwa, 2025). Notably, staff motivation was rated the number one benefit of soft skills development, which directly ties to emotional intelligence and good leadership. In summary, digital transformation highlights the need for emotionally intelligent leadership, with a leader who empowers employees, possesses digital savviness, and embraces change (Tagscherer & Carbon, 2023).

The combined data also highlight some potential gaps and areas of concern. While managers acknowledge that soft skills are important, there is little formal training being provided, as suggested in the BHAS survey. The managers might expect new hires to possess them already, or assume people will learn them informally on the job. In a rapidly changing digital environment, however, relying on passive development of soft skills may not be sufficient. The fact that small and medium firms underutilise training and do not hire ICT experts suggests that many employees in these companies wear multiple hats, troubleshooting technical issues, learning new tools on their own, and still performing their core duties.

Digital transformation and soft skills development can create a virtuous cycle if approached strategically. Without adaptability and teamwork, adopting a new technology may fail to deliver the desired results. Thus, soft skills are essential for successfully exploiting the digital transformation (Obermayer et al., 2023). Our findings that communication and teamwork are nearly uniformly valued suggest that managers understand their enabling role.

The intersection of digital trends and soft skills has implications beyond individual companies. It calls for a coordinated approach involving educational institutions, government policy, and industry initiatives to bridge the skills gap.

The first policy recommendation is to integrate soft skills in formal education by introducing the relevant courses and training into university and high school

curricula. While technical programmes naturally focus on hard skills, they could include modules on teamwork, communication, and problem-solving. Likewise, business and humanities programmes can modernise their content to discuss digital collaboration tools and remote teamwork dynamics, preparing students for the reality of the contemporary workplace. Education authorities could promote experiential learning, such as internships, project-based learning, and interdisciplinary projects, which have been shown to improve soft skills. The goal would be to produce graduates who not only have knowledge in their field but are also digital-ready communicators and adaptable thinkers.

Government and industry bodies in BiH might consider funding or facilitating national upskilling initiatives, especially for SMEs (small and medium-sized enterprises) that may lack resources for training. For example, chambers of commerce or development agencies could offer subsidised workshops on digital skills and complementary soft skills, targeting the existing workforce. Given that only about 18% of firms provide in-house ICT training (BHAS, 2024), external training support could fill this gap. Topics could range from basic digital literacy to advanced digital strategy sessions for managers, always paired with modules on effective communication in virtual teams, change management, and critical thinking in decision-making.

Companies should explicitly refine their human resource strategies to address the digital-era soft skills gap. This includes recruitment practices that assess soft skills, rather than hiring solely on technical prowess. Once employees are on board, mentorship programmes can be effective. Performance evaluations could also incorporate soft skills to signal their importance and encourage self-development in these areas. Our research suggests that interactive, feedback-driven learning is essential and that this principle can be embedded in daily work culture by enabling managers and peers to regularly give constructive feedback.

The study in the BiH context suggests that communication, adaptability, and teamwork form a triad of top-tier soft skills for the current stage of the digital economy. Communication is the linchpin for collaboration and effective technology use, adaptability is the mindset that allows employees to embrace change and continuous learning, and teamwork enables complex projects to be accomplished collectively. Emotional intelligence plays a supportive but essential

role, especially in leadership and maintaining a healthy organisational climate amidst change. Critical thinking and problem-solving, although not yet entirely in the spotlight in BiH, are undeniably the next crucial layer as more data and automation flow into businesses. Those who can think critically will be able to leverage these tools rather than be led by them. Therefore, if we project into the near future, we would emphasise a set of five core soft competencies for the digital age: communication, teamwork, adaptability, emotional intelligence, and critical thinking. This priority set mirrors the conclusions of other studies in the region, which also highlight communication, adaptability, teamwork, and critical thinking as vital skills in the digital era (Andjelkovic et al., 2025).

In conclusion, the overarching recommendation is that stakeholders in Bosnia and Herzegovina should actively work to bridge the gap between digital progress and workforce preparedness in soft skills. Soft skills development should be integrated into companies' digital transformation roadmaps, and human resource strategies must evolve to prioritise these competencies at every stage of the recruitment process. Educational institutions should update curricula to produce digitally competent graduates who are also strong communicators and team players. Government and industry groups should provide support mechanisms, such as training programmes, certifications, and knowledge-sharing platforms, focused on soft skills in the context of ICT. By implementing such strategies, BiH can cultivate a workforce that is not only technically proficient but also resilient, collaborative, and emotionally intelligent, capable of navigating the challenges and opportunities of an increasingly digitalised economy.

The limitations of this study include a geographical concentration of responses in the sample, due to non-response from the targeted population, which may limit generalisability to the entire country. Second, the concise survey design offers focused insights but limits deeper thematic exploration and a nuanced approach. Third, the understanding and interpretation of specific soft skills, such as critical thinking and emotional intelligence, may differ among respondents, thereby influencing their responses. Future research should expand the questionnaire scope, include qualitative interviews, and involve a more geographically distributed sample.

6. CONCLUSION

Our study underscores that soft skills are indispensable assets in the digital economy, functioning as the human enablers of technological advancement. In a survey of senior managers across Bosnia and Herzegovina, we found that managers generally perceive soft skills as necessary. Additionally, communication, teamwork, and adaptability consistently emerged as the most valued soft skills, with emotional intelligence also recognised as necessary. This pattern confirms that managers do not value all soft skills equally, supporting our hypothesis that communication would outrank other soft skills in perceived importance. These findings reflect a workforce reality in which effective collaboration and flexibility are crucial for leveraging new digital tools and practices. Even though critical thinking was ranked lower by BiH managers, this does not diminish its long-term importance; it instead suggests an area where proactive development is needed to help employees better solve complex problems in an increasingly data-driven business environment.

The integration of ICT adoption data into our analysis revealed a parallel narrative: while digital infrastructure and tools are spreading across firms of all sizes in BiH, investment in human capital, particularly soft skills training, has not kept pace. This misalignment highlights a skills gap that could impede organisations' digital transformation efforts if left unaddressed. For instance, our study shows that many companies expect their staff to develop soft skills informally through workplace experience. Yet, in practice, this often leaves smaller firms at a disadvantage, as they may lack formal training programmes or in-house expertise. The consequence is a workforce that is technically connected but not fully prepared to communicate, adapt, and lead in a digital setting.

Bridging this gap will require concerted action. The implications of our findings suggest that companies should champion soft skills development as a strategic priority by integrating communication and teamwork training into their change management and technology deployment initiatives and encouraging adaptability and continuous learning as part of their corporate culture. Likewise, educational institutions and policymakers in BiH have a role to play by modernising curricula and providing incentives for upskilling programmes that blend technical and soft skill development. Ultimately, cultivating soft skills is not a peripheral aspect of digital transformation but a central determinant of its

success. As Bosnia and Herzegovina continues on its path of digitalisation, fostering a workforce rich in soft skills will be key to unlocking innovation, driving productivity, and ensuring that technological advances translate into sustainable economic growth. In the digital economy, it is the human skills, such as communication, empathy, creativity, and agility, that truly bridge the skills gap, enabling technology to fulfil its promise for businesses and society at large.

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A NEW GROWTH INDICATOR FOR TÜRKIYE: MONTHLY GDP ESTIMATES USING FACTOR MODELS

ABSTRACT: *This article produces monthly GDP estimates in response to the need for growth indicators that are updated more frequently, providing timely information about the Turkish economy. In this context, a dynamic factor model and an expectation-maximisation algorithm were applied using high-frequency macroeconomic indicators for the period 1998–2024. A 29-month indicator was chosen to represent the general structure of the Turkish economy, which is characterised by the dominance of the industrial and services sectors. A high level of agreement was observed between the estimated common factor and the quarterly GDP data published by the Turkish Statistical Institute. It was noted that the model was particularly successful in detecting turning points. In addition, significant and strong correlations were found between the leading indicators of the Central Bank of the Republic of Türkiye and the estimated monthly GDP series. This supports the usability of the indicator in monitoring current economic activity for policy-making purposes. The model is evaluated both in-sample and out-of-sample, achieving 90% directional accuracy in out-of-sample forecasts. However, the model's performance deteriorates during structural shifts, such as major monetary policy transitions. Nevertheless, the study contributes to the literature by providing a monthly GDP estimate with a real-time and structural approach for the first time in Türkiye.*

KEY WORDS: *monthly GDP estimation, dynamic factor model, expectation-maximisation algorithm, Türkiye*

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1. INTRODUCTION

Accurately measuring and monitoring economic growth is crucial for the effectiveness of economic policies. The gross domestic product (GDP) provides a comprehensive picture of economic growth by calculating the total value of goods and services produced in an economy in a specific period (Blanchard, 2021). However, the delayed announcement of quarterly GDP calculations makes it difficult for policymakers and market actors to accurately evaluate current economic dynamics. Higher-frequency growth indicators are needed to guide economic policies promptly and effectively, especially in periods of rapid economic shocks and crises. For this reason, in recent years, many countries have developed monthly GDP estimation methods to monitor economic activity more closely (Angelini et al., 2011; Giannone et al., 2008).

Monthly GDP estimates are essential in creating rapid decision-making mechanisms for macroeconomic policymakers, detecting recession and crisis periods early, and providing timely information to financial markets (Evans, 2005). While most macroeconomic indicators (industrial production, inflation, unemployment rate, etc.) are published monthly, the fact that GDP is calculated only quarterly makes it challenging to analyse the timing of economic cycles. More frequently reported and updated growth estimates are needed, especially for early detection of economic processes such as cyclical fluctuations, crises, or structural transformations. For example, in the UK and the US, GDP estimates are announced one month after the end of the relevant quarter, while in European countries, it takes approximately 2 months (Bańbura et al., 2013). In Türkiye, they are also announced 2 months after the end of the relevant quarter. However, monetary policy committees in many countries meet and make decisions more frequently than every three months. Central banks generally depend on quarterly GDP data, which are announced with a lag, when determining interest rate policies. Therefore, policymakers need to estimate short-term and long-term movements in output. However, monthly GDP estimates can contribute to a healthier direction of monetary policies when evaluated together with other monthly macroeconomic indicators, such as inflation and unemployment. In addition, observing the change in economic activity over time, especially during crisis periods, can increase the effectiveness of policy interventions (Gordon, 2012).

Another important contribution of using monthly GDP calculations is that it provides better strategic guidance for investors and the private sector. Stock markets, bond yields, exchange rates, and other financial indicators are susceptible to economic growth dynamics. Since financial markets are sensitive to economic growth trends, investors can shape market expectations more accurately using monthly GDP data (Croushore & Stark, 2001). However, due to the delay in releasing quarterly data, financial markets often turn to alternative indicators, and market pricing can sometimes be based on incomplete or incorrect information. Monthly GDP estimates can help investors shape their economic expectations more accurately and reduce market uncertainty. Similarly, companies and real sector actors can optimise their production, employment, and investment decisions according to monthly economic activity.

Monthly GDP estimates, particularly in developing economies, play a crucial role in analysing regional growth differences and sectoral dynamics. The Turkish economy is heavily affected by foreign trade imbalances, exchange rate fluctuations, changes in interest rates, and global economic shocks. For this reason, the growth rates of specific sectors may show significant changes from quarter to quarter. For instance, when industrial production is rapidly contracting but the services sector continues to grow, quarterly GDP may not accurately reflect this disparity. Monthly GDP estimates can help implement microeconomic policies more effectively by allowing for earlier detection of inter-sectoral divergences.

Globalisation, the development of financial markets, and the increase in international trade have accelerated economic activities and increased the need for up-to-date data and short-term forecasts in the decision-making processes of economic actors. In recent years, short-term GDP growth forecasts have become widespread to respond to this need, and new forecasting methods have been developed in this area. The fact that GDP data are published quarterly, with a delay in most countries, while many macroeconomic indicators are collected more frequently and announced monthly, has raised the question of how this data can be effectively utilised in GDP forecasts. Monthly GDP forecasts provide critical information for policymakers and market participants by allowing for more frequent and up-to-date monitoring of economic activity. In this context, high-dimensional data sets are effectively used in estimating economic growth.

Moreover, monthly GDP estimation can also be a powerful tool in evaluating the impact of sudden economic shocks such as the COVID-19 pandemic (Chetty et al., 2024), natural disasters, or geopolitical crises. In such circumstances, policymakers need rapid feedback on the economy's condition to implement timely and targeted interventions. Traditional GDP data fail to meet this requirement. Monthly GDP can fill this void and help establish an early warning system for economic contraction.

The Turkish economy presents a unique case for the application of monthly GDP models. Structural characteristics such as high volatility, sensitivity to capital flows, frequent policy shifts, and external fragilities make it imperative to track macroeconomic performance in real-time (Bilici & Çekin, 2020). Moreover, institutions such as the Central Bank of the Republic of Türkiye (CBRT) and the Turkish Statistical Institute (TurkStat) have increasingly incorporated high-frequency indicators in their policy analyses, further reinforcing the need for monthly national accounts (CBRT, 2024).

To summarise, monthly GDP estimation provides a valuable complement to existing economic statistics by offering timelier insights into economic conditions. Its use is becoming increasingly relevant not only for macroeconomic policy and financial markets but also for enhancing the capacity of governments, businesses, and researchers to understand and respond to fast-changing economic environments.

2. LITERATURE REVIEW

Monthly GDP estimation is not only a technical challenge but also a strategic necessity for developing economies. The difficulty of collecting consistent, high-frequency data and integrating them into reliable models requires significant institutional and methodological capacity (Marcellino & Schumacher, 2010). These challenges are even more pronounced in countries with rapidly changing economic structures and political uncertainties, such as Türkiye.

There is also an ongoing methodological debate in the literature regarding the most effective approach to estimating monthly GDP. Some studies advocate for factor models due to their ability to handle large datasets and extract latent economic signals (Stock & Watson, 2002), while others favour mixed-frequency

Bayesian methods or state-space models for their flexibility in capturing structural breaks (Kim, 2020; Proietti & Moauro, 2006). This divergence reflects the importance of aligning methodological choices with country-specific characteristics and data availability.

Rünstler and Sédillot (2003) examined how monthly economic indicators can be used to estimate quarterly GDP growth in the European region. Bridge equations were developed using monthly data, such as industrial production, retail sales, consumer confidence, and composite indicators. The results showed that Bayesian VAR models performed best in missing-data estimations, while univariate ARIMA models were weak. The results show that early estimates are essential for economic policies and market analysis. Similarly, Koop et al. (2023) developed a model that combines mixed-frequency data sets to produce monthly GDP estimates for the United States. They presented a forecast model that reconciles the differences between quarterly expenditure-based and production-based GDP and supports them with monthly economic indicators, such as the unemployment rate, industrial production, and financial indicators. The monthly estimates allowed for earlier detection of business cycles and economic crises and produced more accurate estimates than quarterly data, especially during periods such as the global financial crisis and the COVID-19 pandemic.

Mitchell et al. (2012) aimed to calculate the annual GDP series for the United Kingdom from 1920 to 1938 at both monthly and quarterly frequencies. A new GDP series was derived using 14 monthly economic indicators from *The Economist* magazine. By employing modern econometric techniques, such as the Kalman filter and dynamic factor models, the study addressed missing-data issues and improved the analysis of economic fluctuations in past periods. The findings show that monthly GDP data better explains business cycles than alternative methods. It accurately captures the timing of economic contractions, especially in 1920–21 and 1929–33. Hayes and Turner (2007) also produced quarterly GDP estimates for the interwar period in the United Kingdom. Unlike Mitchell et al. (2012), this estimate does not include comprehensive macroeconomic variables and is based only on industrial production indicators.

Proietti and Moauro (2006) employed a dynamic factor model that harmonises different time series frequencies to forecast quarterly GDP data at a monthly

frequency for the US and the Eurozone. The findings show that GDP estimates derived from monthly economic indicators are broadly consistent with the quarterly data. High-frequency indicators such as industrial production, retail sales, and employment data strongly predict quarterly growth rates. Angelini et al. (2008) developed a dynamic factor model (DFM) to forecast monthly national accounts and quarterly GDP growth for the Eurozone. Their results show that this model is a powerful tool for high-frequency monitoring and short-term economic growth projections. In particular, integrating the Kalman filter and nonlinear time series modelling techniques makes the forecasts more reliable.

Hara and Yamane (2013) aimed to produce earlier estimates based on available data by modelling the relationship between high-frequency economic indicators and quarterly GDP in Japan. The study reduces the data size by extracting common factors from large datasets using principal component analysis (PCA), and the most significant variables representing economic activity are determined. Then, estimates are made by connecting monthly indicators and quarterly GDP growth. This approach produces more reliable estimates than traditional methods.

Luthfiana and Nasrudin (2018) developed a monthly forecast by establishing a relationship between economic indicators, such as the industrial production index (IPI) and quarterly GDP, for Indonesia. In their study, which employed multiple calculation methods, the ARIMA model produced forecasts with the lowest margin of error in the short term. In contrast, linear decomposition methods increased the forecast errors in some periods. Kalman filter and state-space models have successfully estimated missing data and converted quarterly data into monthly data. In addition, mixed-frequency data provide lower error rates compared to traditional methods. Kim (2020) proposed a new method to estimate monthly GDP for the Canadian and South Korean economies. A state-space model and vector error correction model (VECM) were used to convert low-frequency (quarterly) data, such as GDP, to high-frequency (monthly) data. The Gibbs sampling technique, one of the Bayesian methods, was applied for the estimation of the model. These results, especially those from the Gibbs sampling method, have proven to outperform traditional models.

Although the studies in the literature use different methodologies for estimating monthly GDP, they share a common goal: to fill the information gap created by the delayed publication of quarterly GDP and to provide more timely and accurate estimates of economic growth by using high-frequency macroeconomic indicators, such as industrial production, retail sales, consumer confidence indices, and financial indicators.

This study employs dynamic factor models to extract common components from a large set of monthly macroeconomic indicators and to produce a monthly GDP series compatible with official quarterly national accounts. Most studies in the literature demonstrate that factor models are an essential tool for improving short-term forecasts by capturing the typical movements of high-frequency economic indicators. Building on this literature, our study employs factor models to produce monthly GDP estimates using a large dataset that includes variables representing various dynamics of the Turkish economy, such as industrial production, electricity consumption, foreign trade data, credit volume, the unemployment rate, the capacity utilisation rate, and confidence indices. In the next section, we will detail the dataset used in our study, the factor modelling approach, and our estimation process.

3. ESTIMATING MONTHLY GDP WITH THE FACTOR MODEL

This section presents the estimation of monthly GDP using a factor model framework. Unlike previous studies for Türkiye that only convert quarterly GDP into monthly figures, this study estimates monthly GDP in real time by incorporating both monthly and quarterly data from relevant economic indicators, applying an expectation-maximisation (EM) algorithm within the dynamic factor model framework developed by Stock and Watson (2002).

Factor modelling is a multivariate statistical analysis technique designed to identify common features that may exist within a complex structure among a set of correlated variables. In other words, it is a technique used to identify and interpret fundamental characteristics that can explain the relationships between variables. It establishes a statistical model that expresses the relationships between individual variables and their common factors. Since there is no limit to the number of variables that can be used, we can leverage the information from various variables on a large scale in our numerical analysis. Consequently, when

GDP is viewed as an indicator of a country's overall economic situation and performance, a factor model allows us to identify common features among different economic indicators that explain each area of economic activity. This model also enables us to capture the monthly movements of GDP effectively.

In the factor model, it is assumed that N random variables (X_{it}, for $i = 1, 2, ..., N$) that satisfy the stationarity condition consist of two components at each time point t: a common component and a unique component. The common components represent shared properties among the variables, while the unique components capture the idiosyncratic characteristics of each variable. Thus, the factor model can be expressed as the sum of the common components ($\Omega_i'\Psi_t$) and the unique components (ξ_{it}), which are linear combinations of M common factors (Ψ_t) and factor loadings (Ω_i). Therefore, the following model can be written for $t = 1,2, \ldots, T$ and $i = 1,2, \ldots, N$:

$$X_{it} = \Omega_i'\Psi_t + \xi_{it} \tag{1}$$

If equation (1) is expressed as a vector at each time point t of X_{it}, the following equation can be written for $t = 1,2, \ldots, T$:

$$X_t = \Omega\Psi_t + \xi_t \tag{2}$$

where $X_t = (X_{1t}, \ldots, X_{Nt})$, $\Omega = (\Omega_1, \ldots, \Omega_N)$, and $\Psi_t = (\Psi_{1t}, \ldots, \Psi_{Mt})$. We can express Equation (2) in vector form for each variable. For $i = 1, \ldots, N$, this leads us to Equation (3):

$$X_i = \Psi'\Omega_i + \xi_i \tag{3}$$

where $X_i = (X_{i1}, \ldots, X_{iT})$ and $\Psi = (\Psi_1, \ldots, \Psi_T)$.

The principal components technique is commonly used to estimate common factors (Ψ_t) and factor loadings (Ω_i). To do this, the sample covariance matrix $\left(T^{-1}\sum_{i=1}^{T} X_t X_t'\right)$ of the random variable vector X_t is utilised to calculate the eigenvector $\Lambda = (\Lambda_1, \ldots, \Lambda_M)$ corresponding to the M eigenvalues. Using these values, estimates of the common factors and factor loadings are obtained as follows:

$$\widehat{\Psi}_t = \Lambda' X_t \text{ and } \hat{\Omega}_t = \Omega_i \tag{4}$$

The factor model we have considered so far assumes that the indicators are observed at the same frequency. It is not possible to directly apply it to indicators observed at different frequencies, such as monthly indicators and quarterly GDP. However, to address this issue, Stock and Watson (2002) proposed using the EM algorithm to adapt the factor model to simultaneously analyse data collected over different time frames. In this context, the process of estimating monthly GDP consists of the following steps:

1. By assigning a temporary value to the monthly GDP estimate $\hat{X}_i$, the initial value $\hat{X}_i^{(0)}$ is obtained and the factor model is applied to the monthly indicator used in order to calculate the initial estimates of the common factor $\left(\widehat{\Psi}^{(0)}\right)$ and factor loadings $\left(\hat{\Omega}_i^{(0)}\right)$.
2. The EM steps described below are repeated until the monthly GDP estimates converge (for $k = 1, \ldots, K$). Convergence is achieved when the maximum difference between the estimate obtained in the iteration stage and the estimate obtained in the previous stage is less than 10^{-4}.

Stage E: The (k-1)th stage monthly GDP estimate $\left(\hat{X}_i^{(k)}\right)$ is obtained as the conditional expected value using the common factor estimate $\left(\widehat{\Psi}^{(k-1)}\right)$, the re-estimated factor loadings $\left(\hat{\Omega}_i^{(k-1)}\right)$, and the observed$(X_i^*)$.

$$\begin{aligned}\hat{X}_i^{(k)} &= E\left(X_i \middle| X_i^*, \widehat{\Psi}^{(k-1)}.\hat{\Omega}^{(k-1)}\right) \\ &= \Gamma.\widehat{\Psi}'^{(k-1)}\hat{\Omega}_i^{(k-1)} + \hat{\xi}_i^{(k-1)}\end{aligned} \tag{5}$$

where (X_i^*) is defined as

$$X_i^* = \Gamma X_i = \frac{1}{3}\begin{pmatrix} \ddots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \cdots & 1 & 1 & 1 & 0 & 0 & 0 \\ \cdots & 0 & 0 & 0 & 1 & 1 & 1 \end{pmatrix} X_i,$$

which represents the relationship between monthly and quarterly GDP figures. The derivation of matrix Γ in Equation (5), which represents the conditional expectation, is given in Appendix 1.

Similarly, the estimate of the unique component is as follows:

$$\hat{\xi}_i^{(k-1)} = \Gamma'(\Gamma\Gamma')^{-1}\left(X_i^* - \Gamma\widehat{\Psi}^{(k-1)}\hat{\Omega}_i^{(k-1)}\right)$$

Stage M: In the E-stage, monthly GDP estimates $\hat{X}_i^{(k)}$ and monthly indicators are recalculated by applying the factor model to the common factor and factor loading estimates. That is, the common factor estimate $\widehat{\Psi}^{(k)}$ and the factor loading estimate $\hat{\Omega}_i^{(k)}$ of the kth iteration are obtained from the standard covariance matrix $S = T^{-1}\sum_{t=1}^{T}\hat{X}_t^{(k)}\hat{X}_t'^{(k)}$ using Equation (4). This numerical analysis process is repeated sequentially until the monthly GDP converges and the final monthly GDP $\hat{X}_t = \hat{X}_t^{(K)}$ is obtained. At this point, the common factor estimate is $\widehat{\Psi} = \widehat{\Psi}^{(K)}$ and the factor loading estimate is $\hat{\Omega}_i = \hat{\Omega}_i^{(K)}$.

The DFM and the EM algorithm together offer a practical framework for estimating latent economic variables such as monthly GDP from high-dimensional indicator datasets. DFMs are particularly effective in summarising co-movements in large panels of macroeconomic series by extracting a small number of unobserved common factors that drive the dynamics of observed indicators (Stock & Watson, 2002). This dimensionality reduction is particularly useful in high-frequency estimation contexts such as nowcasting, where timely insights are prioritised.

However, the DFM assumes linear relationships among variables and stationarity in the underlying data-generating process. These assumptions can limit the model's ability to capture structural breaks or nonlinear dynamics commonly observed in emerging markets (Doz et al., 2011). While some robustness can be achieved through careful data preprocessing, the model may still underperform during periods of abrupt economic change, such as crises or policy regime shifts.

The EM algorithm facilitates the estimation of model parameters and unobserved factors even when data are missing or the latent variable is partially observed (Dempster et al., 1977). Nevertheless, it is well-known that the EM algorithm is sensitive to the choice of initial values and may converge to local rather than global maxima. This is particularly relevant in dynamic factor settings where likelihood surfaces can be complex and multi-modal. Furthermore, convergence

can be slow, especially when dealing with large datasets or when the signal-to-noise ratio is low.

Despite these challenges, the DFM–EM framework remains one of the most widely used methodologies in high-frequency GDP estimation, offering transparency, replicability, and strong empirical fit when carefully calibrated.

4. MONTHLY GDP FORECAST FOR TÜRKİYE

In this section, we will estimate monthly GDP for Türkiye using the factor model and evaluate the appropriateness of the estimates.

4.1. Data

To estimate monthly GDP, it is essential to identify the various indicators for the factor model. When preparing the monthly GDP estimate, the goal was to select as many monthly indicators as possible that explain each sector of the country's economy from the available data. The definitions and data sources for a total of 64 preferred indicators are provided in Appendix 2. The correlation of these indicators with GDP on a quarterly basis from 1998 to 2024 was examined (see Appendix 3). Following the suggestion by Cuevas and Quilis (2012), 29 indicators exhibiting a correlation of 40% or higher were included in the factor analysis. These indicators are classified under the main categories of production (industry and services), expenditure, and other indicators (see Table 1 below). The selection process prioritises indicators that capture sector-specific dynamics and exhibit minimal publication delay. Particular attention was given to high-frequency series, such as industrial production, electricity consumption, capacity utilisation, foreign trade flows, and credit volume – variables widely used in the literature on monthly GDP estimation (Angelini et al., 2011; Giannone et al., 2008). Each time series used in the factor model estimation consists of 324 observations covering the period from January 1998 to December 2024. To ensure stationarity and comparability across series, all variables were seasonally adjusted using the TRAMO/SEATS method and transformed into logarithmic first differences, as commonly applied in factor-based macroeconomic models (Marcellino & Schumacher, 2010; Stock & Watson, 2002). This transformation enables the model to focus on the co-movements in growth rates rather than levels, thereby minimising the impact of structural breaks or base effects in the raw data.

The Turkish data environment presents several challenges for real-time macroeconomic estimation, as indicators may be subject to irregular revisions, definitional changes, or publication lags. Therefore, an additional filtering process was applied to ensure consistency over time and minimise the influence of data gaps or methodological shifts. In line with Koop et al. (2023), preference was given to indicators with a relatively stable historical structure and continuous monthly availability throughout the entire period. The common factor, representing the shared features of each indicator, was estimated by applying the EM algorithm to the factor model. Additionally, monthly GDP series were estimated for the period 1998 to 2024 based on the available quarterly GDP data.

4.2. Estimation results

Table 1 presents the factor model using 29 monthly indicators, with factor loadings derived from the application of the EM algorithm. The analysis identified a single common factor, which accounts for approximately 83% of the total variance. Factor loadings indicate the relative influence of each indicator on the common factor and are used to calculate the weights assigned to individual indicators in determining the common factor. The table shows that all indicators have a positive effect on the common factor. This suggests that the estimated common factor can serve as a comprehensive indicator reflecting the average characteristics of the 29 indicators in question. According to the table, the industry and services sectors exert the highest impact on the common factor, contributing approximately 26% and 62%, respectively. In the industrial sector, manufacturing accounts for approximately 20%, with clothing, basic metals, textiles, and vehicles as the key sub-sectors. In the services sector, wholesale and retail trade, transportation, and support services are the prominent sub-sectors.

Table 1: Weighting of monthly indicators according to factor loadings

Sector	Factor loadings	Weight	Sector total
*Industrial production**	18.73	2.78	25.90
-Mining and quarrying*	10.53	1.56	
-Electricity, gas, steam, and air conditioning supply*	11.90	1.76	
-Manufacturing*	21.62	3.20	
-- Motor vehicles, trailers and semi-trailers*	12.33	1.83	
-- Fabricated metal products, except machinery and equipment*	7.12	1.06	
-- Rubber and plastic products*	9.89	1.47	
-- Wearing apparel*	23.52	3.49	
-- Basic metals*	13.82	2.05	
-- Food products*	9.17	1.36	
-- Coke and refined petroleum products*	6.27	0.93	
-- Textiles*	18.85	2.79	
-- Machinery and equipment*	7.02	1.04	
-- Chemicals and chemical products*	3.91	0.58	
-- Other manufacturing*	0.08	0.01	
*Service production**	97.58	14.46	62.31
-- Retail and wholesale trade*	79.55	11.79	
-- Accommodation and food service activity*	66.90	9.92	
-- Administrative and support service activities*	77.82	11.53	
-- Transportation and storage*	92.08	13.65	
-- Education and health*	6.49	0.96	
*Total private consumption expenditures**	16.84	2.50	5.40
-- Semi-durables*	12.88	1.91	
-- Durables*	6.67	0.99	
*Import***	1.27	0.19	0.19
*Export***	9.21	1.36	1.36
*Total investment expenditures**	2.66	0.39	0.39
*Construction production index***	15.44	2.29	2.29
*Capacity utilisation rate***	14.61	2.17	2.17
Total	674.76	100	100

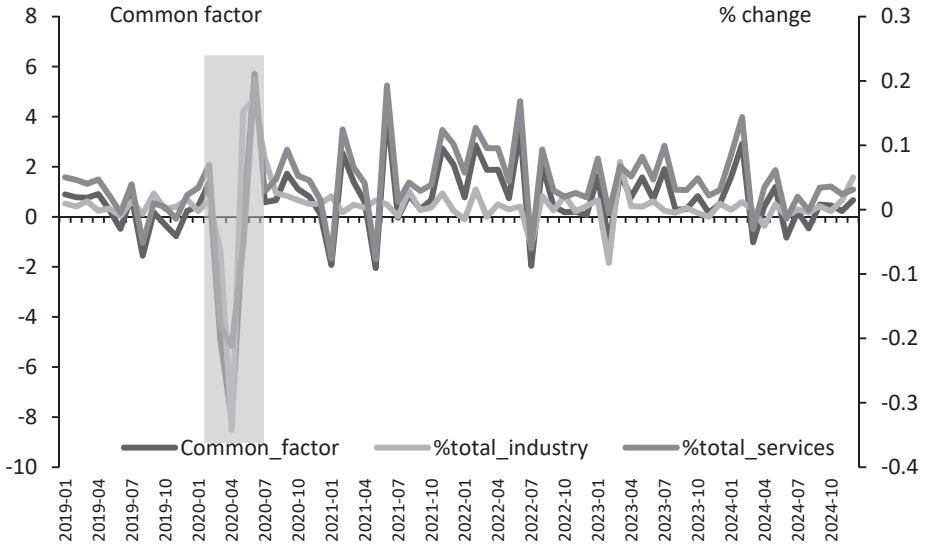
Note: * indicates a 4-week delay, while ** signifies a 2- to 3-week delay in the publication of the relevant data.

Table 2 presents the cross-correlation coefficients for the main sector groups, clearly demonstrating both the forward and backward monthly correlations between the common factor and the industry and services sectors. The prominence of service sector indicators highlights the structural transformation of the Turkish economy during the sample period, with services contributing over 55% of GDP post-2010. These results confirm that the extracted factor effectively captures the cyclical behaviour of key sectors in the Turkish economy. The significant contemporaneous and lead correlations with service production, reaching 0.97, indicate that the common factor is strongly aligned with the short-term dynamics of the service sector, which accounts for a substantial portion of GDP. Furthermore, the positive lead correlations suggest that the common factor may serve as a reliable early indicator of economic activity, particularly in service-oriented environments. This forward-looking attribute is crucial for policymakers aiming to anticipate shifts in business cycles and implement timely interventions (Giannone et al., 2008). This relationship is further illustrated in Figure 1, which encompasses the last six years and highlights the substantial influence of these sectors on the common factor. The evidence from Table 2 and Figure 1 supports the interpretation of the common factor as a composite business cycle indicator. This indicator effectively correlates with short-term sectoral performance and demonstrates predictive capability for forthcoming movements in aggregate output.

Table 2: Cross-correlations between the common factor and its components

Common factor component	Lag (month)			Current	Lead (month)		
	3	2	1	0	1	2	3
Industrial production	0.10	0.35	0.29	0.53	0.20	0.18	0.09
Manufacturing	0.16	0.19	0.41	0.56	0.24	0.12	0.10
Service production	0.19	0.45	0.67	0.97	0.51	0.33	0.11
Private consumption	0.05	0.25	0.21	0.21	0.38	0.37	0.09
Construction production	0.01	0.09	0.09	0.16	0.43	0.40	0.32
Capacity utilisation	0.03	0.14	0.24	0.36	0.21	0.12	0.08

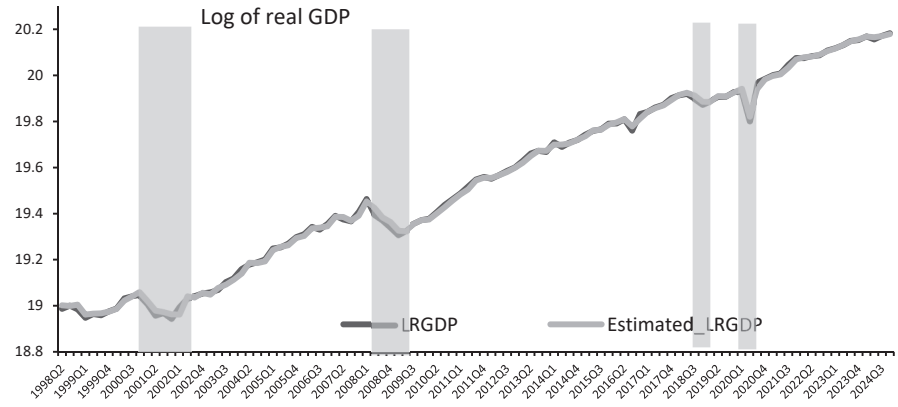
Figure 1: Common factor, industry and services (% change)



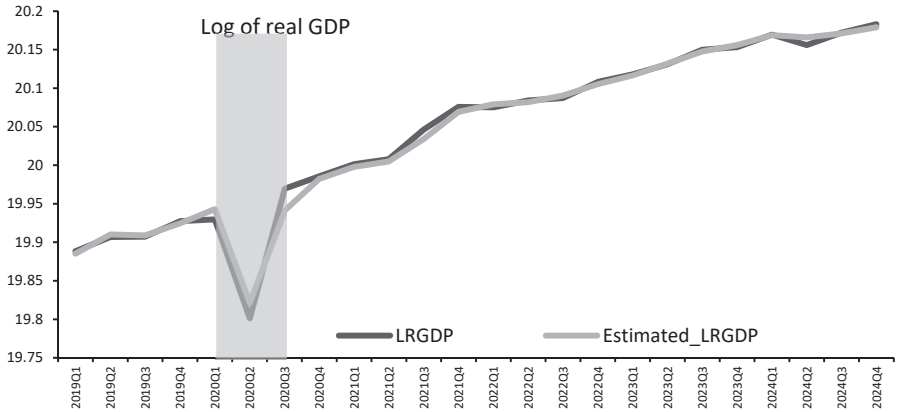
Note: Shaded area represents the economic turbulence period.

Part A of Figure 2 compares quarterly GDP values derived from monthly estimates with the actual quarterly GDP values for the entire sample period. In contrast, Part B focuses on the same variables for the last six years. Following this systematic approach, Figure 3 presents the estimated and actual annual change rates. Both figures demonstrate the consistency of the estimates, with particular emphasis on their success in identifying turning points. Examining the mean, standard deviation, and coefficient of variation for the estimates and actual values presented in Table 3 reveals a close alignment between these values, supporting our previous findings. Additionally, we assess forecast performance using Theil's U coefficient. As shown in Table 3, the coefficient is very close to zero, indicating that the error percentages attributable to bias and variance are extremely low. However, the high percentage of unsystematic (covariance-related) error highlights the accuracy and consistency of the estimates.

Figure 2: Estimated and actual real GDP (in log levels)



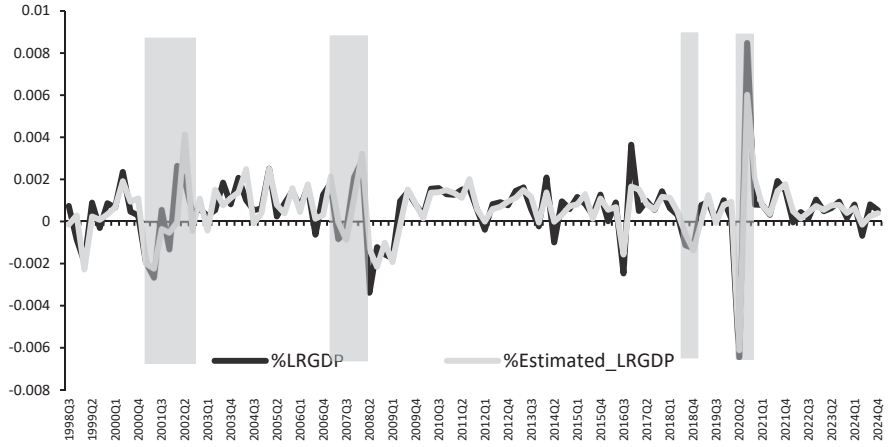
(A) Full sample



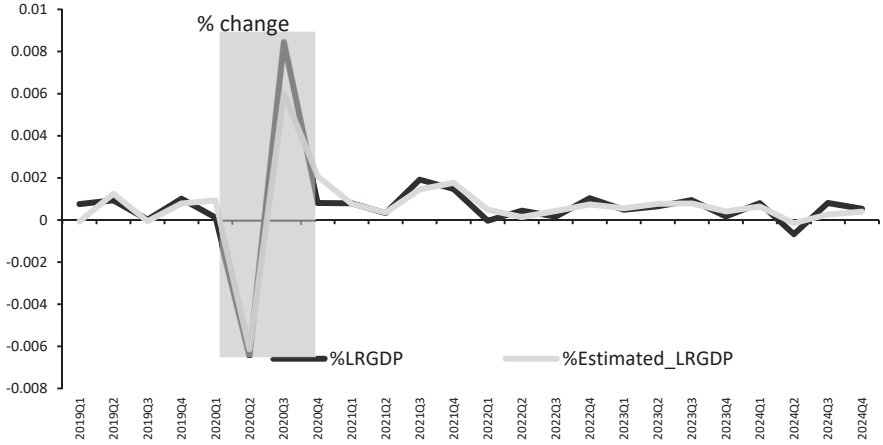
(B) 2019–2024

Note: Shaded areas represent the economic turbulence periods

Figure 3: Estimated and actual GDP (annual % change)



(A) Full sample



(B) 2019–2024

Note: Shaded areas represent the economic turbulence periods

Table 3: In-sample forecast performance metrics

	Estimated GDP	Actual GDP
Mean (log level)	19.54055	19.54048
Standard deviation	0.384989	0.386098
Coefficient of variation	0.019702	0.019759
Theil's U coefficient	0.000263	
Bias component	0.000059	
Variance component	0.011522	
Covariance component	0.988418	

The low value of Theil's U coefficient indicates the necessity of evaluating the model's out-of-sample predictive performance to mitigate potential bias. To achieve this objective, the factor model was re-estimated using the previously identified variables and data covering the period from January 1998 to December 2019. The results obtained were used to estimate monthly GDP growth rates for the out-of-sample period from January 2020 to December 2024. The rationale for this selection as to assess the model's forecasting performance during the contraction phase resulting from the epidemic in 2020. Figure 4 displays the estimated and actual quarterly economic growth rates. The results indicate that the model effectively captures the contraction period in question; however, it overestimates the extent of the contraction and underestimates the subsequent post-contraction period. Moreover, the model forecasts a negative growth rate for 2023, which is inconsistent with the actual outcomes. The specified period corresponds to the initial increase of interest rates in the Turkish economy from 8.5% to 15%, followed by a gradual rise to 40.5%. In this process, the model results in negative economic growth because of the contraction in industrial production.

Figure 4: Estimated and actual growth rates of real GDP (2020–2024)

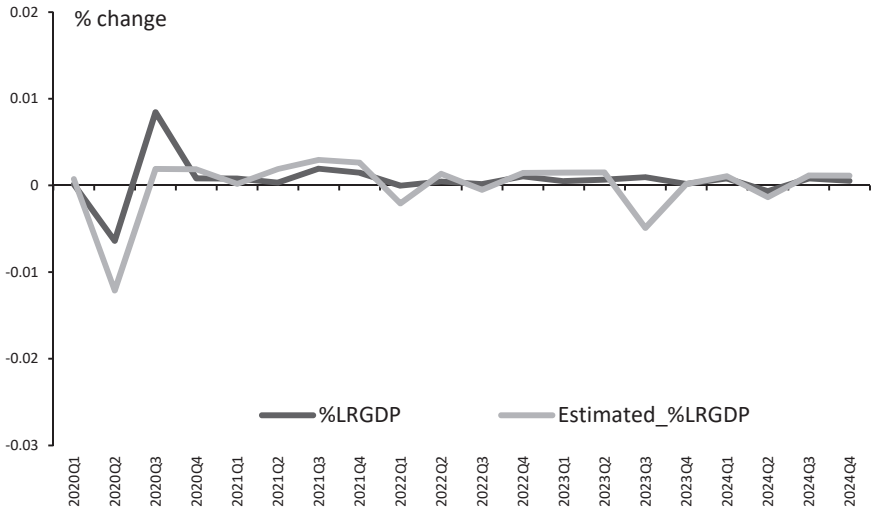


Table 4: Out-of-sample forecast performance metrics

Metric	Value
ME	-0.0006
MAE	0.0016
DA	90.48%
RMSFE	0.0032
sMAPE	46.80%
Theil's U coefficient	0.1765
Bias component	0.0739
Variance component	0.1428
Covariance component	0.7834

Table 4 summarises the metrics related to the model's out-of-sample forecast performance. A negative mean error (ME) value indicates that the model's predictions exceed the actual values, reflecting an optimistic bias. Conversely, a very low ME value suggests that this bias is not substantial. A low mean absolute error (MAE) value of 0.0016 indicates that the model's predictions closely align with actual outcomes during normal periods, reflecting satisfactory performance.

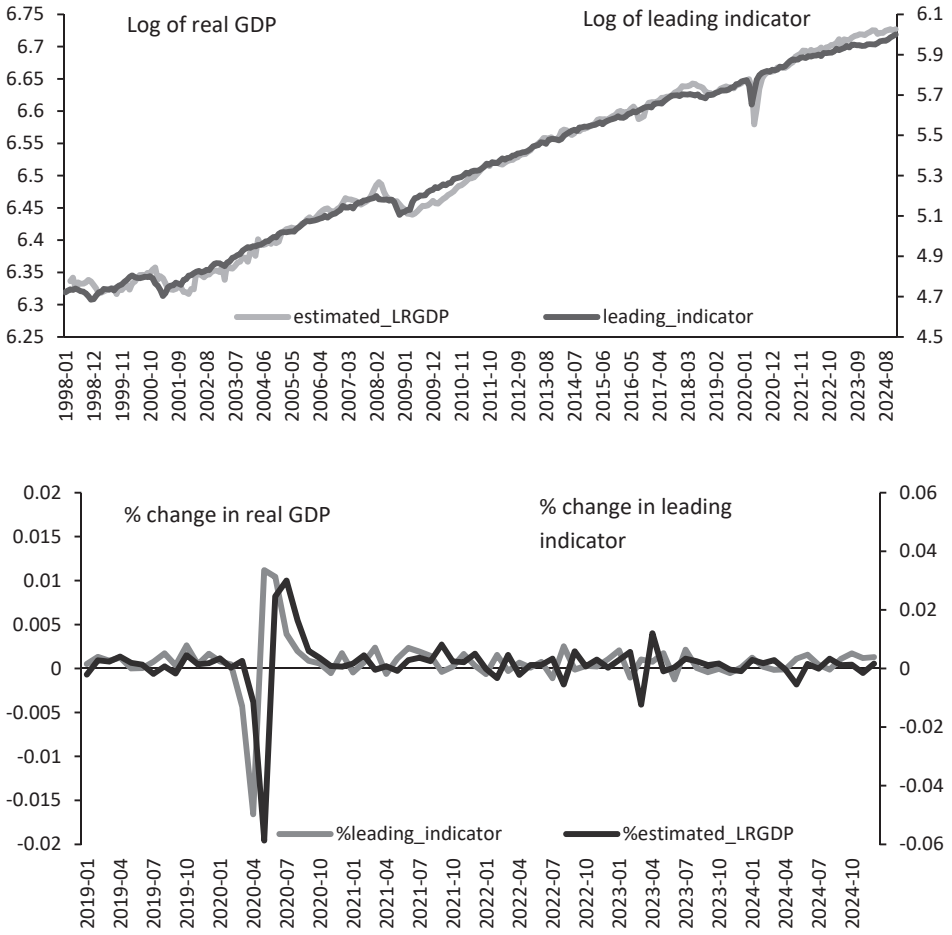
The elevated value of the directional accuracy (DA) criterion suggests that the model effectively captures the direction of growth or contraction in the majority of instances. However, a directional deviation was observed during an atypical period in 2023. A smaller root mean squared forecast error (RMSFE) indicates that the model's predictions are more closely aligned with the actual values. Given that this metric is scale-dependent, it is more accurate to evaluate it in conjunction with the ME. The elevated RMSFE value in relation to the ME value highlights the magnitude of the forecast errors produced by the model, especially during exceptional periods, such as 2020 and 2023. The symmetric mean absolute percentage error (sMAPE) is a metric used to quantify forecast errors as a percentage, effectively normalising the discrepancy between forecasted and actual values. The observation that this ratio is below the generally accepted threshold of 50% indicates that while the predictions are acceptable, they lack robustness as strong predictors. It is important to recognise that using small values in the calculation – especially when the actual value is close to zero – can artificially inflate the sMAPE. Theil's U coefficient indicates that, although the estimate is not perfect, it is at an acceptable level. Achieving low error percentages attributable to bias and variance suggests that the model is free from systematic bias and accurately represents fluctuations. In other words, the model's dynamic structure is appropriate. As anticipated, the significant proportion of covariance in the errors suggests that the majority of the errors are random and do not exhibit a systematic component.

To further contextualise our out-of-sample results, it is worth noting that similar studies for the Turkish economy have adopted factor-based nowcasting frameworks. For instance, Modugno et al. (2016) applied a mixed-frequency dynamic factor model to nowcast quarterly Turkish GDP and assess the contribution of incoming data through news decomposition. While their model is designed for quarterly GDP nowcasting, our approach provides monthly structural estimates using a unified DFM–EM framework over a longer period. Nonetheless, their evaluation strategy offers a useful benchmark, and future work could integrate similar nowcasting validations more systematically.

To demonstrate the usefulness of monthly GDP estimates for economic evaluations, Figure 5 illustrates their relationship with the leading indicators index prepared by the CBRT. The figure shows that both series exhibit a

compatible trend within a specific lag structure. Notably, the one-month lag correlation value of approximately 94% indicates a strong alignment in their cyclical movements. Consequently, it is evident that the monthly GDP values serve as meaningful estimates for assessing the volume of activities in the country's economy.

Figure 5: Leading economic indicators index and monthly GDP



4.3. Model evaluation strategy

To assess the reliability and robustness of the estimation framework, the performance of the DFM combined with the EM algorithm was evaluated both

in-sample and out-of-sample. While the in-sample evaluation reflects how well the model replicates historical GDP data, the out-of-sample analysis provides insight into its predictive capacity under real-time forecasting conditions.

During the in-sample period covering 1998Q1 to 2021Q4, the model demonstrated near-perfect accuracy, with a Theil's U coefficient of 0.000263 and an sMAPE of just 2.34%. This strong fit was expected, given that the latent factor was extracted directly from the observed indicator panel. However, the out-of-sample evaluation – based on predictions for the period 2022Q1 to 2023Q4 – offered a more stringent test of model performance. During this test phase, the model achieved a directional accuracy of 90%, correctly predicting the sign of GDP growth in 7 out of 8 quarters. The out-of-sample Theil's U rose to 0.1765, and the sMAPE increased to 47.83%, which, while higher than the in-sample values, remains within acceptable forecasting standards for high-frequency GDP estimation in emerging market economies. A side-by-side summary of key performance indicators is presented in Table 5:

Table 5: In-sample vs. out-of-sample forecast performance

Metric	**In-sample**	**Out-of-sample**
Theil's U	0.000263	0.1765
sMAPE (%)	2.34	47.83
RMSFE	0.0021	0.0357
Directional accuracy	100%	90%

The decomposition of Theil's U reveals that most of the forecast error in the out-of-sample period stems from the unsystematic component, with the covariance proportion reaching 78%. This indicates that the model does not systematically over- or under-predict but may struggle in periods of abrupt structural change.

Indeed, the model failed to capture the magnitude and direction of GDP growth in 2023Q2, which coincided with a period of extraordinary monetary tightening – when the policy interest rate increased sharply from 8.5% to 40.5%. This reinforces the finding that while the DFM–EM framework performs well under stable conditions, its accuracy may deteriorate during sudden policy regime shifts. These limitations align with findings from Modugno et al. (2016), who also

noted performance deterioration of similar models during periods of intense structural adjustment.

Despite these constraints, the model's high directional accuracy and alignment with leading indicators, such as the CBRT's composite index, underscore its value as a real-time monitoring tool. The results also highlight the importance of complementing traditional factor-based approaches with robustness checks and, potentially, regime-sensitive models in future research.

5. CONCLUSION

In this study, high-frequency macroeconomic indicators were used to make monthly GDP estimates for the Turkish economy by combining a dynamic factor model and an EM algorithm. The common factor estimated through 29 monthly indicators covering the period 1998–2024 effectively represents the movements of real GDP; the decisive effect of the industry and services sectors on this factor is particularly striking. A high level of compliance was observed between the quarterly growth rates derived from monthly estimates and the official data published by the Turkish Statistical Institute; it was also observed that the forecast model exhibited a strong performance in terms of identifying turning points.

The high correlation between the forecast results and the leading indicator index of the Central Bank of the Republic of Türkiye confirms the usability of the developed monthly GDP indicator in both monitoring current economic activity and macroeconomic policy-making processes. Especially during periods of rapid economic shocks, the ability of decision-makers to evaluate economic growth trends without waiting for the publication of quarterly data provides a significant advantage in terms of the timing of policy interventions. Similarly, financial markets and private sector actors can shape their expectations more accurately by using monthly GDP indicators.

As a result, unlike previous studies conducted for Türkiye, this study not only converts quarterly GDP data into the monthly form but also presents a structural framework that enables real-time monthly estimation using high-frequency indicators. The monthly GDP figures produced here are model-based estimates within a dynamic factor model framework and are not official statistics. Although

not endorsed by TurkStat, they serve as useful complementary tools for analytical and policy-making purposes.

The model demonstrated a near-perfect in-sample fit (Theil's U = 0.000263), and its forecasting ability was tested through out-of-sample validation. The results indicate strong out-of-sample performance, achieving 90% directional accuracy and a symmetric mean absolute percentage error below 50%, with most forecast errors being unsystematic. This finding underscores the model's value in tracking macroeconomic trends during normal periods. However, a clear deterioration in performance was observed during structural regime changes, such as the sharp monetary policy shift in 2023 (interest rates increased from 8.5% to 40.5%), which the model failed to anticipate directionally.

This contrast between interpolation quality and true forecasting performance offers valuable insights into the model's strengths and limitations. While the framework is highly effective for nowcasting and trend detection under stable conditions, it should be used with caution during episodes of structural volatility. In this respect, the study contributes to both the academic literature and policy circles by offering a transparent and replicable monthly GDP proxy for Türkiye and by providing a case study of the trade-offs between in-sample precision and out-of-sample robustness.

Future work may improve this framework by experimenting with different numbers of factors and indicator groupings, or by incorporating alternative models, such as regime-switching or nonlinear approaches that better adapt to structural breaks.

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APPENDICES

Appendix 1: Derivation of matrix Γ in conditional expectation equation

According to Stock and Watson (2002), the matrix Γ in Equation 5, representing the conditional expectation, is obtained as follows. If we take the natural logarithms of quarterly real GDP $\left(Y_t^q\right)$ and monthly real GDP (Y_t^m), we can write following relationship:

$$logY_t^q = \frac{1}{3}(logY_t^m + logY_{t-1}^m + logY_{t-2}^m)$$

This equation is valid as long as $t = 3, 6, .., T$. When the above equation is converted into seasonal difference form, the following is obtained:

$$\Delta_{12}logY_t^q = logY_t^q - logY_{t-12}^q = \frac{1}{3}(\Delta_{12}logY_t^m + \Delta_{12}logY_{t-1}^m + \Delta_{12}logY_{t-2}^m)$$

If we define

$$\Delta_{12}logY = \left(\Delta_{12}logY_3^q, \dots, \Delta_{12}logY_{T-3}^q, \Delta_{12}logY_T^q\right)$$

and

$$\Delta_{12}logY^m = (\Delta_{12}logY_1^m, \dots, \Delta_{12}logY_{T-1}^m, \Delta_{12}logY_T^m),$$

the last equation above can be expressed as

$$\Delta_{12}logY^q = \Gamma.\Delta_{12}logY^m$$

$$\Gamma = \frac{1}{3}\begin{pmatrix} \ddots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \cdots & 1 & 1 & 1 & 0 & 0 & 0 \\ \cdots & 0 & 0 & 0 & 1 & 1 & 1 \end{pmatrix}$$

Therefore, the relationship between $X_i^*(= \Delta_{12}logY^q)$ and $X_i(= \Delta_{12}logY^m)$ is expressed as $X_i^* = \Gamma X_i$.

Appendix 2: Definition and sources of the data

Indicator	Period
Industrial production	1998:01–2024:12
- Mining and quarrying	1998:01–2024:12
-- Mining of coal and lignite	1998:01–2024:12
-- Extraction of crude petroleum and natural gas	1998:01–2024:12
-- Mining of metal ores	1998:01–2024:12
-- Other mining and quarrying	1998:01–2024:12
- Manufacturing	1998:01–2024:12
-- Food products	1998:01–2024:12
-- Beverages	1998:01–2024:12
-- Tobacco products	1998:01–2024:12
-- Textiles	1998:01–2024:12
-- Wearing apparel	1998:01–2024:12
-- Leather and related products	1998:01–2024:12
-- Wood and products of wood and cork	1998:01–2024:12
-- Paper and paper products	1998:01–2024:12
-- Printing and reproduction of recorded media	1998:01–2024:12
-- Coke and refined petroleum products	1998:01–2024:12
-- Chemicals and chemical products	1998:01–2024:12
-- Basic pharmaceutical products and pharmaceutical preparations	1998:01–2024:12
-- Rubber and plastic products	1998:01–2024:12
-- Other non-metallic mineral products	1998:01–2024:12
-- Basic metals	1998:01–2024:12
-- Fabricated metal products	1998:01–2024:12
-- Computer, electronic and optical products	1998:01–2024:12
-- Electrical equipment	1998:01–2024:12
-- Machinery and equipment	1998:01–2024:12
-- Motor vehicles, trailers and semi-trailers	1998:01–2024:12
-- Other transport equipment	1998:01–2024:12
-- Furniture	1998:01–2024:12
-- Other manufacturing	1998:01–2024:12
-- Repair and installation of machinery and equipment	1998:01–2024:12
- Electricity, gas, steam and air conditioning supply	1998:01–2024:12
Service production	1998:01–2024:12
- Retail and wholesale trade	1998:01–2024:12
- Services of the business economy	1998:01–2024:12
- Financial services	1998:01–2024:12

- Transportation and storage	1998:01–2024:12
- Accommodation and food service activities	1998:01–2024:12
- Education and health	1998:01–2024:12
- Information and communication	1998:01–2024:12
- Real estate activities	1998:01–2024:12
- Professional, scientific and technical activities	1998:01–2024:12
- Administrative and support service activities	1998:01–2024:12
Agriculture production index	1998:01–2024:12
Construction production index	1998:01–2024:12
Total private consumption expenditures	1998:01–2024:12
- Durables	1998:1–2024:4*
- Semi-durables	1998:1–2024:4*
- Nondurables	1998:1–2024:4*
Government consumption expenditures	1998:1–2024:4*
Total investment expenditures	1998:1–2024:4*
Export	1998:1–2024:4*
Import	1998:1–2024:4*
Changes in stocks	1998:1–2024:4*
Building cost index	1998:01–2024:12
Construction cost index	1998:01–2024:12
Housing cost index	1998:01–2024:12
Import quantity index	1998:01–2024:12
Import price index	1998:01–2024:12
Export quantity index	1998:01–2024:12
Export price index	1998:01–2024:12
Consumer price index	1998:01–2024:12
*Capacity utilisation rate***	1998:01–2024:12
Real gross domestic product	1998:1–2024:4*
*Leading indicators index***	1998:1–2024:12

(*) The original frequency of the data is quarterly

(**) The Central Bank of the Republic of Türkiye calculates and publishes the data.

Note: All the data are compiled by the Turkish Statistical Institute on a monthly frequency unless otherwise indicated. All the data are seasonally adjusted by using the TRAMO/SEATS methodology, and log-differenced before the factor analysis.

Appendix 3: Correlation coefficients for quarterly change rates

Indicator	Correlation with GDP
Industrial production	0.86
- Mining and quarrying	0.43
-- Mining of coal and lignite	0.09
-- Extraction of crude petroleum and natural gas	0.47
-- Mining of metal ores	0.08
-- Other mining and quarrying	0.20
- Manufacturing	0.86
-- Food products	0.42
-- Beverages	0.06
-- Tobacco products	0.03
-- Textiles	0.49
-- Wearing apparel	0.44
-- Leather and related products	0.24
-- Wood and products of wood and cork	0.27
-- Paper and paper products	0.24
-- Printing and reproduction of recorded media	0.04
-- Coke and refined petroleum products	0.30
-- Chemicals and chemical products	0.49
-- Basic pharmaceutical products and pharmaceutical preparations	0.09
-- Rubber and plastic products	0.57
-- Other non-metallic mineral products	0.08
-- Basic metals	0.74
-- Fabricated metal products	0.59
-- Computer, electronic and optical products	0.04
-- Electrical equipment	0.24
-- Machinery and equipment	0.49
-- Motor vehicles, trailers and semi-trailers	0.75
-- Other transport equipment	0.10
-- Furniture	0.12
-- Other manufacturing	0.70
-- Repair and installation of machinery and equipment	0.22

- Electricity, gas, steam, and air conditioning supply	0.46
Service production	0.90
- Retail and wholesale trade	0.66
- Services of the business economy	0.12
- Financial services	0.18
- Transportation and storage	0.49
- Accommodation and food service activities	0.45
- Education and health	0.43
- Information and communication	0.28
- Real estate activities	0.13
- Professional, scientific and technical activities	0.22
- Administrative and support service activities	0.72
Agriculture production index	0.20
Construction production index	0.48
Total private consumption expenditures	0.86
- Durables	0.49
- Semi-durables	0.71
- Nondurables	0.12
Government consumption expenditures	0.26
Total investment expenditures	0.74
Export	0.49
Import	0.83
Changes in stocks	0.13
Building cost index	0.03
Construction cost index	0.03
Housing cost index	0.12
Import quantity index	0.35
Import price index	0.28
Export quantity index	0.09
Export price index	0.24
Consumer price index	0.14
Capacity utilisation rate	0.58

Note: Indicators with a correlation coefficient of 0.40 or higher are included in the factor analysis.

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POST-PANDEMIC SHIFTS IN AIR-TOURISM SEASONALITY: ATHENS AND REGIONAL AIRPORTS IN GREECE, 2019–2024

ABSTRACT: *This paper examines post-pandemic shifts in the seasonality of Greek air-tourism demand over 2019–2024. It compares Athens International Airport with a group of 14 regional airports operated by Fraport Greece, which mainly serve leisure destinations. Seasonality is assessed using three standard inequality and concentration measures (Gini, Theil T and Herfindahl–Hirschman indices) applied to monthly passenger shares, complemented by heat maps and coefficient-of-variation checks. The data cover the pre-pandemic, pandemic and recovery phases, capturing both the one-off COVID-19 shock and subsequent adjustment. The share of traffic in the shoulder months rose modestly (Athens: from 38.4% to about 41%; regions: from 48.5% to around 49%), but the concentration indices for Athens fell below their 2019 levels, indicating a clearer rebalancing of demand across the year. In contrast, regional airports remain strongly dependent on the July–August peak, despite some easing of seasonality. The findings suggest that COVID-19 acted as a catalyst for seasonality smoothing at the metropolitan hub, while adjustments in island destinations have been slower. These results underline the importance of destination management, coordinated airline–airport strategies and targeted incentives for off-peak traffic as part of broader sustainable-tourism and climate policies in Mediterranean countries.*

KEY WORDS: *seasonality indices; COVID-19; Greece; sustainable tourism; shoulder season; destination management*

JEL CLASSIFICATION: R41, L93, Z32, C43

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1. INTRODUCTION

Air travel demand in tourism is strongly characterised by seasonality. In Mediterranean economies, where the tourism product relies heavily on summer leisure, a large share of annual traffic is concentrated in just a few months. The result is an uneven demand profile with periods of intense peak load and periods of underutilisation. Seasonality is not merely a statistical feature; it has direct implications for infrastructure investment, labour markets, business viability and the pressures exerted on the environment and local communities (Butler, 2001).

The COVID-19 pandemic abruptly disrupted established patterns. Restrictive measures, uncertainty and the gradual return of travel under new conditions created an environment in which not only the overall volume of movements fell dramatically, but the timing of these movements also changed. Several international studies report evidence that, after the initial collapse, travellers came back in different ways, making greater use of periods with lower crowding and showing a preference for shoulder seasons, namely spring and autumn (Daglis, 2024; Galiano Martínez et al., 2025).

In the Mediterranean, where seasonality is particularly pronounced, the debate on extending the tourism season is not new (Duro, 2016; Koenig-Lewis & Bischoff, 2005). The pandemic, however, seems to have acted as an accelerator, speeding up changes that had previously been unfolding more slowly. Shifts in working trends, the spread of remote work and the search for less crowded travel periods have created conditions more favourable to the shoulder months. At the same time, destinations and airlines have adapted by adjusting schedules and pricing strategies.

Greece is a typical example of a country with high tourism dependence and strong seasonality, especially in island and coastal destinations. At the same time, it possesses a major metropolitan hub, Athens, with a more complex and diversified demand profile. In Athens, urban tourism, business travel, visits to friends and relatives and cultural activities complement classic summer tourism, potentially leading to milder seasonality compared with islands and purely resort areas.

Despite the importance of this distinction, the Greek literature has not yet provided a systematic quantitative comparison of seasonality between Athens

International Airport and the regional airports that mainly serve tourism destinations. Previous work has examined spatial concentration of air traffic and network structures (e.g., Burghouwt & de Wit, 2005), as well as the impact of the pandemic on tourism activity (Daglis, 2024). What has been missing is an approach focusing specifically on the evolution of seasonality before, during and after COVID-19, using standard measures of temporal concentration.

In this study, we aim to address this gap. We examine the seasonality of air-tourism demand in Greece over the period 2019–2024 by comparing Athens International Airport (AIA) with the group of 14 regional airports operated by Fraport Greece.

Our analysis is based on monthly passenger shares, treating air traffic as a proxy for destination-level tourism demand in locations that rely heavily on air access. We use three standard inequality and concentration measures – Gini, Theil T and the Herfindahl–Hirschman Index (HHI) – to quantify how annual traffic is distributed across the twelve months of the year. In parallel, we compute the share of shoulder months (May–June and September–October) and construct heat maps to visualise monthly patterns.

The contribution of this paper is threefold. First, it provides a harmonised, comparable measurement of air-tourism seasonality in Greece over a period of severe disruption. Second, it highlights the contrast between a diversified metropolitan hub and a group of regional airports predominantly oriented towards leisure tourism. Third, it links the empirical findings to the broader debate on sustainable tourism development and demand-management policies, particularly in the context of the EU's climate objectives.

In the sections that follow, we first review the relevant literature on tourism seasonality and COVID-19 and discuss the main drivers of post-pandemic changes in the temporal distribution of demand. We then present the data and methodology, including the rationale for our choice of indices, the construction of gap and normalised measures, and a brief reflection on their limitations. The empirical results are set out for Athens and the regional airports, followed by a discussion that situates our findings within the international evidence and considers their implications for labour markets and regional development. We

conclude by drawing policy implications for Mediterranean destinations and outlining directions for future research.

2. LITERATURE REVIEW

2.1 Seasonality in tourism and transport

Seasonality has been a central topic in tourism research for decades. Butler (2001) underlines that the concentration of demand in a small number of months is linked to a series of challenges: uneven use of infrastructure, sharp fluctuations in employment, pressures on the environment and local communities, and unstable business conditions. In the same vein, the review by Koenig-Lewis and Bischoff (2005) shows that seasonality is not simply a "natural" outcome of climate; it is shaped by the interaction of demand and supply factors, pricing strategies, institutional frameworks (such as school holidays) and the way the tourism product is organised.

Measuring seasonality has attracted considerable attention, with a variety of indices used to capture both its intensity and its structure. Duro (2016), in a systematic analysis of hotel demand seasonality across Spanish provinces, applies inequality and concentration measures to examine how overnight stays are distributed over the year and how these patterns differ across regions. Similar methodological tools are used in other studies that look at temporal distribution of demand, confirming that such indices provide a standardised basis for comparison between destinations (Viera-González & Hernández-Martín, 2025).

In transport, seasonality is closely tied to how networks and schedules are organised. Mazzola et al. (2022) analyse island regions in Southern Europe and underline the pivotal role of air transport in shaping tourism flows: the supply of seats and routes not only follows demand but also contributes to structuring it. In destinations with a strongly summer-oriented profile, the seasonal concentration of flights and arrivals reinforces a pattern of sharp summer peaks, which is difficult to reverse without coordinated policies.

2.2 The impact of COVID-19 on seasonality

The COVID-19 pandemic generated an unprecedented shock to tourism demand and air transport. Galiano Martínez et al. (2025) examine the case of Spain and its

access routes, comparing observed data with a counterfactual scenario without the pandemic. Their analysis documents not only the dramatic fall in overall volumes but also a reshaping of the temporal distribution of travel, with shifts towards periods in which restrictions were milder.

Similarly, Daglis (2024) investigates the performance of the tourism industry during the pandemic years, with a focus on Eastern Mediterranean countries. His work shows that COVID-19 did not simply lead to a temporary collapse of demand; it also accelerated structural changes in seasonality, as destinations and businesses attempted to "salvage" part of the season by shifting activity and offers to months when conditions were more favourable (Efthimiou, 2025).

A key element of the post-pandemic period relates to the spread of more flexible forms of work and travel (remote work, work–leisure combinations), which make it easier for people to travel in the shoulder months. This development reinforces trends towards a longer tourism season that had already been observed in some destinations before the pandemic, albeit at a slower pace (Duro, 2016; Koenig-Lewis & Bischoff, 2005).

2.3 Evidence from the Mediterranean and Greece

Mediterranean destinations, and especially islands, have traditionally displayed strong seasonality due to climate and the dominance of the "sun and sea" model. The existence of metropolitan poles with diversified products (city breaks, business travel, culture) provides an interesting counterexample. Athens, for instance, combines the role of national transport hub with that of an urban tourism destination, where demand outside the peak summer months has been increasing.

Greek literature has examined aspects of spatial concentration and the structure of air traffic. Papatheodorou (2002) and Burghouwt & de Wit (2005) analyse spatial concentration in the airline industry in Europe and the US, situating Greece within a broader network context in which hubs and secondary airports play different roles. Although their work is not specifically focused on seasonality, it underscores the distinction between metropolitan centres and regional airports.

At policy level, international debates around sustainability and climate (e.g. the EU Fit-for-55 package; Council of the European Union, 2022) explicitly link seasonality smoothing with the environmental and social impacts of tourism. Butler (2001) emphasises that spreading demand more evenly throughout the year can support more sustainable development models by reducing pressure on sensitive ecosystems and local communities.

2.4 Methodological approaches

On the methodological side, many studies use inequality and concentration indices to quantify seasonality. Duro (2016) employs indices such as Gini and Theil, which allow for comparison of different regions and periods on a common scale. The Herfindahl–Hirschman Index (HHI), although originating in industrial organisation to measure market concentration (Herfindahl, 1950), has also been applied in contexts where the dominance of specific categories is of interest – in our case, dominance of peak months.

The use of heat maps (Wilkinson & Friendly, 2009) has become a standard visual tool, enabling researchers to detect trends, shifts and patterns that may not be immediately obvious from numerical indicators alone. Combining quantitative indices with graphical representations thus offers a more complete picture of seasonality.

2.5 The gap addressed by this study

Despite the above, there is still a lack of systematic quantitative comparison between a large metropolitan airport with diversified demand, such as Athens, and a group of regional airports with a predominantly leisure tourism profile, with specific focus on seasonality and its evolution after COVID-19. To our knowledge, no previous study has analysed this question using harmonised measures of temporal concentration applied to air traffic.

The present paper attempts to fill this gap by applying standardised inequality and concentration indices (Gini, Theil T, HHI) and heat maps to monthly shares of passenger traffic, combined with the explicit tracking of shoulder season shares. In doing so, it places the Greek case within the broader debate on post-pandemic changes in tourism seasonality in Mediterranean destinations. In the next subsection, we turn to the main demand- and supply-side mechanisms that have

been identified as drivers of post-pandemic changes in seasonality in order to frame the empirical analysis that follows.

2.6 Drivers of post-pandemic seasonality change

We have already highlighted how seasonality has been measured and discussed in the tourism and transport literature, with particular emphasis on Mediterranean destinations. Building on this foundation, it is useful to set out more explicitly the main mechanisms through which the pandemic may have affected the temporal distribution of demand.

On the demand side, several developments point towards greater use of the shoulder months. Travellers have become more sensitive to issues of crowding and health, particularly in enclosed spaces and during peak periods. This has reinforced preferences for travel in spring and autumn, when destinations are perceived as less congested and more manageable (Galiano Martínez et al., 2025; Khan & Morency, 2024; Koenig-Lewis & Bischoff, 2005; Park et al., 2021). The expansion of remote and hybrid work has also broadened the time window in which people can travel. The traditional distinction between business trips, leisure trips and work–leisurecombinations has become more fluid, allowing individuals and households to plan trips outside strict holiday periods and to adapt more flexibly to changing conditions.

On the supply side, airlines and destinations have not been passive recipients of these shifts. Carriers restructured their schedules in the recovery years, reallocating capacity to months when travel conditions were more predictable and the risk of sudden restrictions lower (Daglis, 2024; Galiano Martínez et al., 2025). At the same time, destination management organisations intensified their efforts to promote the shoulder season, often combining targeted marketing campaigns with cultural events, conferences or sports activities designed to attract visitors outside the traditional peak. In island regions, where air access is central to tourism flows, such supply-side decisions can reinforce or partly counteract underlying demand trends (Mazzola et al., 2022).

Institutional and policy factors add a further layer. In the first phases of the pandemic, the timing and severity of travel restrictions directly shaped when people could move, compressing effective demand into short windows of

opportunity. In subsequent years, broader debates about sustainability and climate – already present in European tourism policy – strengthened the case for a more even distribution of flows across the year (Butler, 2001). Seasonality smoothing is increasingly viewed as a way to reduce pressures on infrastructure, local communities and sensitive ecosystems, and as a contribution to the climate objectives encapsulated in initiatives such as the EU's Fit-for-55 package.

These demand-side, supply-side and institutional drivers help to frame the Greek case. A metropolitan hub such as Athens, with diversified motives for travel and year-round connectivity, was better placed to benefit from post-pandemic adjustments. Island and coastal destinations, whose air traffic is still dominated by summer leisure tourism, remain more tightly bound to the July–August peak (Daglis, 2024; Mazzola et al., 2022). The empirical analysis that follows examines how these differentiated responses are reflected in the evolution of concentration indices and shoulder-month shares between 2019 and 2024.

3. DATA AND METHODOLOGY

3.1 Data

We used the official monthly passenger traffic data for AIA along with the 14 regional airports of Fraport Greece covering the period 2019–2024 (AIA, 2024; Eurostat, 2024; Fraport Greece, 2024). These airports were Thessaloniki, Chania, Rhodes, Corfu, Kefalonia, Zakynthos, Mykonos, Santorini, Kos, Skiathos, Mytilene, Samos, Kavala and Aktion. For the regional group, figures represent the aggregated traffic of the 14 airports (domestic and international combined).

The time coverage allowed us to distinguish between the pre-pandemic period (2019), the crisis years (2020–2021) and the post-pandemic recovery (2022–2024). Therefore, we managed to compare a metropolitan hub with airports that are heavily dependent on leisure tourism. Including all years lets us capture the one-off pandemic shock and the medium-term adjustment. Air travel is a good proxy for estimating visitor demand in destinations that rely heavily on air transportation. Because the fourteen regional airports primarily serve leisure destinations, their monthly passenger series closely reflect tourism demand cycles at the destination level.

3.2 Seasonality measures

To study traffic patterns over time, we calculated the monthly share of annual traffic. The shoulder months were set as May–June and September–October. This convention follows tourism-seasonality practice, capturing periods targeted by destination marketing to extend stays and disperse peaks. Seasonality was then assessed with three well-known concentration measures:

The Gini coefficient (Dagum, 1997) is a classic measure of inequality. In this study, it is used to express the uneven distribution of annual passenger traffic over the twelve months of the year. It is calculated as shown in Eq. (1):

$$G = (\Sigma|p_i - p_j|) / (2n^2 * \bar{p}), \quad (1)$$

where p_i are the monthly shares, $\bar{p}$ the average and n the number of months. The higher the value of G, the greater the uneven distribution of traffic.

The Theil T index (Theil, 1967) represents a measure found in information theory. It evaluates the deviation of the monthly distribution from a perfect uniform distribution, as defined in Eq. (2):

$$T = \Sigma\, p_i * \ln(p_i / (1/n)) \quad (2)$$

The closer the value of T is to zero, the more uniform the distribution. The higher the value, the greater the concentration of traffic in a few months.

The Herfindahl–Hirschman Index (HHI) (Herfindahl, 1950) is used to examine levels of concentration within markets. It is used to capture the degree to which peak months dominate annual traffic. HHI is expressed in Eq. (3):

$$HHI = \Sigma\, (p_i)^2 \quad (3)$$

The higher the *HHI* value, the higher the percentage of yearly demand in a small number of months.

The simultaneous use of the three indicators offered us a multidimensional assessment of inequality (Gini), entropy (Theil T) and peak month dominance

(HHI). Heat maps (Wilkinson & Friendly, 2009) were used for visualisation. They reflect the share of annual traffic by month and year.

This method enabled us to conduct multivariate comparisons with international seasonality studies (e.g., Duro, 2016). It offers a reliable basis for understanding differences between Athens and the region in light of the pandemic. We also calculated the coefficient of variation (CV) of monthly shares over the years as a robustness check (Field, 2018).

3.3 Robustness check and modelling choices

Our choice to work with monthly passenger shares rather than absolute volumes reflects the seasonality focus of the paper. By normalising each year to 100 per cent, we abstract from the level effects of the pandemic shock and concentrate on how demand is distributed across months. This inevitably comes with a trade-off: we do not distinguish between domestic and international passengers or between different market segments. However, for highly seasonal, air-dependent destinations such as the Greek islands, monthly totals provide a reasonable approximation of destination-level tourism cycles.

We also opted to keep the analysis at the level of Athens versus the aggregated group of 14 regional airports, instead of examining each airport separately. Our intention here is to contrast a diversified metropolitan hub with a predominantly leisure-oriented regional system, rather than to provide a full typology of individual destinations. We see this study as a first step and a basis on which more granular, market-specific analyses can be built in future work.

3.4 Derived seasonality-gap and normalised indices

In addition to the raw concentration measures, we derive two simple sets of indicators that help us summarise and compare the evolution of seasonality between Athens and the regions.

First, we construct "seasonality-gap" indicators as the difference between the regional and Athens indices for each year *t*. Formally, for the Gini coefficient we define:

$$\Delta G\_t = G\hat{}R\_t - G\hat{}A\_t, \tag{4}$$

where $G^{\wedge}R\_t$ and $G^{\wedge}A\_t$ denote the regional and Athens Gini coefficients, respectively, in year t. Analogous gaps ΔT_t and ΔHHI_t are defined for the Theil T and HHI indices. Positive values indicate higher seasonality in the regional airport system relative to Athens. Tracking these gaps over time allows us to see whether the metropolitan–regional contrast narrows or widens during and after the pandemic.

Second, for each index we construct a set of normalised values that take the pre-pandemic year 2019 as a baseline. For an index I_t (Gini, Theil-T or HHI), the normalised value is given by:

$$I^*\_t = I\_t \,/\, I\_2019 \tag{5}$$

These normalised indices express each year as a multiple of the 2019 level. They provide a compact way to illustrate by how much the pandemic shock increased concentration in 2020–2021, and to what extent the subsequent recovery years brought the system closer to, or further away from, the pre-pandemic benchmark. In the empirical section, we use these derived measures mainly for interpretation and comparison, rather than as formal econometric inputs.

Before moving to the empirical results, it is useful to acknowledge the limitations of these indices and to situate them within the broader set of tools available for analysing seasonality. This is the focus of the next subsection.

3.5 Limitations of the indices and alternative measures

The previous subsections have set out the main indices used in this paper – Gini, Theil T, HHI, the coefficient of variation, and derived gap and normalised measures – and have explained how they are constructed from monthly passenger shares. While these tools provide a coherent framework for comparing Athens and the regional airport system, it is important to acknowledge their limitations and to situate them within the broader set of methods available for studying seasonality.

First, the concentration indices used here summarise how total passenger traffic is distributed over the twelve months of the year, but they do not distinguish between different market segments. A destination may exhibit a similar Gini or

HHI value in two years even if the composition of passengers has shifted substantially between domestic and international travellers, or between leisure, business and visiting-friends-and-relatives segments. Likewise, these measures do not capture the intra-month distribution of demand: short-lived peaks around specific holidays or events are averaged out within the monthly total. In this sense, the indices provide a clear picture of seasonality at an annual horizon, but they leave finer temporal patterns unobserved (Duro, 2016).

Second, alternative measures exist that could complement or refine the picture obtained from Gini, Theil T and HHI. Simple peak-to-low ratios and seasonality indices based on the difference between the highest and lowest months have a long tradition in tourism research, as do graphical tools such as Lorenz curves (Butler, 2001; Koenig-Lewis & Bischoff, 2005). Time-series approaches such as X-13 or TRAMO/SEATS, which decompose a series into trend, seasonal and irregular components, can also be informative when long historical series are available and when the main interest lies in the stability or change of seasonal paradigms over time (Field, 2018).

In the present study, the choice to focus on a small set of concentration measures reflects both data constraints and analytical priorities. The time span – from 2019 to 2024 – is relatively short and includes a large structural shock, which limits the usefulness of more elaborate decomposition techniques. Our primary objective is to compare the seasonal profile of a metropolitan hub with that of a group of leisure-oriented regional airports using indices that are transparent, widely used and amenable to simple interpretation (Duro, 2016). Within this context, the combination of Gini, Theil T, HHI and the derived gap and normalised indicators offers a pragmatic balance between parsimony and explanatory power.

Recognising these limitations opens space for further work. Future research could extend the analysis by disaggregating passengers by origin market or purpose of travel, by combining air data with ferry and road transport, or by examining individual regional airports rather than the aggregated group. It would also be useful to compare results obtained from standard concentration indices with those derived from time-series decomposition in order to assess the robustness of observed trends in seasonality. These extensions go beyond the scope of this paper, which is confined to a relatively short and turbulent period, but they suggest that

the methods used here can serve as a starting point for more detailed investigations of how shocks such as COVID-19 reshape the temporal structure of tourism demand.

4. RESULTS

Table 1 presents the Gini, Theil T and HHI values, together with the proportion of shoulder months' traffic for 2019–2024, while Figure 1 uses heat maps to represent the distribution of monthly shares. Taken together, they confirm clear differences between Athens and the regions in terms of the intensity and evolution of tourism seasonality.

In 2019, seasonality in Athens was already lower than in regional airports (Gini from Eq. (1): 0.150 vs. 0.405; HHI from Eq. (3): 0.089 vs. 0.129). The share of shoulder months was 38.4% in Athens, compared to 48.5% in the region. This fact reflects the dependence of island destinations on the summer peak.

During the COVID-19 period (2020–2021), the indicators recorded substantial distortions. In Athens, Gini (Eq. (1)) increased to 0.357 in 2020, while in the region it reached 0.553. At the same time, Theil T (Eq. (2)) rose sharply in Athens (to 0.228) and nearly doubled in the region (0.528).

After 2022, seasonality de-escalated. In Athens, Gini (Eq. (1)) decreased to 0.210 in 2022 and to 0.162 in 2023, even lower than in 2019. Theil T (Eq. (2)) fell to 0.041 in 2023 and then edged up to 0.046 in 2024. In the regions, normalisation was slower (Gini 0.452 in 2022 and 0.418 in 2023). The indices remain higher than in Athens, demonstrating a persistent dependence on the July–August peak. The CV fell from about 9.5% to around 7.3% in Athens and from about 5.9% to roughly 4% in the regions, confirming the post-2021 decline in concentration (Table 1).

Looking at the indices relative to their pre-pandemic levels helps to quantify the magnitude of the COVID-19 shock. For Athens, the Gini coefficient rose from 0.150 in 2019 to 0.357 in 2020, while the Theil T index increased from 0.024 to 0.228. In other words, the information-theoretic measure of concentration in 2020 was almost ten times its 2019 value. For the regional airports, the Theil T index nearly doubled between 2019 and 2020 (from 0.280 to 0.528), and the HHI also

increased from 0.129 to 0.180. These normalised changes underline how the pandemic compressed effective activity into short windows of time, especially when travel restrictions were temporarily relaxed. The subsequent years show a clear unwinding of these extreme values, even though for some indices the post-2022 levels remain above the 2019 benchmark.

In terms of shoulder months, in Athens, they grew to about 41% in 2022–2023. In the regions, the improvement is marginal (48.7% to 48.9%). Figure 1 visually confirms the shift in demand from the absolute peak of August to May–June and September–October, mainly for Athens. There is a stronger adjustment due to diversified travel motives (business, cultural and conference). Island airports continue to have a considerable reliance on leisure tourism.

Table 1. Seasonality indicators for AIA and Fraport (2019–2024)

Year	Gini (AIA)	Gini (Fraport)	Theil T (AIA)	Theil T (Fraport)	HHI (AIA)	HHI (Fraport)	Shoulder share (AIA)	Shoulder share (Fraport)	CV (AIA, %)	CV (Fraport, %)
2019	0.150	0.405	0.024	0.280	0.089	0.129	0.384	0.485	8.2	5.1
2020	0.357	0.553	0.228	0.528	0.147	0.180	0.339	0.445	9.5	5.9
2021	0.258	0.481	0.115	0.396	0.121	0.147	0.355	0.454	8.8	5.4
2022	0.210	0.452	0.067	0.350	0.108	0.141	0.411	0.487	7.6	4.0
2023	0.162	0.418	0.041	0.306	0.092	0.135	0.408	0.489	7.4	3.9
2024	0.169	0.394	0.046	0.388	0.086	0.134	0.391	0.476	7.3	4.1

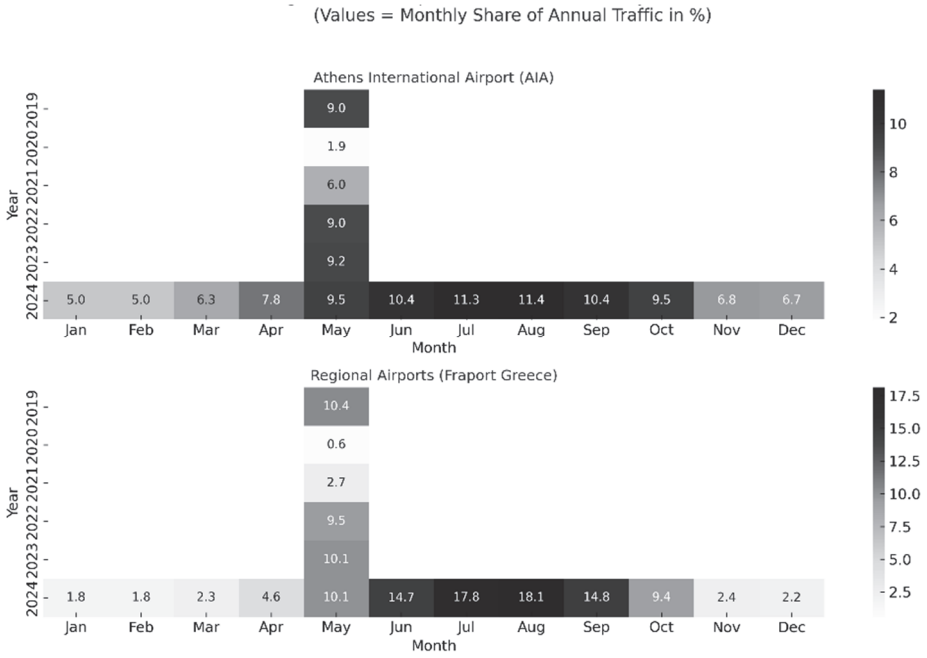
Source: AIA (2024); Fraport Greece (2024); Eurostat (2024)

Note: Lower Gini, Theil T, and HHI values (Eqs. (1)–(3)) indicate smoothing of seasonality and a reduction in traffic concentration in a few months. CV is the coefficient of variation of monthly shares (%). It confirms the same post-2022 declining concentration trend.

The heat maps in Figure 1 help to visualise these conditions over time. For Athens, 2019 shows a relatively broad summer plateau, with June–September appearing in darker shades but without an extremely sharp August spike. In 2020, by contrast, the pattern is highly irregular: some months almost disappear in terms of shares, while short windows of activity become much more prominent as restrictions were loosened and tightened. From 2022 onwards, the colour gradient becomes smoother again, with May–June and September–October clearly gaining weight relative to the pre-pandemic baseline. In our reading, this suggests that the recovery at the metropolitan hub was accompanied by a redistribution of demand

towards the shoulder season, rather than a simple return to the previous peak-only pattern.

Figure 1. Tourism-seasonality heat maps for AIA and regional airports operated by Fraport Greece, 2019–2024.



Source: AIA (2024); Fraport Greece (2024); Eurostat (2024)
Note: The degree of shading indicates the proportion of annual traffic, with monthly values labelled within the cells. At AIA, shoulder months' traffic is observed to firm up post-2022. Regional airports still have peak month traffic in August, which is often high compared to neighbouring months.

For the regional airports, the heat maps tell a subtly different story. The pre-pandemic year 2019 is dominated by a very dark August, flanked by strong July and, to a lesser extent, September. During 2020–2021, the structure of the season remains recognisable – the main peak is still in August – but the surrounding months become more uneven, reflecting the stop-and-go nature of international travel restrictions. In the recovery years, the August peak remains visually dominant, even though its relative share declines slightly and shoulder months improve at the margin. This visual evidence reinforces the message from Table 1:

regional airports are slowly moving towards a smoother seasonal profile, but their dependence on summer remains much stronger than in Athens.

The derived seasonality-gap indicators provide another way to summarise the Athens–regions contrast. For the Gini coefficient, the gap ΔG_t (regional minus Athens) fluctuates between roughly 0.20 and 0.26 points over the period 2019–2024. It narrows somewhat in 2020, when Athens experiences a sharper temporary increase in seasonality, but widens again by 2023 as the metropolitan hub moves closer to a smoother seasonal profile. The Theil T gap remains consistently positive at around 0.25–0.35, and the HHI gap mostly lies in the range of 0.03–0.05. Taken together, these differences confirm that regional airports systematically exhibit higher concentration than Athens in every year of the sample. The post-pandemic adjustment has reduced overall seasonality on both sides, but it has not eliminated the structural gap between a diversified metropolitan hub and a strongly summer-oriented regional airport system.

5. DISCUSSION

The results for 2019–2024 suggest that the pandemic accelerated a process of seasonality smoothing, at least in Athens, while adjustment at regional airports has been slower and more limited. In this section, we relate our results to the existing literature and highlight points of convergence and divergence.

5.1 Convergence with international trends

The post-2022 increase in Athens' shoulder-month share is in line with evidence from Spain. This evidence points to a shift of demand towards periods with fewer restrictions and lower seasonal concentration after the initial collapse (Galiano Martínez et al., 2025). It is also consistent with arguments that COVID-19 accelerated seasonality change in the Eastern Mediterranean, with spring and autumn gaining weight in the recovery phase (Daglis, 2024). The decline in Athens' Gini, Theil T and HHI indices to at or below their 2019 levels is in agreement with the broader literature on seasonality mitigation (Duro, 2016; Koenig-Lewis & Bischoff, 2005). In particular, seasonality tends to ease when the tourism product is diversified, year-round connectivity strengthens and preferences shift away from crowded peak periods.

5.2 Differences between a metropolitan hub and island destinations

Regional airports consistently display higher seasonality throughout the period. Although concentration indices decrease after 2020, they remain markedly above the levels observed in Athens. This picture is consistent with the findings of Mazzola et al. (2022) for island regions in Southern Europe, where reliance on summer leisure tourism and direct air connections generates very sharp seasonal patterns.

Unlike European metropolitan hubs, where business travel and city break tourism support demand throughout the year, Greek island airports operate largely as "seasonal gateways". This helps explain why, even though shoulder months already account for a relatively high share of annual traffic (around 48–49%), Gini and HHI remain elevated: July and August still capture a disproportionately large share of the yearly total.

This contrast reinforces Butler's (2001) observation that destinations with a more complex and diversified product tend to experience milder seasonality. Athens fits this profile as the country's administrative, economic and cultural centre, whereas the regional airports correspond more closely to the classic Mediterranean model of summer resort destinations. At the same time, aggregating the fourteen regional airports necessarily masks heterogeneity across destinations. Airports linked to larger urban areas or more diversified local economies, such as Thessaloniki, are likely to have smoother seasonal profiles than highly specialised island airports, where demand remains concentrated in the summer peak. Airport-level analysis could therefore yield more differentiated insights into post-pandemic adjustment and sharper policy implications. This is left for future research.

5.3 Methodological contribution

By using Gini, Theil T and HHI indices, our study follows the methodological tradition outlined by Duro (2016), but applies it to air traffic rather than hotel overnights. This provides an alternative perspective on seasonality rooted in transport data, which are available at monthly frequency and capture the timing of demand in a straightforward way.

Furthermore, combining these indices with heat maps (Wilkinson & Friendly, 2009) allows us not only to compare levels of seasonality, but also to detect shifts in the timing and shape of peaks. In the case of Athens, for example, the heat maps clearly show that May–June and September–October gain importance after 2022, a pattern that is less visible if one only looks at a single numeric indicator.

5.4 The Greek case in the wider international debate

When set against broader European and Mediterranean trends, the Greek case appears to confirm the hypothesis that the pandemic acted as a catalyst for extending the tourism season in destinations with diversified demand. Athens follows a trajectory closer to that of large European cities, with strong post-pandemic recovery and an enhanced role for the shoulder months, while the regional airports move along a more gradual path.

The Greek case suggests that seasonality does not ease automatically as traffic recovers. It requires product diversification, deliberate air-service planning, close destination–carrier coordination and clear year-round demand-management measures.

In this sense, our results also support the view that post-COVID changes in seasonality represent both an opportunity and a policy challenge, particularly for Mediterranean destinations facing high tourism dependence and strong pressure on local ecosystems.

5.5 Implications for labour markets and regional development

The previous subsections have discussed the alignment of our findings with international trends and have situated the Greek case within broader debates on tourism seasonality and sustainability. It is also useful to consider more explicitly how the observed patterns of concentration in Athens and the regional airports relate to labour markets and regional development outcomes.

In highly seasonal destinations, employment in tourism and related activities tends to follow a pronounced cycle. Recruitment rises sharply in spring as businesses prepare for the summer, peaks in July and August and then falls rapidly at the end of the season. The relatively high Gini and HHI values for the regional airports are consistent with a large share of annual activity being compressed into

a short period, reinforcing the prevalence of temporary contracts, repeated hiring and separation, and higher income volatility for local workers (Butler, 2001; Ruggieri & Platania, 2024). By contrast, the smoother seasonal profile in Athens supports a broader range of year-round activities linked to air transport, urban tourism, conferences and cultural events, which in turn makes it easier to sustain more stable employment relationships.

Seasonality also affects the economics of infrastructure and investment. In island and coastal regions, airports and tourism businesses must dimension their capacity to accommodate summer peaks that are far above average-month levels. This implies higher capital and operating costs relative to the effective utilisation of facilities over the year. When seasonality eases and shoulder months become stronger, the same infrastructure can be used more intensively and more evenly, improving the balance between peak load and annual usage. The post-2022 trajectory of Athens points in this direction: lower concentration indices and higher shoulder shares are consistent with a more efficient use of airport and tourism infrastructure, even if peak pressures remain significant.

From a regional development perspective, the persistence of sharp summer peaks in the regional airports means that local economies remain highly dependent on a short window of intense activity. This dependence amplifies the impact of shocks that coincide with the peak, such as extreme weather events, disruptions in airline capacity or sudden changes in source markets. In metropolitan areas with a more diversified and less seasonal demand base, such as Athens, the same shocks may be easier to absorb because they are spread over a longer effective season and a wider set of activities (Daglis, 2024). The metropolitan–regional seasonality gap is an indicator of differing degrees of economic resilience.

These considerations reinforce the view that seasonality management is closely linked to broader questions of labour market stability, infrastructure planning and regional cohesion. Policies aimed at strengthening the shoulder season – through product diversification, targeted promotion and coordinated scheduling – have the potential not only to ease pressures during the peak months but also to support more balanced and resilient local economies. The quantitative evidence presented in this paper offers a basis for such discussions in Greece, while also

pointing to issues that may be relevant for other Mediterranean destinations facing similar challenges.

6. CONCLUSIONS AND POLICY IMPLICATIONS

The analysis of Athens and the 14 regional airports over 2019–2024 shows that COVID-19 did more than temporarily depress air-tourism demand. It also altered the temporal profile of that demand. At Athens International Airport, seasonality indices fell below their pre-pandemic levels and the share of shoulder months increased from 38.4% to roughly 41%. Regional airports also experienced some smoothing, but their dependence on the July–August peak remains structurally high.

From a policy perspective, these findings point to both an opportunity and a warning. The opportunity lies in the fact that demand can be redistributed over the year, especially in destinations with diversified products and strong connectivity. This supports more efficient use of infrastructure, reduces peak strain on local environments and communities, and is broadly consistent with the EU's Fit-for-55 climate objectives. The warning is that, without targeted interventions, highly seasonal island destinations may revert to a narrow summer pattern with all the familiar pressures.

Our results suggest three broad directions for policy. First, destination management organisations and airports can jointly design marketing campaigns and events that explicitly promote May–June and September–October as core parts of the season. Second, airport charging schemes and slot allocation can be adjusted to provide stronger incentives for off-peak flights, especially on international routes. Third, regional destinations need to invest in product diversification – from cultural and nature-based tourism to small-scale conferences – so that there are genuine reasons to visit outside the peak.

The study has clear limitations. It focuses solely on air passengers, leaving aside cruise, road and ferry traffic, which are particularly important in the Greek context. It also uses aggregate monthly totals rather than distinguishing by origin market or purpose of travel. Future research could expand the analysis to multimodal data, explore specific source markets and compare Greek airports with those in other Mediterranean countries. Even with these caveats, we believe

the evidence presented here is useful for understanding how a major shock such as COVID-19 can reshape air-tourism seasonality and for designing targeted, data-driven demand-management strategies.

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ASYMMETRIC PRICE TRANSMISSION IN THE FUEL MARKET OF BOSNIA AND HERZEGOVINA: AN ANALYSIS OF PETROL AND DIESEL PRICE RESPONSES TO OIL PRICE CHANGES

ABSTRACT: *The paper explores the phenomenon of asymmetric price adjustments of petroleum products to changes in oil prices on the Bosnian and Herzegovinian market. We examine the existence of an asymmetric response of retail diesel and petrol prices to changes in oil prices, analysing whether there is a slower adjustment in the case of a decrease in oil prices compared to an increase. The study is conducted using monthly data, for the period from 2010 to 2024. The methodological framework includes the Engle–Granger cointegration test, the error correction model, and the Wald test to check for short-term asymmetric effects. The findings show that there is a long-term equilibrium in crude oil and petroleum products prices, with the degree of adjustment in derivatives prices being significant but not complete.*

KEY WORDS: *crude oil prices, retail petroleum prices, cointegration, asymmetric error correction model, Bosnia and Herzegovina*

JEL CLASSIFICATION: F61, O13, C22, Q40

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1. INTRODUCTION

Increasing volatility in global crude oil prices in recent years has caught the attention of researchers because of its implications for economic stability, inflation, energy security, and energy policy. Researchers at the global and European levels have studied the asymmetric adjustment of petroleum product prices to oil shocks, and the results show that fuel prices react faster to rises in oil prices than to decreases. This phenomenon of asymmetric adjustment has been observed in different markets, with factors such as market structure, regulatory frameworks, exchange rates, and external economic shocks affecting the scope and speed of price adjustment.

Compared to the crude oil market, which is global, petroleum product markets are smaller, local markets. As a result, oil prices directly determine the prices of petroleum products, while the reverse is not true. In the absence of external disruptions, there is a long-term equilibrium relationship between the two. External disturbances in this system (for example, a spike in oil prices due to geopolitical tensions in one of the oil-exporting countries) will result in short- and long-term adjustments of final product prices. Oil traders adjust prices to maximise profits, while, in the long run, prices also reflect limitations of this good in terms of available supply. In the short term, only oil prices define changes in the price of petroleum products. Price elasticity in the short term is very low because petroleum products do not have adequate substitutes.

Taking into account the above, an adjustment in the prices of petroleum products can be expected as a result of changes in oil prices. This adjustment entails changes both in price levels and the time it takes to adjust. If the change in the prices of petroleum products is the same as the change in oil prices in terms of direction, strength, and timing of the adjustment, then the price adjustment is symmetrical. Otherwise, deviations in the direction, intensity or duration of the adjustment indicate the presence of price asymmetry.

However, the way in which fluctuations are passed on to domestic prices is not always straightforward. The problem of asymmetric adjustment is widely discussed in the economic literature, which is presented in more detail in the next section.

Bosnia and Herzegovina (B&H) is highly dependent on oil imports, with liquid fuels accounting for the largest part of energy imports, while domestic oil production does not exist (Agency for Statistics of Bosnia and Herzegovina [BHAS], 2024; Republika Srpska Institute of Statistics [RZS], 2025). In such economies, oil is one of the vital factors of economic growth (Wang, 2013). Import dependency on oil and petroleum products in the European Union (EU) reached a record 98% of total liquid fuel consumption in 2022 (Eurostat, 2024). In the context of B&H, it is important to note that developing countries are generally more dependent on oil imports than developed countries. The impact of oil on economic growth is not as significant in economies such as the United States (US). By contrast, oil prices play a more significant role in small open economies due to their high energy intensity (Abeysinghe, 2001). The reduced energy intensity of developed economies is one of the reasons for their low sensitivity to changes in oil prices, which is not always the case in developing countries (Özbek & Özlale, 2010).

B&H consumes more oil than it produces, which makes its small open economy vulnerable to oil shocks due to this dependence on imports of oil and petroleum products (BHAS, 2024). In the past 10 years, imports of petroleum products have increased by 131%, with a downward trend in crude oil imports (BHAS, 2024). Annual crude oil imports after the accident in the Brod a.d. Oil Refinery in the fall of 2018 amounted to zero tons (before the accident, crude oil imports had been decreasing on average by 6% on an annual basis; RZS, 2025). The largest share of imported petroleum products is consumed in the transport sector (83% in 2023; BHAS, 2024). In addition to the refinery in Brod, there are oil refineries in Sisak and Rijeka (Croatia), as well as in Pančevo and Novi Sad (Serbia).

At the national level, only a negligible share of oil is consumed in unrefined form, since end users primarily consume refined oil products. Consequently, petroleum products are purchased on the retail market at prices that, in theory, should reflect movements in world oil prices, but in practice may adjust at different rates for increases and decreases.

The occurrence of asymmetry is influenced by various factors, such as market power, oligopolistic pricing, regulatory and tax policies, exchange rates, adjustment costs, and inventory management, which limits the choice of an

appropriate research model. The error correction model and the asymmetric error correction model are the most common econometric techniques used to analyse the long-term and short-term relationships of variables. However, there is a fundamental difference between the two models. The first model assumes symmetric adjustments, which makes it inadequate for our research problem, since this assumption is not valid in real market conditions, especially in fuel price dynamics. If fuel prices react faster when crude oil prices rise than when they fall, the symmetric model cannot capture this asymmetry, leading to biased or incomplete results.

Another widely used approach for analysing asymmetric relationships is the nonlinear autoregressive distributed lag (NARDL) model introduced by Shin et al. (2014). Odionye and Chukwu (2023) utilise this framework to examine how exchange rate shocks impact stock prices and industrial output, while Aminu and Afolabi (2024) employ it to investigate the pass-through from official and parallel exchange rates to domestic prices in Nigeria.

Our analysis uses monthly data on retail prices of petroleum products (petrol and diesel) and international crude oil prices. We follow the same methodological frameworks as Liu et al. (2010) and Bastianin et al. (2014), both of which concentrate specifically on how price signals are transmitted between crude oil and its derivative products. The focus here is on the price response of petroleum products to changes in crude oil prices in order to determine the reaction of business entities that place petroleum products on the retail market.

In the context of B&H, there is a gap in the literature dealing with this transmission mechanism. Although some research is focused on Southeast Europe, there is a lack of empirical research that analyses the impact of oil price shocks on retail prices of petroleum products in B&H. Limited available research, such as the study by Szomolányi et al. (2024), points to asymmetric adjustment in Croatia, but does not provide a detailed analysis for B&H.

This study seeks to fill the gap in the domestic literature. In countries such as Bosnia and Herzegovina, which are characterised by a high degree of dependence on oil imports, examining the adjustment of petroleum product prices to the rise and fall of oil prices provides valuable insights for economic policymakers, entrepreneurs, and consumers. Understanding these adjustments helps to design

effective pricing policies and mitigate the negative impacts of volatile energy prices. The research question we are dealing with is: Do the prices of petroleum products in B&H adjust asymmetrically to changes in crude oil prices and do the prices of petroleum products respond faster to increases in oil prices than to decreases?

The paper is organised as follows. In the next section, we provide an overview of the literature dealing with the problem of asymmetry. The third and fourth sections present the methodology, data sources, and econometric models used to test the research question. In the fifth section, we present and analyse in detail the results obtained, and compare them with relevant theoretical and empirical findings in the field of research. Then, in Section 6, we discuss the implications for economic policy, economic agents, and consumers. Finally, we summarise the results obtained, list the limitations typical of this type of study, and provide suggestions for future research.

2. LITERATURE REVIEW

The literature on the asymmetric adjustment of the prices of petroleum products to changes in oil prices has been developed in response to the growing importance of global oil price volatility and its impact on countries' economies. Many studies in the U.S., Europe, and Asia (Cha & Lee, 2023; Cook & Fosten, 2019; Haliloglu & Berument, 2021; Kamyabi & Chidmi, 2023; Khan et al., 2019) investigate whether the price adjustments of petroleum products to oil price shocks are symmetric or asymmetric, referring to the "rockets and feathers" phenomenon. The term is attributed to Bacon (1991), who introduced it in his study in the United Kingdom, describing the finding that the prices of petroleum products rise faster when crude oil prices rise than when they fall. Since the inception of this line of research, there has been sustained interest in asymmetric price adjustment, as well as market phenomena that cause it in the petroleum product markets.

The most consistent finding of studies from developed countries is the presence of this rockets and feathers phenomenon. It is particularly pronounced in the U.S. petrol market, where the speed and magnitude of price adjustment depends on market structure, companies' retail strategies, and consumer behavior (Kamyabi & Chidmi, 2023). Chesnes (2016) provides evidence of asymmetric price

transmission in the U.S. petrol supply chain. Using a detailed city-level dataset and an error-correction model, Chesnes finds that petrol prices respond about 3–4 times faster to crude oil price increases than to decreases. The asymmetry is most pronounced in the wholesale-to-retail segment (rack to retail), and it is larger for branded petrol than unbranded, supporting consumer search-cost theories of asymmetry. Additionally, markets with higher retail concentration exhibit greater asymmetry, consistent with a market-power explanation.

European markets show similar asymmetries, with countries such as Germany, France, and Italy recording faster adjustments for petroleum product prices to increases in oil prices. Research by Haliloglu and Berument (2021) indicates that European regional factors, such as tax policies and exchange rates, play a significant role in the speed of adjustment. The study points out that in markets where a few big players dominate the fuel supply, price increases are passed on more quickly, raising questions about the effectiveness of price regulation and market concentration. Martín-Moreno et al. (2019) also analysed petrol and diesel price adjustments to crude oil shocks in several major European markets using advanced nonlinear models. They report robust evidence of asymmetric responses in both petrol and diesel retail prices in the short run, as well as asymmetry in the speed of adjustment back to equilibrium in the long run. In essence, European fuel prices tend to exhibit the rockets and feathers pattern. Their study strengthens the theoretical argument that price transmission can be regime-dependent, possibly reflecting periods of faster pass-through (rocket) versus slower pass-through (feather) tied to underlying market conditions or strategic pricing behaviour in Europe.

Studies conducted in selected Asian markets, particularly China, Japan, and South Korea, show similar asymmetric responses, although they are influenced not only by oil shocks but also by local economic factors, including elasticity of demand and government intervention in price formation. Chen et al. (2017) studied wholesale petrol and diesel prices in China under a government-regulated pricing system. Using an asymmetric error correction model for the 2006–2013 period, the authors find that both petrol and diesel wholesale prices in China exhibit asymmetric responses, where price increases in crude oil have a larger and faster impact than price decreases. The study focuses on the role of official maximum retail price adjustments as a key factor, highlighting how regulatory

and market structure factors can create and sustain asymmetric price transmission in petroleum markets. In Japan, government regulation of fuel prices acts as a protective mechanism against extreme fluctuations, but asymmetric adjustment still persists. The dependence of these countries on oil imports increases their vulnerability to shocks, which produces asymmetric price responses due to limited domestic production capacity (Khan et al., 2019).

Cha and Lee (2023) examined the petrol supply chain in South Korea, decomposing the price transmission into three stages: international spot market to domestic wholesale, wholesale to retail, and overall spot to retail. They find that retail petrol prices react faster when oil prices rise than when they fall, consistent with rockets and feathers. Interestingly, the wholesale level shows the opposite asymmetry (wholesale prices fall faster than they rise), and the retail stage alone does not exhibit strong asymmetry. This implies that the observed asymmetry at the pump is primarily driven by the upstream transmission from the international spot price to retail. The authors argue that consumer search costs are most relevant for Korea, as major refiners quickly pass along cost increases, knowing that consumers do not search as aggressively when prices are rising. The study highlights how analysing different market layers can pinpoint where asymmetry arises and which theory (inventory costs, market power, or search frictions) best explains it in a given context.

By contrast, there is significantly less research focused on developing countries, especially those in Southeast Europe. Although we will mention several studies that address this dynamic in this region of Europe, empirical research for a number of countries in the Balkans is still lacking. B&H, as a developing country that depends on oil imports and that due to a combination of circumstances does not currently have the capacity for domestic production, faces unique challenges in responding to fluctuations in crude oil prices, making it ideal for exploring asymmetric adjustment.

Asymmetric adjustment of petrol prices in Greece was addressed by Bragoudakis and Sideris (2021), examining the impact of structural reforms on the Greek energy market after 2010. They apply the method of cointegration with the threshold and find evidence of symmetric behaviour in the specified period, citing the market competition of companies as the reason. The symmetric adjustment

indicates the efficiency of the Greek market after a process of liberalisation and economic reforms that removed barriers to competition.

Szomolányi et al. (2024) focus on asymmetry in the Croatian retail fuel market using various econometric models, including the Linex approach to modelling asymmetry. The study confirms the asymmetric price response in Croatia, with a faster increase in the prices of petroleum products when oil prices increase. The authors explain such a situation by the pricing strategies of dominant companies that have great market power – they pass on the increase in operating costs to consumers, producing cost inflation. These are important findings for economic policymakers, especially in countries where fuel expenditure accounts for a significant portion of household costs.

Each of the above studies reinforces or challenges the rockets and feathers phenomenon under different conditions, offering insights into the speed of adjustment and underlying causes of symmetric vs. asymmetric fuel price responses. Collectively, they demonstrate that price adjustment dynamics depend on market structure, regulation, and methodological approach. Many developed-country markets exhibit asymmetric price transmission, often attributed to oligopolistic pricing power or consumer search behaviour. Yet, some cases – certain European markets or specific periods, as well as studies using improved models – find symmetric adjustment, suggesting efficient pass-through under competitive or reformed conditions.

A review of the research provides evidence to support the hypothesis of an asymmetric price adjustment of petroleum products to crude oil price shocks. In order to investigate the possible existence of price asymmetry, i.e. to examine the way in which the prices of petroleum products in B&H react to changes in crude oil prices, we put forward the following hypotheses:

H1: Prices of petroleum products in B&H react asymmetrically to changes in crude oil prices.

H2: Prices of petroleum products in B&H adjust to upward crude oil price shocks more rapidly than to downward shocks.

With these hypotheses, we investigate whether retail prices of petroleum products in B&H adapt faster to the growth of crude oil prices than to their decline. H1 tests for asymmetric magnitude effects. H2 explicitly tests for differences in the timing (speed) of adjustment to oil price rises versus falls. First, we establish a long-term balance, i.e. cointegration between crude oil prices and retail prices of petroleum products. Next, we examine the existence of price asymmetry through an analysis of the speed of adjustment of domestic prices of derivatives to changes (increases and decreases) of world oil prices. The aim of this research is to determine whether market participants in the retail petroleum sector in Bosnia and Herzegovina adjust prices more slowly in response to decreases in crude oil prices than to increases.

3. METHODOLOGY

The sample period spans from January 2010 to December 2024, providing a comprehensive dataset that captures various market conditions, including periods of volatility and stability. Retail fuel price data are sourced from a national statistical agency, while crude oil prices are obtained from the U.S. Energy Information Administration (U.S. Energy Information Administration [EIA], 2025). We use the average monthly retail prices of Eurodiesel and Eurosuper 95 excluding VAT and duties (time series of 180 data) in Bosnia and Herzegovina convertible marks (BAM) per litre, as well as the nominal price of oil in BAM per litre. The conversion of oil prices was carried out on the basis of the middle exchange rate of BAM to USD published by the Central Bank of B&H, i.e. on the basis of the conversion factor according to which one barrel contains 158.987 litres of oil (Central Bank of Bosnia and Herzegovina [CBBH], 2025; EIA, 2026).

In B&H, diesel and petrol fuels account for 90% of the total consumption of petroleum products, with diesel having a significantly higher share (Macroeconomic Unit of the Governing Board of the Indirect Tax Authority [MAU], 2020). This is why we use the prices of Eurodiesel and Eurosuper 95. As is the practice in comparable research on price asymmetry in the market for petroleum products, we use prices excluding VAT and duties (Galeotti et al., 2003; Liu et al., 2010; Radchenko, 2005). In practice, VAT and duties are generally uncorrelated with the movement of oil prices on the world market.

Although the model presented by Liu et al. (2010) omits control variables, Bettendorf et al. (2003) incorporate excise taxes as a control variable in the error correction model (ECM). They integrate excise taxes to examine whether these taxes are neutral in the price formation process. Chesnes (2016) employs city-level fixed effects to account for differences across cities in the long-term relationship between wholesale and retail prices. Additionally, Chesnes includes a dummy variable to control for large price fluctuations that result from missing daily data during weekends.

Our study adopts the methodological frameworks established by Liu et al. (2010) and Bastianin et al. (2014), which both focus exclusively on the price transmission mechanisms between crude oil and its derivatives. Since the model includes only the crude oil price as an explanatory variable, we acknowledge the potential risk of omitted variable bias. If autocorrelation is present, employing the Newey–West (HAC) correction might be a solution (Newey & West, 1987).

Bastianin et al. (2014) develop an econometric framework to examine whether allowing for asymmetric price transmission improves the ability to forecast the oil-petroleum price relationship. They compare several models (including an asymmetric ECM) with a standard symmetric ECM. In these models, deviations from the long-run equilibrium are split into positive and negative components so that the speed of adjustment can differ when prices are above or below equilibrium. The authors then evaluate point, sign, and probability forecasts of petroleum prices generated by the asymmetric models and compare them to forecasts from the symmetric ECM.

Liu et al. (2010) do not include any control variables beyond crude oil prices and pre-tax fuel prices (diesel and petrol). Their analysis focuses on the direct pass-through effects without incorporating a regulatory framework, exchange rates, or other factors that affect the scope and speed of price adjustment. By analysing pre-tax prices, they aim to isolate the direct impact of crude oil price changes on the prices of petroleum products, thereby avoiding the confounding effects of tax-related factors. Bachmeier and Griffin (2003) also share the same research objectives and do not employ control variables beyond the price series and its lags.

To examine the long-term relationship, we use the model proposed by Liu et al. (2010):

$$Y_t = \alpha_0 + \alpha_1 X_t + \varepsilon_t \,, \tag{1}$$

where:

- Y_t is the natural logarithm of the average monthly retail price of petroleum products, measured as eurodiesel (*lneurodiesel*) and motor petrol (*lnBMB95*) in BAM/L and excluding VAT and duties;
- X_t is the natural logarithm of oil prices (denominated in BAM/L);
- ε_t is the error.

The short-term dynamics of the prices of petroleum products in relation to oil prices are examined using the ECM (Engle & Granger, 1987). To this end, we include the residual deviations (ε_t) of the previously estimated Equation (1) in the model as an additional error correction term ($\hat{\varepsilon}_{t-1} = Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}$). Using an ECM, we investigate differences in the prices of petroleum products when they are below or above the equilibrium level. The model in standard form has the following form (Bachmeier & Griffin, 2003, Bettendorf et al., 2003):

$$\triangle Y_t = \beta_0 + \beta_1 \triangle X_t + \beta_2 \hat{\varepsilon}_{t-1} + v_t \,, \tag{2}$$

or

$$\triangle Y_t = \beta_0 + \beta_1 \triangle X_t + \beta_2 (Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}) + v_t \,, \tag{3}$$

where:

- β_1 is the short-term rate of adjustment of petroleum products prices to oil prices, which shows the extent to which the change in oil prices is reflected in the change in the prices of petroleum products;
- β_2 is the estimated coefficient of the error correction term (ECT), where $-1 < \beta_2 < 0$. The coefficient determines the "speed of adjustment" towards the long-run equilibrium – the fuel prices adjustment speed toward equilibrium after oil price changes. The deviations from the long-run

equilibrium are corrected gradually by the ECT through a series of partial short-run adjustments. β_2 must be statistically significant at the 1% level;

- $\hat{\varepsilon}_{t-1} = Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}$ is the lagged residual, representing the deviation from the long-run equilibrium relationship in period $t-1$;
- v_t is the innovation process.

The specified mean adjustment lag (MAL) is calculated based on the model's coefficient and represents the weighted average of all lags. It indicates the monthly rate at which the retail prices of oil derivatives adjust to changes in crude oil prices. The MAL concept is often used within autoregressive distributed delay (ADL) models and ECMs under the assumption of a homogeneous equilibrium relationship (Chong & Liu, 2009; Fuleky & Ventura, 2016; Liu et al., 2010; Nyangu et al., 2021).

The MAL formula was proposed by Hendry (1995):

$$MAL = (\beta_1 - 1)/\beta_2 \tag{4}$$

In order to take into account the possibility of asymmetric adjustment of the prices of petroleum products when deviating from the long-run equilibrium, positively or negatively, we introduce an appropriate indicator, λ. The indicator λ is equal to 1 if the residual $\hat{\varepsilon}_{t-1} = Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}$ is positive; otherwise, it is 0 (Bachmeier & Griffin, 2003).

The asymmetric error correction model is an extension of the standard model and allows asymmetries to be captured by separating the error correction component into two parts, which adjust at different rates when prices are rising compared to when they are falling. This model provides a more precise and realistic representation of the price dynamics, and represents an adequate econometric technique for conducting an analysis of the market of petroleum products of B&H in the observed time period. An asymmetric short-term dynamic relation is represented by the equation (Bachmeier & Griffin, 2003):

$$\triangle Y_t = \delta_1 \triangle X_t + \delta_2 \lambda \hat{\varepsilon}_{t-1} + \delta_3 (1 - \lambda) \hat{\varepsilon}_{t-1} + \eta_t \,, \tag{5}$$

where:

- δ_1 – the equivalent of β_1 in the previous model – is the short-term rate of adjustment of the prices of petroleum products to the prices of oil (shows how much the change in oil prices is reflected in the change in the prices of petroleum products);
- δ_2 is the speed of adjustment to the equilibrium value when the value is above equilibrium;
- δ_3 is the rate of adjustment to the equilibrium value when the value is below equilibrium.

By interpreting the coefficients of the model using the Wald test, we will determine whether there is an asymmetric response in the adjustment, whether it is more pronounced when prices are above or below the equilibrium level, and whether it is statistically significant. Thus, in the end, the verification of the existence of price asymmetry boils down to the verification of the existence of a statistically significant difference between the values of the parameters δ_2 and δ_3.

As with the symmetric adjustment case, we can define the asymmetric MAL of a complete pass-through using Hendry's formula (1995). For our case:

$$MAL^{+} = (\delta_1 - 1)/\delta_2 \tag{6}$$

$$MAL^{-} = (\delta_1 - 1)/\delta_3 \,, \tag{7}$$

where MAL^{+} represents the period of time required to adjust to the mean value when the prices of petroleum products are above the equilibrium value (in months), and MAL^{-} the period of time required to adjust to the mean value when the prices of petroleum products are below the equilibrium value. Leszkiewicz-Kedzior and Welfe (2014) apply such an approach in the study of price asymmetry in the Polish fuel market. Additionally, Mordi et al. (2019) use an identical approach when examining the impact of the transfer of benchmark interest rates on interest rates on loans and deposits.

4. DATA

The selection of variables was designed with the aim of analysing the transmission channels of oil price shocks to the retail market of petroleum products identified

by a literature review. For the purposes of the analysis, we use monthly data from January 2010 to December 2024. The variables are listed in Table 1, which, in addition to the name of the variable, provides information about the unit of measurement of the original time series and the data source.

Table 1. Variable description

Nr	Variable	Description	Unit	Data source
1	*brentprice*	Dated Brent crude oil price	US Dollars per barrel	U.S. Energy Information Administration (EIA, 2025)
2	*BMB95*	Eurosuper 95 retail price	BAM per litre	B&H Agency for Statistics (BHAS, 2025)
3	*eurodiesel*	Eurodiesel retail price	BAM per litre	B&H Agency for Statistics (BHAS, 2025)

Source: Authors' compilation

The price of Brent crude oil. The first indicator represents real oil prices. The price of oil is represented using Dated Brent, which since 1980 has been calculated by Platts based on trading activities in the North Sea oil market. It is the most famous and most widely used benchmark globally (the other two are WTI for the Americas and Dubai Fateh for Asia). Dated Brent is used for approximately 78% of the world's crude oil trade (Wittner, 2020), which is why it is commonly taken as an indicator of the world oil price, especially for Europe and Africa (Speight, 2017).

Prices of petroleum products (BMB95/Eurodiesel). As measures of the prices of petroleum products, we use the monthly average prices of motor petrol and diesel, i.e. BMB95 and Eurodiesel (excluding VAT and duties), respectively. The prices at petrol stations reflect not only changes in oil prices on the world market but also fiscal policy measures, which are not necessarily linked to global movements of raw material prices. Therefore, we exclude the impact of VAT and taxes from the analysis. The *Law on Amendments to the Law on Excise Duties in B&H* (2017) increased excise duties on petroleum products by 0.15 BAM/L. The

amendments came into effect on February 1, 2018, and have been taken into account. We also use logarithmic values of the time series, since this transformation stabilises the variance of the time series and increases the accuracy of further statistical-econometric analysis (Lütkepohl & Xu, 2009).

The fundamental statistical characteristics of the monthly time series used are presented in Table 2. Data are expressed in logarithmic form. Of particular interest are the relatively high standard deviation as well as the wide range between the minimum and maximum oil prices, which supports earlier findings of high oil price volatility.

Table 2. Descriptive statistics in natural logarithms

Variable	Obs	Mean	Std. Dev.	Min	Max
lnbrentprice	180	– 0.266	0.314	– 1.569	0.356
lneurodiesel	180	0.230	0.238	– 0.449	0.819
lnBMB95	180	0.173	0.216	– 0.496	0.743

Source: Authors' compilation

In the next section, to examine the relationship between the prices of oil and petroleum products, we use the ECM to create a long-term and short-term relationship. Such a model will serve as a basis for further testing of the asymmetric adjustment.

5. RESULTS AND DISCUSSION

Before conducting the stationarity test, a lag order test was performed. Using the Akaike Information Criterion (AIC), Hannan–Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC), we define the model with a length of two lags (see Table A.1 in the Appendix for detailed lag order criteria selection results). As data are monthly, we initially anticipated a higher lag order; however, increasing the number of lags may not effectively capture the immediate interactions between variables. Higher-order lags primarily account for delayed effects, whereas our focus is on modelling contemporaneous asymmetric relationships.

The next step concerns checking stationarity and ensuring our variables are integrated of the same order. The unit root tests from Table 3 indicate that the observed time series – the natural logarithms of oil prices as well as of the petroleum products Eurodiesel and Eurosuper 95 – are non-stationary, i.e. that their first differences are stationary. In other words, the variables are of integrated order one, i.e. I(1).

Table 3. Unit root test results

	MacKinnon approximate p-value for Z(t)					
	l2.lnbrentprice	*d.l2.lnbrentprice*	*l2.lneurodiesel*	*d.l2.lneurodiesel*	*l2.lnBMB95*	*d.l2.lnBMB95*
Dickey–Fuller test	0.1844	0.000	0.4102	0.000	0.3665	0.000
Phillips–Perron test	0.1567	0.000	0.2193	0.000	0.1994	0.000

Source: Author's calculation

To examine the long-term relationship between the prices of oil and petroleum products, we use the model proposed by Liu et al. (2010). Using the long-term equation (1), we analyse the long-run relationship between oil prices and the prices of Eurodiesel and Eurosuper 95.

Before applying robust standard errors, we performed the Breusch–Pagan/Cook–Weisberg test (for heteroscedasticity), the Breusch–Godfrey and Durbin–Watson alternative (for serial correlation), and the Jarque–Bera test (for normality) on the standard model (without robust standard errors). All tests reported statistically significant issues, supporting the use of robust standard errors in the final model. Additionally, Newey–West correction (HAC standard errors) was applied, as robust variance ensures consistency in heteroscedasticity, but not in autocorrelation.

The heteroscedasticity problem is addressed by employing robust standard errors in the final model. Robust standard errors are typically larger due to the presence of heteroscedasticity. However, the direction and magnitude of the estimated coefficients remain unchanged and the findings and interpretations therefore

remain the same. Furthermore, the findings remain consistent when employing the Newey–West method, which adjusts for both heteroscedasticity and autocorrelation, reinforcing the robustness and reliability of the conclusions.

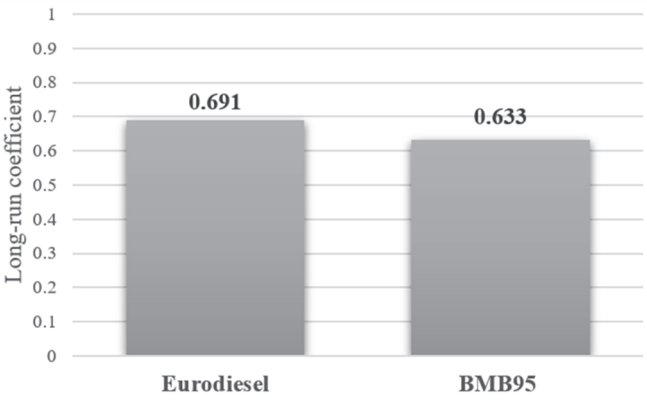
The estimated parameters of the final model are shown in Table 4 and visualised in Figure 1. The long-term adjustment of petroleum products to oil prices is complete if $\alpha_1 = 1$; If $\alpha_1 < 1$, the price adjustment is incomplete, which happens when the markets for petroleum products are not perfectly competitive.

Table 4. Results of long-run models

	Model (1)	Model (2)
	Dependent variable: *l2.lneurodiesel*	Dependent variable: *l2.lnBMB95*
α_1 (lag 2)	0.691^{***}	0.633^{***}
	(0.043)	(0.037)
Constant	0.413^{***}	0.341^{***}
	(0.011)	(0.009)
Observations	178	178
R^2	0.832	0.843

Notes: Coefficients are reported with robust standard errors in brackets.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's calculation

Figure 1. Long-run pass-through of crude oil to retail petroleum prices



Source: Authors' compilation

All estimated parameters are statistically significant at the 1% level, which confirms the validity of the model. The estimated values of α_1 of 0.691 (Eurodiesel) and 0.633 (BMB95) indicate an incomplete adjustment of the prices of petroleum products to the prices of oil on the B&H market. The bar chart figure (Figure 1) compares the estimated long-run coefficients and represents the proportion of a crude oil price change that is passed through to retail fuel prices in the long run. The fact that the value of α_1 for Eurodiesel is higher than that for motor petrol implies faster adjustment of diesel fuel prices to oil prices as compared to motor petrol prices.

After analysing the long-term relationship, we estimate the existence of cointegration of the prices of oil and petroleum products using the residual equations. The Engle–Granger test is a residual-based test for cointegration – we test whether the series residuals contain a unit root. The null hypothesis is that our series are not cointegrated; rejecting the null hypothesis implies that our series are cointegrated. Since oil prices are a key factor in the formation of prices of petroleum products, it is theoretically justified to hypothesise that the prices of oil and petroleum products are cointegrated. From Table 3, we can see that the variables we analyse (oil price and Eurodiesel, oil price and Eurosuper 95) have the same order of integration I(1), which is an econometric prerequisite for the existence of cointegration. The cointegration is tested by the Engle–Granger test, the results of which are shown in Tables 5 (for Eurodiesel) and 6 (for Eurosuper 95).

Table 5. Results of the Engle–Granger cointegration test for Eurodiesel

	Test statistic	1% Critical value	5% Critical value	10% Critical value
Z(t)	– 4.668	– 3.959	– 3.371	– 3.068

Source: Author's calculation

If the test statistic, in absolute value, is greater than the critical value, the null hypothesis of no cointegration is rejected, indicating that the variables are cointegrated. In both cases, the Engle–Granger test indicates the existence of cointegration at the 1% significance level. This is in accordance with the assumptions of the model and the econometric adjustments of the methodology used, which implies that there is a cointegration relationship between the two

variables (the price of the petroleum product and the price of oil) (Enders, 2009). We confirm that the prices of petroleum products and crude oil exhibit a long-run equilibrium relationship.

Table 6. Results of the Engle–Granger cointegration test for BMB95

	Test statistic	1% Critical value	5% Critical value	10% Critical value
Z(t)	– 5.021	– 3.959	– 3.371	– 3.068

Source: Author's calculation

Moving forward, using the previously described ECM (3), and with the help of the residues of the long-term equations, we estimate the short-term equations. Table 7 shows the values of the estimated coefficients. The parameters β_1 in both equations are statistically significant at the 1% level and positive, indicating that changes in crude oil prices and changes in the prices of petroleum products move in the same direction. Higher values, close to 1, imply that domestic prices rise and fall with crude oil prices. This is typically associated with prices being determined in an open market by the supply and demand of fuel. In contrast, a negative correlation in some countries means fuel prices fall when oil prices increase (which is sometimes the case in oil-rich countries). Bamberger and Pirog (2008) explain this phenomenon with factors such as weather conditions, strikes or the business policies of companies, which lead to an incomplete adjustment of petroleum products prices to oil prices.

The fact that β_2 coefficients are negative and statistically significant at the 1% level reaffirms the evidence of the existence of a long-term relationship between the variables. The parameters β_2 capture the speed of adjustment to the equilibrium state and, as expected, have a negative sign. This indicates a periodic correction of the deviation of derivatives prices from their estimated long-term level. The estimated values, based on Equation (4), suggest that in each period (monthly) 33% (for Eurodiesel) and 38% (for Eurosuper 95) of the deviations from the equilibrium state are corrected, implying that the variables return to long-term equilibrium in just over two months. The calculation of the time period required to adjust to the mean value shows that it takes an average of 2.30 months to adjust Eurodiesel prices (i.e. return to long-term equilibrium), while it takes 2.09

months to adjust Eurosuper 95 prices. The price adjustment of Eurosuper 95 is thus slightly faster compared to Eurodiesel.

Table 7. Results of short-run models

	Model (1)	Model (2)
	Dependent variable: *d.l2.lneurodiesel*	Dependent variable: *d.l2.lnBMB95*
β_1 (lag 2)	0.230^{***}	0.211^{***}
	(0.071)	(0.068)
β_2 (lag 1)	-0.335^{***}	-0.378^{***}
	(0.069)	(0.069)
Constant	0.001	0.001
	(0.003)	(0.003)
Observations	177	177
R^2	0.584	0.591

Note: Coefficients are reported with robust standard errors in brackets.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's calculation

In the next step, using the short-term equation residuals, we estimate the asymmetric short-term dynamic relation. In accordance with Equation (5), Table 8 shows the estimated parameters $\delta_1, \delta_2, \delta_3$, where the parameter δ_1 is equivalent to the previously interpreted parameter β_1. We note that all calculated coefficients are statistically significant at the 1% level. More importantly, however, the results of the Wald test show that the difference in the estimated values of the parameters δ_2 and δ_3 are not statistically significant in the case of Eurodiesel (although the time of adjustment to the long-term equilibrium supports the thesis of the existence of price asymmetry), while in the case of Eurosuper 95 the difference is statistically significant at the 5% level.

Table 8. Results of asymmetric short-run models

	Model (1)	Model (2)
	Dependent variable: *d.l2.lneurodiesel*	Dependent variable: *d.l2.lnBMB95*
δ_1 (lag 2)	0.233^{***}	0.215^{***}
	(0.065)	(0.057)
δ_2 (lag 1)	-0.391^{***}	-0.509^{***}
	(0.111)	(0.111)
δ_3 (lag 1)	-0.222^{***}	-0.175^{***}
	(0.065)	(0.063)
Constant	0.007	0.012^{**}
	(0.005)	(0.005)
Wald Test	1.17	4.59
$F\ (1, 175)$	(0.282)	(0.034)
Observations	177	177
R^2	0.591	0.612

Note: Coefficients are reported with robust standard errors in brackets.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Wald test: the null hypothesis is H_0: $\delta_2 = \delta_3$ (shocks are symmetric if the *p*-value is greater than 1%).
F-statistics and *p*-value given for robust test.
Source: Author's calculation

Equations (6) and (7) of the estimated asymmetric ECM are summarised in Table 9 and Figure 2, which show the corresponding values of MAL^+ and MAL^-. MAL measures the average number of months required for retail prices to return to the long-run equilibrium after a shock.

Table 9. The time interval required to adjust toward the mean value

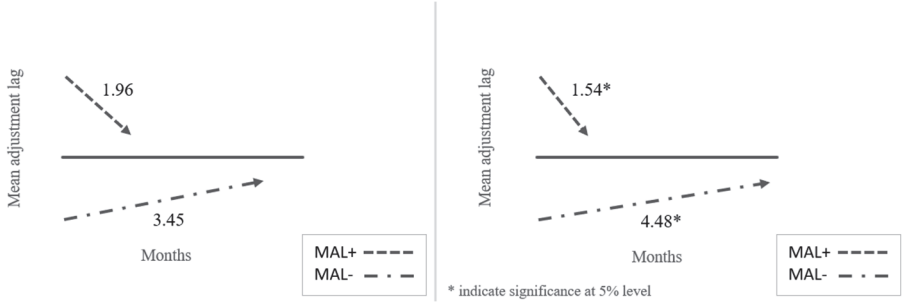
Dependent variable	MAL^+	MAL^-
eurodiesel	1.96	3.45
BMB95	1.54	4.48

Source: Author's calculation

The table distinguishes between positive deviations from equilibrium (MAL^+) when the retail price is above the long-run level, and negative deviations (MAL^-)

when the retail price is below the equilibrium. Smaller values indicate faster adjustment back to the equilibrium price.

Figure 2. Mean adjustment lag for Eurodiesel (left) and Eurosuper 95 (right)



Source: Authors' compilation

For Eurodiesel, the estimated MAL^{+} is 1.96 months, meaning that when Eurodiesel prices are above the long-run equilibrium, they move back within two months. By contrast, the MAL^{-} of 3.45 months implies that when prices are below equilibrium, it takes more than three months to close the gap. This suggests a slower downward adjustment, but the Wald test indicates the result is not statistically significant.

For Eurosuper 95, the MAL^{+} is 1.54 months, while the MAL^{-} is 4.48. The larger gap between these values shows that Eurosuper 95 prices adjust quickly when they are above equilibrium but much more slowly when they are below equilibrium. In this case, the Wald test indicates significance at the 5% level, suggesting a mild form of asymmetry, with downward adjustments taking nearly three months longer than upward adjustments.

Using the same model, Bettendorf et al. (2003) in the Netherlands and Bachmeier and Griffin (2003) in the US reject the hypothesis of price asymmetry in the analysed markets. Bettendorf et al. (2003) investigated whether retail prices react differently to cost increases versus decreases in the Dutch petrol market, employing an asymmetric ECM. A key finding highlights that the conclusion on price asymmetry is sensitive to the specific weekday chosen for price observation, suggesting that data selection significantly impacts the results. The study

concludes that the overall effect of asymmetry on Dutch consumer costs is negligible. Bachmeier and Griffin (2003) find no evidence of asymmetry in wholesale petrol prices. Using an ECM with daily spot petrol and crude oil price data, they conclude that petrol prices adjust almost instantaneously and symmetrically to crude oil price changes.

Using an identical methodology, the Croatian National Bank conducted a survey on the price asymmetry of petroleum products in Croatia for the period April 2014–December 2018 (Croatian National Bank [CNB], 2018). The CNB notes that there is no price asymmetry in the adjustment of Eurodiesel to oil prices. Buyers of diesel fuel are often industrial consumers who negotiate prices with suppliers by buying in bulk, and they can also create strategic reserves that discourage suppliers from behaving asymmetrically when adjusting the price of diesel fuel. The results of the CNB for petrol motor fuel indicate the possible existence of a positive price asymmetry, as they accept this hypothesis only with 10% significance. The results for both types of fuel are directly comparable to ours.

6. CONCLUSION

The results of the analysis of the long-term relationship indicate the existence of a statistically significant long-term relationship between the prices of crude oil and Eurodiesel and Eurosuper 95. The equations show that, when forming the retail price of Eurosuper 95 and Eurodiesel (excluding VAT and duties), 0.34 BAM/L and 0.41 BAM/L, respectively, represent the portion of the price that does not depend on the movement of oil prices. As a partial consequence, the value of the parameter α_1, used to estimate the degree of adjustment of the prices of petroleum products to oil prices, is explained by asymmetric information, storage and distribution costs, and profit margins.

Wald tests of the estimated short-term asymmetric equations show that, assuming the basis for the calculation of the Wald test are coefficients that are statistically significant at the 1% level, the difference in the estimated coefficients for Eurodiesel is not statistically significant, while for Eurosuper 95 the difference is statistically significant at the level of 5%. This implies that there is no asymmetry in the adjustment of Eurodiesel to oil prices; Eurodiesel prices return to long-term equilibrium regardless of whether they are above or below it, that is,

regardless of whether they adjust to a decrease or increase in oil prices. In contrast, the price asymmetry analysis for Eurosuper 95 shows that it takes longer to adjust to long-term equilibrium when prices are below the equilibrium level (4.48 months) than when prices are above it (1.54 months), which indicates the existence of price asymmetry. However, this estimate is statistically significant at the 5% level, but not at the 1% level, indicating that evidence of asymmetry is present but relatively weak.

This study deals with the asymmetric adjustment of prices of petroleum products to changes in oil prices in B&H. We presented the way in which oil companies in B&H adjust diesel and petrol prices to fluctuations in global crude oil prices, using the BAM/USD exchange rate. The literature on price asymmetry points to the factors that lead to its occurrence, among the most significant being market structure, regulatory framework, exchange rates, methodological differences, and the costs of adjusting and managing inventories. The frequency of the data and the time frame are also important, because research with a larger time span, such as ours, more easily dismisses the asymmetry hypothesis. Surveys of different countries give different results – some confirm the existence of asymmetry, while others find symmetry.

A review of regional studies on asymmetric fuel price adjustments in less developed Southeast European markets reveals mixed evidence. These markets generally exhibit symmetric or mildly asymmetric price pass-through. Studies of Croatia and Greece find that standard error correction models rarely detect significant asymmetry, and asymmetries emerge only under nonlinear models or over short periods. Prior findings, together with the present study's results, imply that regulated margins and limited market power in smaller economies such as B&H contribute to nearly symmetric pass-through.

These patterns contrast with findings from developed countries (e.g., Italy, France, Germany, and the U.S.), where "rockets and feathers" effects are more pronounced. Developed countries are generally more competitive and better regulated, yet not wholly immune to rockets and feathers dynamics. We highlight how market structure and competition shape price adjustments. The degree of asymmetry and the speed of adjustment also differ due to structural and policy factors.

We have not confirmed the presence of rockets and feathers. There is no asymmetric adjustment mechanism in the petroleum products market in B&H; therefore, we reject the H1 hypothesis. The results show that the retail market of petroleum products in B&H functions efficiently, i.e. that energy entities behave in a fair and competitive manner. Asymmetric price adjustment is definitely not a continuous feature of the petroleum products market, but occurs in individual, shorter time intervals. Therefore, the possibility of its existence in B&H should not be completely dismissed.

The results of the empirical analysis indicate a long-term cointegration of oil and diesel and petrol prices. Nevertheless, the analysis of short-term dynamics showed that there is no statistically significant asymmetry in the adjustment of diesel prices, although prices adjust faster downwards than upwards. For petrol, there are indications of faster downward asymmetry, but with a low significance level (5%). As such, the H2 hypothesis remains unsupported.

Despite certain limitations, our study contributes to a better understanding of the dynamics of the B&H retail market of petroleum products. The implications that are relevant for both economic policymakers and participants in the petroleum products market. Regulators may benefit from the these findings because effective policy design can mitigate the full impact of oil price volatility – balancing regulation and market liberalisation is essential for preserving economic stability. Furthermore, petroleum product traders can use the findings to understand the dynamics of price adjustment and optimise their business strategies.

The study provides valuable insights for economic policymakers, businesses, and consumers. Since the literature on price asymmetry is not uniform, recommendations must be adapted to the observed context. The recommendations vary depending on the state of the country's economy and the maturity of its energy market. B&H, as a developing country, needs to rebuild local oil production by expanding processing capacities to reduce import dependence, which is a key vulnerability factor. The high import dependence of the B&H economy on oil underscores the threatening character of oil shocks for small open economies that do not have defense mechanisms, such as strategic commodity reserves, against exogenous shocks. In such conditions, economic measures cannot adequately amortise the spillover of oil shocks to the prices of

petroleum products. One area of particular interest in developing countries is green infrastructure projects that contribute to decarbonisation, increasing energy efficiency, and the sustainability of the energy sector. Compressed natural gas (CNG) and hydrogen are often proposed as lower-emission alternatives to conventional petroleum fuels, but supplying filling stations with these products poses a challenge as the development of a widespread refuelling infrastructure is capital-intensive, necessitaing generous funding of these projects. The state can encourage companies to include these products in their portfolios by exempting them from paying excise duties on petroleum products for a specified period after the commissioning of CNG and hydrogen filling installations, thereby allowing companies to retain part of their operating revenues. In addition, the state can be directly involved in the co-financing of such projects by issuing calls for proposals, or create special credit lines for companies through development banks to provide them with favourable financing for projects, thus expanding the range of fuels offered by filling stations.

Introducing control variables determines the specific focus of a study – prediction versus structural interpretation. Previous studies have included control variables; however, their analytical focus differs from that of our study. This does not suggest that these factors are insignificant; rather, they fall outside the primary scope of our analysis. Given the study's focus on the direct relationship between the prices of crude oil and petroleum products, as well as data availability, this simplified specification represents a limitation that future research may address by incorporating additional variables.

Limitations of the study relate to the frequency and degree of aggregation of the data. The appropriate frequency of data should be identical to the frequency of price changes on the petroleum products markets; however, such data (especially weighted averages that take into account the market share of energy entities) do not exist. When there are daily changes in oil prices, correct conclusions can only be drawn from analyses on the basis of daily time series. It is also necessary to use spatially disaggregated data, at the level of filling stations, because it is unrealistic to assume all energy entities on the market behave in exactly the same way. Spatially aggregated data can very easily mask price asymmetry at the level of an individual energy entity. In support of this argument, Balaguer and Ripollés (2012) and Perdiguero-Garcia (2013) point out that the probability of confirming

or rejecting the hypothesis on the presence of price asymmetry depends not only on the frequency of the data used, but also on the methodology used.

Another important aspect to consider is the regulation of maximum retail prices of petroleum products, which has prevented entity governments from freely setting retail prices in the last four years of our observation period. At the beginning of April 2021, the Government of Republika Srpska adopted the *Decree on Determining the Margin to Be Applied in the Formation of Prices of Petroleum Products* (2021), and the Government of the Federation of Bosnia and Herzegovina adopted the *Decision on Prescribing Measures of Direct Price Control by Determining the Maximum Level of Margins for Petroleum Products* (2021). Although these measures were part of a broader economic package of interventions created with the aim of protecting consumers and stabilising the petroleum products market during the COVID-19 pandemic, they remain in force today. A year earlier, in April 2020, the Government of Republika Srpska limited the prices of petroleum products with the *Decree on Determining the Margin to Be Applied in the Formation of Prices of Petroleum Products* (2020), which was repealed in August 2020 by the *Decree on the Termination of the Decree on Determining the Margin to Be Applied in the Formation of Prices of Petroleum Products* (2020).

Asymmetric price adjustment, even if it exists in the retail market of petroleum products in B&H, is not a market phenomenon that is evenly distributed over time; it occurs intermittently at certain moments or for short periods, which is why it is difficult to detect. Perdiguero-Garcia (2013) states that studies using longer time series are more likely to reject the hypothesis of the existence of price asymmetry. Analysing longer periods of time can be counterproductive because it encompasses periods of different market conditions and patterns of behaviour in the market, ultimately making it impossible to draw accurate conclusions.

Building on the above considerations, Cook and Fosten (2019) examine previous research by including more recent data and confirm the existence of price asymmetry in the diesel and motor petrol markets. However, they point out significant variations in the use of alternative methodological approaches, which can also be interpreted as a limitation and, at the same time, as a direction for further research.

Future studies may explore supply-side factors, such as the market concentration of energy entities in the oil market, in order to determine whether B&H companies have a relatively equal market share that prevents them from setting discriminatory prices. In addition, future research could examine the effectiveness of derivatives price control mechanisms during periods when entity governments have imposed maximum retail prices and thus indirectly constrained market-based price formation. With such analyses, we could examine the direct effects of a price control mechanism, and whether it leads to a different pattern of adjustment in the oil market. Comparing the results of such studies with existing ones could yield additional conclusions.

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APPENDIX

Table A.1 Lag order criteria selection

lag	LL	LR	*p*	FPE	AIC	HQIC	SBIC
0	442.633			1.3e–06	–5.05325	–5.03115	–4.99878
1	916.609	947.95	0.000	6.1e–09	–10.3978	–10.3094	–10.1799
2	993.505	153.79	0.000	2.8e–09*	–11.1782*	–11.0236*	–10.797*
3	997.271	7.5313	0.582	3.0e–09	–11.1181	–10.8971	–10.5734
4	1006.9	19.261*	0.023	3.0e–09	–11.1253	–10.8381	–10.4172
5	1013.65	13.497	0.141	3.0e–09	–11.0994	–10.7459	–10.228
6	1017.51	7.7129	0.563	3.2e–09	–11.0403	–10.6205	–10.0054

Note: * Optimal lag according to the information criterion
Source: Author's calculation

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INTENDING TO OWN AT ALL COSTS: PSYCHOSOCIAL FACTORS INFLUENCING HOMEOWNERSHIP INTENTIONS DESPITE FINANCIAL RISKS

ABSTRACT: *Grounded in the Theory of Planned Behaviour (TPB), this study examines whether homeownership intention – driven by consumption needs rather than investment motives – encourages individuals to overlook financial risks in pursuit of immediate housing benefits. Using quota sampling, data were collected from 420 non-homeowners and analysed with partial least squares structural equation modelling. The findings show that attitudes, perceived homeownership control, subjective norms, financial risk perceptions, and household debt significantly affect homeownership intention, whereas credit access does not. Moreover, neither credit access nor household debt moderates the relationship between financial risk perceptions and homeownership intentions. Nevertheless, financial strain emerges as a hidden pressure that undermines the psychosocial drivers of homeownership intentions. These results extend the TPB by integrating behavioural-finance insights, revealing that homeownership intentions are shaped not only by attitudes, norms, and perceived control but also by financial anxiety. For policymakers, the implications are evident: strengthening self-efficacy, social support, and financial literacy may prove more effective and sustainable than merely expanding credit access in enabling vulnerable households to achieve their first step on the property ladder.*

KEY WORDS: *credit access; financial risks; household debt; homeownership intensions; Indonesia; non-speculative motive*

JEL CLASSIFICATION: D14, R21, D91

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1. INTRODUCTION

Homeownership in Indonesia remains a pressing social and economic issue. Currently, 12.7 million families lack homes, and another 29.6 million live in inadequate housing conditions (KemenPUPR & The World Bank, 2023). Despite growing demand, the number of homeowners increased by only 1.02% between 2018 and 2022 (Badan Pusat Statistik [BPS], 2022). While much attention has been given to external factors such as housing policies, property prices, supply, location, and access to financing, less is known about the internal, household-level factors influencing the intention to own a home (Hew et al., 2020). Understanding the perspectives of those who remain without homes is essential for grasping why ownership intentions remain limited.

For low-income groups, access to homeownership poses a persistent challenge in Indonesia. Although successive administrations have rolled out affordable housing schemes, the ownership backlog is still large and housing programme coverage remains low (Dewi et al., 2022). The house-price-to-income ratio in many cities continues to place ownership beyond the reach of low-income households (*Masyarakat Berpenghasilan Rendah* [MBR]) (Urban Land Institute [ULI] Asia Pacific, 2023). Many MBR households face chronic financial uncertainty and limited access to formal mortgage finance. National housing roadmaps emphasise that supply-side expansion and new financing facilities must be matched with a "people-first" approach (World Bank, 2023). Yet, partial subsidy coverage and strict credit screening leave many MBR dependent on informal markets or unsuitable loan products. Consequently, only about 17% of Indonesians have ever accessed formal housing credit (Esquivias et al., 2021).

Examining these economic constraints alongside the internal drivers of homeownership intentions offers a compelling research avenue. One such driver is individuals' perception of financial risk in relation to their homeownership intentions. This perception is not merely peripheral but significantly shapes considerations about homeownership intentions (Reddy & Thanigan, 2023). However, most studies discuss financial risk in the context of speculative investment rather than residential ownership. In investment-driven purchases, buyers focus on resale value and market returns (Gumasing & Niro, 2023; Njo & Sugeng, 2023).

The distinction between buying a home as an investment and intending to own a house to live in is crucial. In investment-driven purchases, speculation plays a central role; properties are acquired for profit, often with little intention of residing in them (Thontteh & Babarinde, 2018). As such, speculative home purchases should, by nature, involve careful consideration of financial risk, given the potential for market fluctuations, price volatility, and uncertain returns. In contrast, homeownership, as explored in this study, focuses on families striving to secure stable housing. This study specifically investigates whether psychosocial factors and perception of financial risk influence homeownership intentions in the absence of speculative motives.

For low-income families, purchasing a home typically involves securing long-term mortgage loans, large down payments, and high financial obligations. Understanding how perceptions of risk influence such non-speculative decisions is essential to designing policies that promote affordable and sustainable homeownership. Moreover, speculative activity in the housing market can inflate property prices, further reducing affordability for genuine first-time buyers.

Household debt and credit access add another layer of complexity. Existing research presents mixed findings. Some studies find that manageable debt and accessible credit encourage ownership intentions (Mazzone & Folch, 2020; Scott III & Bloom, 2022), while others report the opposite (Bleemer et al., 2021; Mezza et al., 2020;). The effect of credit availability follows a similar pattern of inconsistency, suggesting that a more fine-grained examination of the credit access interface and of these financial considerations with risk perceptions and homeownership intentions is warranted.

Risk aversion, access to capital, and subjective financial judgments interact to shape differing levels of intention to pursue homeownership. Perception of risk is fundamental to financial intention formation and prospective decision-making (Gärling et al., 2009). For families viewing homeownership as a necessity, perceived risks may be downplayed; for more risk-averse individuals, such concerns may deter ownership altogether. This underscores the need to analyse how internal economic judgments influence housing decisions.

This study focuses on low-income Indonesian households, one of the most vulnerable groups facing significant barriers to homeownership. Neglecting this

population risks deepening socio-economic inequalities. Although this study focuses on intentions rather than actual behaviour, understanding the psychological and financial underpinnings of housing decisions provides crucial insights for addressing issues such as crime, illness, and poor educational outcomes. Over time, these challenges can strain public systems, whether healthcare, education, or social welfare.

Accordingly, this study pursues two main objectives. First, to examine the direct effects of the core Theory of Planned Behaviour (TPB) variables: attitudes, subjective norms, and perceived behavioural control along with financial risk perceptions on homeownership intentions. Second, to investigate whether credit access and household debt moderate the relationship between financial risk perception and homeownership intentions. These objectives are tested using partial least squares structural equation modelling (PLS-SEM), specifying both direct effects of psychosocial and financial factors on intentions, as well as interaction effects involving credit access and household debt.

2. LITERATURE REVIEW

2.1. Theory of Planned Behaviour for homeownership

Homeownership intentions, though not a behaviour itself, is closely tied to behavioural outcomes and economic decisions. Acquiring a home typically requires substantial financial resources and is often the largest expenditure within an individual's life cycle (Leventhal & Newman, 2010). From an economic perspective, the opportunity cost of allocating such resources to housing may limit spending on other needs. Consequently, individuals must weigh trade-offs and long-term implications before committing to ownership.

The TPB offers a robust framework to explain these decisions through psychosocial underpinnings of homeownership intentions. Internally, individuals evaluate perceived benefits and costs (attitude), assess their ability and confidence to act (perceived behavioural control), and consider emotional readiness and expectations. Externally, perceived encouragement and social approval (subjective norm) shape the motivation to pursue ownership (Al-Nahdi et al., 2015).

Residential choices, whether ownership, renting, or communal, can be explained through behavioural perspectives in which behaviour ultimately reflects the act of engaging in housing actions (Kvietkute & Hauge, 2022). To understand these mixes, one must look at personal characteristics such as financial discipline, risk-taking attitudes, and social influence. The TPB effectively integrates these dimensions, providing a theoretical foundation for this study's hypotheses.

H1: Attitude positively influences homeownership intentions.

H2: Subjective norm positively influences homeownership intentions.

H3: Perceived homeownership control positively influences homeownership intentions.

2.2. Extended TPB and economic factors

Economic conditions significantly influence homeownership intentions alongside locational considerations. Individuals with stable income and savings typically have greater flexibility in choosing housing options, whereas financially constrained households face more significant barriers (Sapiri et al., 2023). Among the many economic determinants, household debt and credit access are particularly influential, although their behavioural implications may not be as visible as those of income and savings.

One's ability to obtain a house is impacted by household debt. Under Merton's Default Risk Theory, solvency is the most relevant event that determines credit risk exposure (Mwirikia et al., 2020). High household debt can elevate perceived default risk and discourage ownership (Head et al., 2023). While mortgage borrowing enables access to housing, excessive debt may cause financial stress, reducing willingness to buy. Prudent debt management thus remains essential to maintaining affordability within sustainable limits.

Conversely, access to credit facilitates homeownership by easing liquidity constraint. The Credit Availability Theory posits that the rational easing of lending requirements by financial institutions can stimulate investment and consumption (Sakanko, 2023). When mortgages are accessible, more individuals qualify for home loans, enhancing homeownership intention (Jorgo, 2020). In

this regard, inclusive access to credit supports broader economic and social goals by enabling more equitable pathways to homeownership intentions.

H4: Household debt negatively influences homeownership intentions.

H5: Credit access positively influences homeownership intentions.

a. Financial risk perception effect on homeownership

Beyond measurable economic variables, financial risk perception is another important factor of homeownership intentions. This includes concerns over market volatility, repayment ability, interest rates, and broader economic uncertainty (Sapiri et al., 2023). People with high perceived risk are less likely to pursue homeownership due to financial instability (Letkiewicz & Heckman, 2017), while those with low risk are more likely to embrace the commitment in the face of uncertainty.

H6: Financial risk perception negatively influences homeownership intentions.

b. Credit access and household debt as moderators

This study also investigates whether credit access and household debt moderate the effect of financial risk perception on homeownership intentions. Formal credit availability, in particular, can serve as a buffer that attenuates perceived financial risk, whereas an existing debt burden may amplify sensitivity to future loss. Behavioural finance theory posits that individuals manage finances across their life cycle to stabilise consumption (Holzmann et al., 2019). Individuals may rely on credit to smooth consumption in early adulthood when income levels are low. As income increases, self-financing capacity improves, and reliance on credit declines (Walid, 2019). Access to credit can therefore function as a buffer against financial uncertainty, reducing perceived risks. Those with greater access to credit often feel more confident in managing the financial commitments associated with homeownership (Suri & Jack, 2016). In short, credit access provides structured financing, longer loan tenures, and subsidy options, thereby weakening the negative link between risk perception and ownership intentions among those who qualify.

Household debt is also associated with risk perceptions. According to behavioural finance theory, individuals burdened by debt tend to be more sensitive to financial risk. Many worry about repayment, leading them to overestimate the likelihood of financial loss (Friedline et al., 2021). This may deter them from pursuing homeownership. In contrast, people with manageable debt often perceive themselves as financially stable and capable of absorbing housing-related risks. Household debt signals existing financial obligations and heightens vulnerability; consequently, higher debt is predicted to amplify the negative effects of both economic and psychological risk (Suri & Jack, 2016). In short, higher household debt increases financial risk perception and reduces homeownership intentions.

Simultaneously, debt and credit access interact to shape an individual's perceived financial risk. Importantly, such perceptions are not purely rational; they are subjective, shaped by heuristics, social comparisons, and personal experiences rather than objective financial metrics (Ricciardi, 2008). Understanding how these perceptions vary across social and economic groups is critical for designing inclusive housing policies and adaptive financial products that promote sustainable and equitable homeownership.

H7: Credit access weakens the negative relationship between financial risk perceptions and homeownership intentions.

H8: Household debt strengthens the negative relationship between financial risk perceptions and homeownership intentions.

2.3. Previous studies on housing intention using the TPB

Empirical studies applying the TPB specifically to homeownership intentions remain limited, especially in developing contexts. Much of the existing literature conflates homeownership with speculative property investment. Since first-time purchase intentions are typically self-occupancy oriented, this study draws on TPB-based works that explicitly define homeownership as owner-occupation. Table 1 presents the few TPB-based studies meeting this criterion.

Table 1. Previous homeownership articles with TPB framework

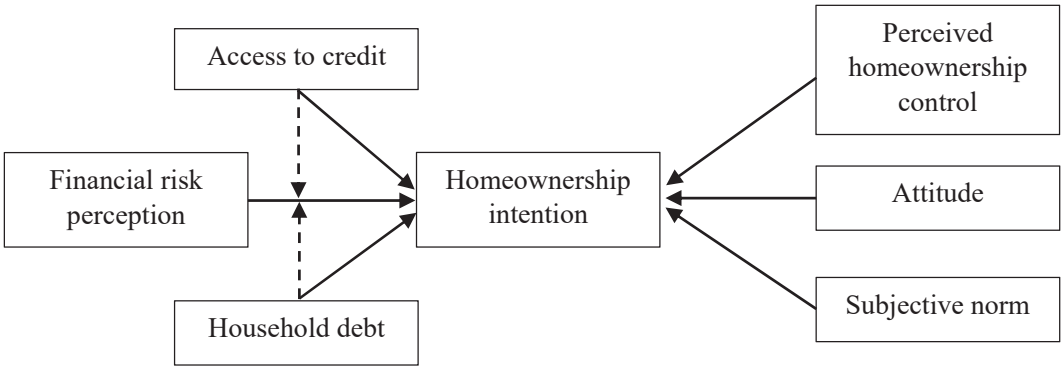
Author	Country scope	Sample/ Method	TPB construct
Hew et al. (2020)	-	-/ Literature review	▪ Residential environment ▪ Attitude ▪ Subjective norms ▪ Perceived behavioural control
Liadi & Tapamose (2021)	Nigeria	300/Quantitative	▪ Attitude ▪ Subjective norms ▪ Perceived behavioural control
Lindblad et al. (2017)	United States	76–93 % of 1,531 samples/ Quantitative	▪ Attitudes ▪ Subjective norms ▪ Perceived behavioural control ▪ Demographic (age, income, gender, race, family size, education, job, and spouse)
Tan & Goh (2018)	Malaysia	304/Quantitative	▪ Attitudes ▪ Subjective norms ▪ Perceived behavioural control ▪ Perceived moral obligation ▪ Environmental concernss ▪ Perceived value ▪ Perceived self-identity ▪ Financial risks ▪ Performance risks ▪ Psychological risks
Yoke et al. (2018)	Malaysia	300/Quantitative	▪ Attitudes ▪ Subjective norms ▪ Perceived behavioural control ▪ Financial factors (mortgage, interest rates, income, house price) ▪ Location ▪ Living space
Zheng et al. (2019)	China	353/Quantitative	▪ Attitudes ▪ Subjective norms ▪ Perceived behavioural control ▪ Government incentives

To our knowledge, the interplay between financial risk perceptions and the moderating roles of credit access and household debt remains underexplored. This study addresses this gap by integrating financial variables into the TPB framework, expanding its psychosocial scope, and clarifying how financial perceptions condition homeownership intention.

3. METHODOLOGY

3.1. Conceptual framework

Figure 1: The conceptual framework for homeownership intention



The conceptual framework (Figure 1) highlights the interrelated influences of psychosocial and financial factors on homeownership intentions. We integrate the TPB core constructs attitudes, subjective norms, and perceived homeownership control with financial risk perceptions, household debt, and credit access.

3.2. Population and sample

Data were collected through face-to-face interviews using a self-administered survey from December 2024 to February 2025. The study targeted non-homeowning households: those living in rental properties, parental homes, boarding houses, or official residences – to capture decision-making at the pre-purchase stage. This sampling strategy ensures that respondents' intentions reflect aspirations toward first-time ownership rather than investment motives.

Central Java was selected for two key reasons. First, it is one of Indonesia's most populous provinces on the island of Java (approximately 32.3 million people). Java as a whole accounts for approximately 56.1% of the national population; however, Central Java has experienced low homeownership growth compared to other provinces. In fact, it has recorded the lowest homeownership growth in the past three years – 95,079 new homeowners compared to 184,367 in West Java and 239,110 in East Java (BPS, 2022). Second, the province is notable for *Sambatan* (self-help housing), a form of social capital that theoretically should strengthen homeownership intention (Diwangkoro et al., 2025; Herlina et al., 2022). Yet, paradoxically, its homeownership growth lags behind that of provinces without such traditions, such as Jakarta (Masduki, 2017). This gap highlights the central puzzle: strong social capital does not necessarily yield higher homeownership rates (BPS, 2022). Accordingly, Central Java provides a counterfactual case to assess how psychosocial drivers and risk perceptions shape housing intentions beyond communal resources.

The sample was drawn from seven districts with the lowest growth in homeownership: Surakarta, Boyolali, Karanganyar, Klaten, Sragen, Sukoharjo, and Wonogiri (Lisnawati, 2015). Due to the absence of a valid sampling frame and privacy restrictions on detailed household records, quota sampling was employed to ensure representation. This approach was deemed most appropriate for capturing determinants of homeownership intentions. Using Daniel Soper's PLS-SEM sample-size calculator (Soper, 2022), a final sample of 420 respondents was determined – sufficiently large for model estimation. District-level quotas were proportionally assigned based on the number of non-homeowning households (Table 2).

Table 2: Sample distribution

District (1)	Population* (2)	Proportion (3) = (2)/Total population	Quota of samples (4) = (3)*420 (Total samples)
Surakarta	52,702	0.24	99
Sukoharjo	49,895	0.22	94
Klaten	45,071	0.20	85
Karanganyar	26,538	0.12	50
Sragen	19,637	0.09	37
Boyolali	15,352	0.07	29
Wonogiri	13,708	0.06	26
Total	222,903	1.00	420

Note: * Population of households without homeownership

3.3. Instrument and measurement

Data were collected using a structured questionnaire comprising three sections. The first section captured respondents' profiles, including demographic factors, education level, and employment status. The second addressed their economic situation, covering monthly income, indebtedness, expenses, credit instalments, and access to banking services. The third and main section examined homeownership intentions, incorporating psychosocial constructs (attitudes, subjective norms, and perceived behavioural control) alongside economic variables (perceived financial risk and credit access). Established and validated measures from prior studies were systematically adapted to the Indonesian housing context.

Given the structured design, item clarity was prioritised, and response variability was intentionally limited to ensure consistency. Items in the third section were measured using a 5-point Likert scale, enabling objective and comparable assessments of psychosocial and economic influences on homeownership intentions (Appendix 1). This structure provided a measurable and context-specific understanding of housing intentions.

The instrument was adapted following a standard cross-cultural adaptation (CCA) protocol. Although no universally accepted CCA procedure exists

(Epstein et al., 2015), this study followed the stepwise approach outlined by Gjersing et al. (2010) to ensure conceptual and semantic equivalence. Written permission was obtained from the original scale developers, and items most relevant to the Indonesian context were selected. The research team, with a bilingual expert, conducted forward translation, which was reconciled into a single draft. An independent translator then performed back-translation, with discrepancies resolved through discussion. A panel of experts from the research group reviewed the draft for face and content validity. Finally, the questionnaire was pretested with prospective respondents and refined after a pilot survey, resulting in the version in the Indonesian language (Bahasa).

3.4. Procedure of analysis

Data analysis began with data cleaning, which involved screening for missing or duplicate responses, uniform response patterns (identical ratings across items), and outliers. Respondents who owned homes outside the study area were excluded. Harman's single-factor test was then applied to assess common method bias (CMB), with bias indicated if a single factor explained more than 50% of the variance across measures (Harman, 1967; Kock et al., 2021; Podsakoff et al., 2003). Next, descriptive statistics (mean, median, mode, standard deviation, frequency) were used to summarise respondent characteristics after cleaning, including demographics (age, sex, education, occupation, income) and key study variables.

Reliability and validity were assessed following established PLS-SEM guidelines (Shmueli et al., 2019). Indicator reliability was evaluated using factor loadings, with thresholds of ≥ 0.60 for exploratory constructs and ≥ 0.70 for established constructs (Hair et al., 2019). Convergent validity was confirmed when the average variance extracted (AVE) exceeded 0.50. Discriminant validity was assessed via the heterotrait-monotrait (HTMT) ratio, with acceptable values below 0.90 (Henseler & Sarstedt, 2013). Internal consistency reliability was evaluated using Cronbach's alpha (CA) and composite reliability (CR), with acceptable values ranging from 0.60 to 0.70 (Taber, 2018).

The structural model was tested using PLS-SEM. The model assessment considered multicollinearity, path significance, explanatory power, and predictive power. Multicollinearity was evaluated using the variance inflation

factor (VIF), with values greater than 5 indicating concern (Hair et al., 2017). Given that all the directional hypotheses were derived from theory and prior empirical findings, the significance tests were conducted using one-tailed tests ($\alpha = 0.05$). The threshold for significance was set at $t > 1.645$ for positive hypotheses and $t < -1.645$ for negative hypotheses.

The analysis followed a two-stage procedure. In the first stage (Model 1), the baseline structural model included latent constructs and their interaction terms to generate latent variable scores and moderation effects. In the second stage (Model 2), these scores and interactions were combined with control variables (age, education, income, family size) in a single equation. Treating controls as single-indicator exogenous constructs allowed direct paths to the endogenous variable while bypassing reliability and validity testing required for multi-item psychosocial constructs. This specification enabled a clean comparison between baseline (no controls) and extended (with controls) models, reducing omitted-variable bias.

Moderation and control effects were tested simultaneously, and interaction significance was evaluated with 5,000 bootstrap subsamples. Effect size (f^2) was interpreted according to Cohen's criteria: small (0.02), moderate (0.15), and large (0.35) (Cohen, 1988). Moderation thresholds of 0.005, 0.01, and 0.025 correspond to small, medium, and large effects, respectively (Kenny, 2018). Predictive power was judged using R^2, with values of 0.75, 0.50, and 0.25 indicating substantial, moderate, and weak explanatory power, respectively (Duarte & Amaro, 2018).

Additional diagnostics tested model fit and predictive relevance. Q^2_predict assessed out-of-sample predictive validity. Model fit indices included the standardised root mean square residual (SRMR), squared Euclidean distance (d_ULS), Geodesic distance (d_G), and the normed fit index (NFI). In PLS-SEM, SRMR values between 0.08 and 0.10 are generally considered acceptable (Hair et al., 2017).

4. RESULT AND ANALYSIS

4.1. Pre-analysis

Data cleaning ensured quality and consistency before analysis. Nine incomplete questionnaires with more than five missing items were excluded, and single or double missing values were imputed using the mode. Twelve responses from participants who did not meet the target criteria (homeowners outside the study area) were also removed. Four duplicate responses from Klaten and Surakarta were consolidated into one valid entry per respondent. No such issues occurred during face-to-face interviews conducted by the researcher.

This process yielded 420 valid responses. Outliers were then assessed using boxplot analysis. Mild outliers were retained as natural variations, while one extreme outlier was detected in case 420 (indicator SN6). Input errors in cases 182 and 320 were corrected due to misinterpretation of the household size question. In case 420, a data entry error produced a zero value for SN6, which was imputed with the mode, 5. These corrections preserved accuracy without discarding valid data.

To address CMB, several procedural remedies were implemented following Kock et al. (2021). Respondents were assured of anonymity and confidentiality, allowed to use pseudonyms, and informed that there were no right or wrong answers. The survey was intentionally brief (< 10 minutes), with a maximum of seven items per construct, and contained both positively and negatively worded questions to minimise response bias.

Statistical tests further confirmed the absence of significant CMB. Harman's single-factor test in SPSS 25.0 indicated that the first factor explained only 29.3% of the variance, below the 50% threshold. A comparable result (27.9%) was obtained using WarpPLS. Additionally, the full collinearity VIF (FCVIF) test in WarpPLS 8.0 showed that all latent variables had VIF values below 3.3, confirming that the dataset was free from substantial CMB (Kock, 2017).

4.2. Demographic profiles of respondents

Most respondents (75.2%) were under 45 years old (Table 3), a stage in life when securing homeownership is often a central priority. Many were transitioning

from renting or co-residing with parents to seeking independent housing. More than half of respondents (51.9%) lived in a household of four people, underscoring the salience of homeownership for growing families. Interestingly, 46.7% of married respondents still lived with their parents, reflecting both cultural norms and economic constraints delaying independent ownership.

Income levels indicated that more than half earned less than USD 159 per month (approx. 2.5 million Indonesian Rupiah [IDR]), positioning them within the low-to-middle-income segment. For these households, dedicating even one-third of monthly income to mortgage payments would impose a severe financial burden, leaving limited capacity for other essential expenditures without external financial support.

Debt levels were generally modest. Half of the respondents reported no debt, and among those indebted, most obligations were to banks (44.5%). The majority reported debts under IDR 1 million (approx. USD 61), and only 2.6% had monthly instalments exceeding IDR 2.5 million (approx. USD 153). While these low levels may indicate financial prudence, they also reveal limited access to substantial credit, which could otherwise facilitate homeownership. Furthermore, limited exposure to larger debt obligations may heighten perceptions of financial risk, as unfamiliarity with credit management amplifies concerns over repayment capacity and long-term financial stability. Overall, the demographic profile illustrates households constrained by low income, restricted credit access, and limited debt experience – factors that collectively exacerbate perceptions of financial risk and complicate the path toward homeownership.

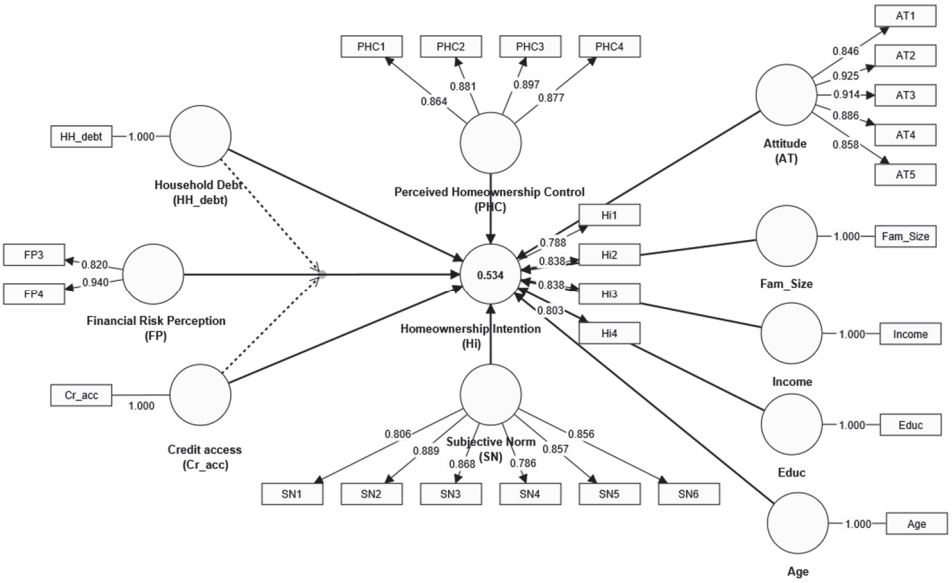
Table 3: Respondent's profile

Demographic attributes			(%)	Demographic attributes		(%)
Sex	Female		45.0	Marital status	Married	94.3
	Male		55.0		Unmarried (Widow/widower)	5.7
Age	1	< 30	31.4	Status of residence	The parents'/relatives' house	46.7
	2	31–45	43.8		Rented house	31.9
	3	46–60	18.3		Leasehold	10.5
	4	> 60	6.4		Rooming house	9.0
					Company house	1.9
Family member	1		0.5	Occupation	Self-employed person	39.7
	2		11.4		Informal worker	35.9
	3		15.7		State employee	17.9
	4		51.9		Private formal employee	6.4
	> 5		20.5			
Educational achievement	Incomplete elementary		0.5	Income	≤ Rp1,500,000	25.5
	Primary completed		27.1		Rp1,500,001 – Rp2,500,000	35.5
	Secondary completed		51.9		Rp2,500,001 – Rp3,500,000	23.3
	University completed		20.5		> Rp3,500,000	15.7

4.3. Outer model evaluation

Indicator reliability was first assessed through outer loadings. In the initial model iteration, five indicators (FP1, FP2, FP6, Hi5, and Hi6) were significantly below the threshold of 0.70 and eliminated from the model. FP5 ($\lambda = 0.605$) improved slightly ($\lambda = 0.693$) but remained below 0.70 and was also dropped. All remaining indicators met the required loading threshold. The valid indicators retained after this process are presented in Figure 2.

Figure 2: The empirical model for homeownership intention



Reliability and validity were then evaluated. The lowest Cronbach's alpha was 0.730 and the lowest composite reliability was 0.874, both exceeding the recommended threshold of 0.70. Convergent validity was confirmed, with the lowest AVE = 0.667 (> 0.50) (Table 4).

Table 4: Reliability and validity indicators

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AT	0.932	0.936	0.948	0.786
FP	0.730	0.866	0.874	0.778
Hi	0.833	0.834	0.889	0.667
PHC	0.903	0.904	0.932	0.774
SN	0.919	0.923	0.937	0.713

Discriminant validity was supported through both the HTMT ratio (< 0.90) and the Fornell–Larcker criterion, where the square roots of AVE exceeded inter-construct correlations (Table 5).

Table 5: Fornell-Larcker criterion

	AT	FP	Hi	PHC	SN
AT	**0.886**				
FP	-0.140	**0.882**			
Hi	0.552	-0.230	**0.817**		
PHC	0.516	-0.092	0.622	**0.880**	
SN	0.518	-0.120	0.569	0.598	**0.844**

4.4. Inner model evaluation

No multicollinearity was detected (highest VIF = 4.689, AT2). Path analysis revealed that attitudes (AT), subjective norms (SN), perceived homeownership controls (PHC), and financial risk perception (FP) significantly affected homeownership intention (Hi). In contrast, credit access (Cr_acc) was not significant. Household debt (HH_debt) exerted a small but significant negative effect ($\beta = -0.059$, $t = 1.718$, $p = 0.043$). Neither interaction term – HH_debt × FP or Cr_acc × FP – was significant, indicating no moderation effect (Table 6).

Table 6: Path analysis — Model 1 (no controls) and Model 2 (with controls)

	Model 1				**Model 2**			
	Sample mean (M)	Std. deviation (STDEV)	*t*-values	*p*-values	Sample mean (M)	Std. deviation (STDEV)	*t*-values	*p*-values
AT -> Hi	0.239	0.046	5.194	0.000	0.228	0.046	4.930	0.000
Cr_acc -> Hi	-0.014	0.069	0.206	**0.418**	0.003	0.070	0.041	**0.484**
FP -> Hi	-0.121	0.049	2.360	0.009	-0.132	0.049	2.585	0.005
HH_debt -> Hi	-0.059	0.034	1.718	0.043	-0.060	0.034	1.754	0.040
PHC -> Hi	0.349	0.058	6.009	0.000	0.356	0.058	6.103	0.000
SN -> Hi	0.222	0.057	3.839	0.000	0.198	0.057	3.421	0.000
HH_debt x FP -> Hi	-0.021	0.038	0.771	**0.292**	-0.024	0.037	0.631	**0.264**
Cr_acc x FP -> Hi	-0.051	0.074	0.548	**0.220**	-0.043	0.072	0.697	**0.243**
Age -> Hi					0.082	0.039	2.121	0.017
Educ -> Hi					-0.054	0.038	**1.429**	**0.076**
Fam_Size -> Hi					0.085	0.035	2.467	0.007
Income -> Hi					-0.061	0.036	1.675	0.047

Note: All *p*-values reported are for one-tailed tests ($\alpha = 0.05$; *t* critical = 1.645)

After controlling for age, education, income, and household size, the psychosocial block remained the strongest determinant of homeownership intentions. Financial risk perception and household debt retained small yet significant negative effects. Psychosocial constructs (AT, SN, PHC) retain the largest direct impacts on Hi. Among controls, age (β = 0.082, p = 0.017) and family size (β = 0.085, p = 0.007) positively and significantly influenced homeownership intentions, while income had a small negative effect (β = –0.061, p = 0.047) and education exerts no significant influence (β = –0.054, p = 0.076) (Table 6).

The construct with the largest effect size was perceived homeownership control (f^2 = 0.144), categorised as low to moderate. Attitude (f^2 = 0.077), subjective norm (f^2 = 0.057), and financial risk perception (f^2 = 0.013) showed smaller effects, while the moderating effect of household debt was negligible (f^2 = 0.001) (Table 7). The model explained 51.2% of the variance in homeownership intentions (R^2 = 0.512), representing moderate explanatory power (Hair et al., 2019). The adjusted R^2 = 0.502 confirmed consistency with minimal bias.

Table 7: Effect size of variables

	Homeownership Intention _(Hi)
Attitude _(AT)	0.077
Credit Access_(Cr_acc)	0.000
Financial Risk Perception_(FP)	0.013
Household Debt _(HH_debt)	0.007
Perceived Homeownership Control _(PHC)	0.144
Subjective Norm_(SN)	0.057
Household Debt _(HH_debt) x Financial Risk Perception_(FP)	0.001
Credit Access_(Cr_acc) x Financial Risk Perception_(FP)	0.002

Additional predictive power indicators (SRMR, *d*_ULS, *d*_G, and NFI) demonstrate that the model achieves a satisfactory fit with the observed data, reinforcing the validity of the results. A saturated SRMR of 0.043 and a *d*_G of 0.295 indicate that the covariance structure is well reproduced. The NFI value of 0.879 reflects an acceptable fit, although minor refinements could enhance accuracy. Similarly, the *d*_ULS value of 0.513 falls within the good-fit threshold

and does not compromise model validity (Table 8). Overall, these indices confirm that the PLS-SEM model provides a robust and reliable foundation for subsequent analyses.

Table 8: Goodness of fit indicators

	Saturated model	Estimated model	Cut-off	Interpretation
SRMR	0.043	0.043	< 0.08	Good fit
*d*_ULS	0.505	0.513	Small value	Good fit
*d*_G	0.294	0.295	Equally small and close	Good fit
Chi-square	760.937	766.416	The smaller, the better	The value is quite moderate; in PLS-SEM it is not the primary focus
NFI	0.880	0.879	> 0.80 → acceptable; > 0.90 → ideal	Acceptable

Predictive power was assessed using Q^2_predict analysis, which confirmed that the PLS-SEM model outperformed the linear model (LM). The predictive relevance values were all positive (Q^2_predict = 0.298–0.353), indicating moderate to strong predictive ability (Table 9). Moreover, PLS-SEM showed lower RMSE and MAE values than the LM for most indicators, demonstrating superior predictive accuracy. Although the LM performed marginally better for one indicator (Hi3, MAE), this advantage was insufficient to outweigh the overall superiority of PLS-SEM. These findings support the conclusion that the PLS-SEM model provides substantial and reliable predictive power, making it more appropriate for capturing the complexity of homeownership intentions compared with a traditional linear approach.

Table 9: Predictive power indicators

	Q^2_predict	PLS-SEM_RMSE	LM_RMSE	Comparison	PLS-SEM_MAE	LM_MAE	Comparison
Hi1	0.353	0.733	0.749	PLS is better	0.553	0.553	PLS = LM
Hi2	0.327	0.850	0.856	PLS is better	0.643	0.654	PLS is better
Hi3	0.313	0.956	0.956	PLS = LM	0.755	0.743	LM is better
Hi4	0.298	0.948	0.960	PLS is better	0.760	0.768	PLS is better

4.5. Discussion

This study demonstrates that the psychosocial core of the TPB – attitudes, subjective norms, and perceived behavioural control – remains the dominant driver of homeownership intentions among low-income, non-home-owning households in Central Java, Indonesia. Attitudes (AT), subjective norms (SN), and perceived homeownership control (PHC) exert strong effects on intentions (Hi), supporting H1–H3 and aligning with prior research. Consistent with Zheng et al. (2019) and Lindblad et al. (2017), these factors represent core precursors to housing-related decisions. Similar conclusions are reported by Al-Nahdi et al. (2015) and related studies, underscoring the robustness of the psychosocial block. Favourable attitudes ($\beta = 0.239$, $t = 5.194$, $p < 0.001$) – shaped by local social experience and peer influence – strongly reinforce the desirability of owner-occupation (Walters et al., 2021). In contrast to Liadi & Tapamose (2021), who report non-significant subjective-norm effects among Igbo households, the current sample shows a modest yet significant effect ($\beta = 0.198$, $t = 3.421$, $p < 0.001$); cultural collectivism in Java may explain the discrepancy.

These findings reaffirm the explanatory strength of the TPB constructs – attitude, subjective norms, and perceived behavioural control – in predicting homeownership intentions among low-income households. To contextualise the magnitude of the psychosocial effects identified in this study, it is instructive to compare the results with recent TPB-based homeownership studies conducted in emerging economies. In some comparable studies, attitudes, subjective norms, and perceived behavioral control have commonly been found to be significant predictors of intentions to become a homeowner, but with differing relative strengths. For example, studies in Malaysia and China show normalised effects which are relatively similar, with perceived behavioural control being the

dominant predictor of intentions, followed by attitudes and subjective norms (Yoke et al., 2018; Zheng et al., 2019). The current findings align closely with this pattern, particularly in highlighting the dominant role of perceived homeownership control among low-income households.

Notably, while the magnitude of the subjective norm effect in this study is smaller than that reported in some East Asian contexts, it remains statistically significant, underscoring the continued relevance of social influence in collectivist societies. Overall, this comparison reinforces the robustness and cross-contextual validity of the TPB in explaining homeownership intentions, while also suggesting that institutional and socio-cultural settings shape the relative salience of its core components. These similarities suggest that the psychosocial foundations of housing decisions remain remarkably stable across emerging economies, even under differing institutional and financial constraints.

At the same time, the significant effects of financial risk perception and household debt highlight the value of extending the TPB with financial variables. This enriched framework captures how vulnerability and debt burdens shape intentions, bridging psychosocial theory with financial realities. By integrating these dimensions, the study demonstrates the adaptability of the TPB and enhances its relevance for understanding complex socio-economic behaviours such as non-speculative homeownership.

Next, H4 – which predicts a negative effect of household debt on homeownership intentions – receives only marginal support. Household debt exhibits a small but statistically significant negative effect on homeownership intentions ($\beta = -0.059$; $t = 1.718$; $p = 0.043$), indicating limited practical relevance. The limited effect of household debt contrasts with findings by Bleemer et al. (2021), Mezza et al. (2020), and Mountain et al. (2020). This divergence may be explained by respondent characteristics, particularly their low income or informal employment. These individuals prioritise short-term financial survival and are cautious about incurring large debts for housing. Their high perceived financial risk and debt-averse mindset, coupled with limited financial literacy, reduce their ability and willingness to access credit for home purchases (Guo et al., 2023; Liu & Zhang, 2021).

Conversely, H5 – which posited that credit access would exert a positive influence on homeownership intentions – finds no empirical support. The coefficient for Cr_acc is negative, but its high *p*-value indicates non-significance. Although many prior studies suggest a positive relationship between credit access and homeownership (Acolin et al., 2019; Xu, 2016), some research reports only a minimal or non-significant impact (Blagg et al., 2022). In this study, the lack of access and conservative borrowing attitudes may explain why credit access does not significantly influence homeownership intentions. In fact, policies that target the low-income group (such as our sample) are likely to have only a marginal impact because their constraints extend beyond the down-payment to the ability to meet monthly instalments, income stability, and net wealth (Choi et al., 2019; Kang, 2019; Miranda, 2020).

Furthermore, the evidence substantiates H6 that stronger perceptions of financial risk (FP) decisively suppress homeownership intention. The financial risk perception (FP) negatively affects homeownership intentions (Hi). The path coefficient for FP → Hi is -0.121 and statistically significant ($p = 0.009$), indicating that higher financial risk perception diminishes the intention to own a home. This finding is aligned with Ma et al. (2022), who argue that heightened risk perception reduces property ownership intentions. Similarly, Zhang et al. (2020) and Sapiri et al. (2023) show that perceived financial risks and low financial literacy suppress housing intentions. Individuals are less likely to intend to engage in long-term financial contracts if they are concerned about their financial insecurity (they cannot pay the mortgage, are worried that they will lose their job, or that the economy will further deteriorate) (Peng, 2020).

Nevertheless, Gathergood and Weber (2017) show that limited mortgage literacy can cause young households to underestimate financial risks, pushing them toward high-risk mortgages and excessive leverage. This suggests that financial risk does not always deter entry into the housing market; its discouraging effect can be muted or even reversed when literacy is low. However, this mechanism differs from the context of the present study. Here, most respondents earn less than USD 159 per month, with many engaged in informal employment, conditions linked to vulnerability to financial shocks and limited insurance coverage. Consequently, respondents exhibit heightened perceptions of financial risk, which substantially weaken their willingness to pursue homeownership. In

this setting, limited financial literacy does not propel risk-taking but instead reinforces aversion, as financial hardship amplifies the perception of homeownership as an onerous burden (Daud et al., 2024). These findings provide strong empirical support for the argument that financial insecurity acts as a decisive deterrent to homeownership intentions.

Furthermore, the unexpected result is that the economic constraints of credit access (H7) and household debt (H8) do not amplify (or dampen) the way perceived financial risk feeds into the intention to own a home; the perceived risk carries the same weight regardless of how easily households can borrow or how heavily they are already leveraged. Two possible explanations emerge: relevance and feasibility. For low-income individuals, credit may appear irrelevant due to the individual's limited capacity to repay loans under uncertain economic conditions. This aligns with Atkinson (2019), who warns that expecting low-income households to sustain future loan payments is overly optimistic. Moreover, credit may be unattractive or inaccessible due to high interest rates, strict lending conditions, or a mismatch between borrower needs and lender requirements (Lan & Truong, 2023). Therefore, the absence of meaningful credit access results in an unchanged perception of financial risk.

Even after incorporating control variables – age, education, income, and family size – the core findings remained intact: the psychosocial constructs still dominated the explanation of homeownership intention, whereas perceived financial risk and household debt continued to exert small but significant negative effects. The moderation results also remained unchanged with credit access, and household debt still failed to significantly condition the relationship between financial-risk perceptions and homeownership intentions. Among the controls, age and family size emerged as positive and significant predictors. The positive control effects of age and family size revealed in this study are in line with several previous studies such as Aguda & Ebohon (2021), Liu et al. (2016), and Wang & Zhou (2017).

Interestingly, income shows a significant negative coefficient, while education exerts no significant effect. Although income typically exerts a positive influence on homeownership intentions (Aziz et al., 2022), this relationship appears subject to diminishing returns. Once household income exceeds a certain threshold,

additional income increases ownership probability at a decreasing rate – and this marginal effect may even turn negative (Raman, 2023). The negative income coefficient observed here reflects this plateau effect. As earnings rise, households become less willing to take high-leverage mortgages; preferring instead to deploy internal capital or pay cash (Board of Governors of the Federal Reserve System, 2024a). Higher-income households are generally less reliant on leveraged borrowing, reflecting both greater access to internal funds and a desire to limit exposure to credit risk, particularly in contexts of elevated interest rates and economic uncertainty (Board of Governors of the Federal Reserve System, 2024b). Therefore, although socio-demographic factors shape the margins, the primary drivers of homeownership intention remain psychosocial, consistent with the theoretical framework.

5. CONCLUSION

Across both model specifications, psychosocial factors explain 51% of the variance in homeownership intentions, eclipsing the marginal contribution of credit access ($\Delta R^2 < 0.025$). Attitudes, subjective norms, and perceived homeownership control show robust positive effects, emphasising that aspirations are driven not only by financial means but also by confidence, social support, and perceived agency in pursuing ownership.

Conversely, financial risk perception and household debt significantly weaken intentions. Each one-point increase in financial-risk perception lowers intention 0.12 standard deviations ($\beta = -0.121$, $p = 0.009$), while household debt adds a small but significant decrement ($\beta = -0.059$, $p = 0.043$). Heightened concerns over financial insecurity, coupled with debt burdens, directly discourage individuals from aspiring to homeownership. These findings suggest that subjective perceptions of vulnerability may carry greater weight than objective financial resources in determining ownership aspirations.

Notably, credit access does not emerge as a significant predictor. Null findings for credit access both as a direct ($\beta = -0.014$, $p = 0.418$) and moderating predictor ($\beta = -0.051$, $p = 0.220$) suggest that merely expanding micro-mortgage supply without addressing income volatility and financial anxiety is unlikely to stimulate demand among MBR households. This underscores that policies aimed solely at

widening credit access are unlikely to strengthen homeownership intentions if concerns over financial stability persist.

Overall, the evidence indicates that psychosocial resources are as critical as financial ones. Therefore, we recommend a dual-track intervention: (1) behavioural nudges embedded in community-based savings groups to strengthen perceived control, and (2) targeted 'bridge subsidies' that reduce the monthly mortgage-to-income ratio, thereby mitigating risk perception without increasing leverage. Practically, addressing both the psychological and material barriers faced by low-income households offers a more comprehensive path to encouraging sustainable homeownership intentions.

Finally, while this study provides valuable insight, its cross-sectional design limits causal inference, and the Central Java focus may restrict generalisability. Future research should employ longitudinal or experimental designs to test causality, conduct cross-regional or cross-country comparisons to enhance external validity, and examine additional moderators such as financial literacy, policy exposure, or macroeconomic shocks. These efforts would further refine the extended TPB framework and strengthen its relevance for both theoretical development and applied housing research.

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APPENDICES

Appendix 1. Measurements

Construct	Adapted Items	References	Scale
Homeownership intention (Ho)	Ho1= I tend to choose an affordable home Ho2= I am interested in owning and using a decent home from a housing developer Ho3= I am interested in owning and occupying an affordable house from a housing developer or another in the future Ho4= I like to live in a decent home from a housing developer Ho5= I will start occupying a decent house soon	(Lutfi & Prihatiningrum, 2023)	5 points Likert's Scale
Attitude (AT)	AT1= Buying a house is beneficial for me AT2= Buying a house is pleasant for me AT3= Buying a house is good for me AT4= Buying a house is valuable for me AT5= Buying a house is enjoyable for me	(Islam et al., 2022)	5 points Likert's Scale
Subjective norm (SN)	SN1= My guardians encourage me to have my own house SN2= My spouse encourages me to own a house SN3= My family members expect me to own a house SN4= My friends influence me to buy a house SN5= People who are important to me think that I should live in my own home instead of rent SN6= People who are important to me would support my home usage	Islam et al. (2022)	5 points Likert's Scale

Perceived homeownership control (PHC)	PHC1= I have enough time to decide to own a house PHC2= I have enough money to own a house PHC3= I have enough skills and knowledge about housing to make my own decision if I would like to own a house PHC4= I have complete control over owning a house	Al-Nahdi et al. (2015)	5 points Likert's Scale
Household debt (HH_debt)	My family's debt amount: 1. 0 or < IDR 500,000 2. IDR 500,000 - 1 million 3. IDR 1 – 3 million 4. > IDR 3 million		Ordinal
Credit access (Cr_acc)	I have and can access bank credit for housing: 0 = No 1 = Yes		Dummy
Financial risk perception (FP)	FP1 = For households that already have debt, purchasing a house on credit poses a significant financial risk. FP2 = If viewed as a form of investment, buying a house on credit is risky. FP3 = I am not sure if I can get the house I want through a mortgage (KPR). FP4 = I am not sure if I can get the house I want through a personal loan. FP5 = I am worried that homeownership will cause unnecessary problems when it comes to installment payments (bank/personal). FP6 = Failure to meet mortgage payment obligations endangers my and my fa mily's socio-economic aspects.	Weedige et al. (2019)	5 points Likert's Scale

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TRUST IN THE MANAGER AND ITS RELATIONSHIP WITH EMPLOYEE JOB SATISFACTION: EMPIRICAL EVIDENCE FROM A LOW-TRUST SOCIETY

ABSTRACT: *This article explores the relationship between trust in the manager and job satisfaction of employees. Data was collected via a structured questionnaire from 591 respondents in Bulgaria. The correlation analyses confirm the two hypotheses formulated regarding positive relationships between trust in the manager and specific facets of job satisfaction (H1) and overall job satisfaction (H2). The relatively low levels of trust in the manager and job satisfaction align with previous conclusions that the country is a low-trust society. Cross-tabulation analyses and ranking of the relationships' strength between each of the trust indicators (dependability, reciprocity, and shared understanding) and job satisfaction indicators (several specific facets and overall satisfaction) are interpreted. The findings are complemented through the lens of other national culture dimensions (power distance and individualism). This study's conclusions highlight the need for a more comprehensive understanding of trust and the mechanisms through which it shapes the organisational context and outcomes, especially in low-trust societies.*

KEY WORDS: *trust in the manager, employee job satisfaction, low-trust society, Bulgaria*

JEL CLASSIFICATION: D23, L29, M14, M54, Z13

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1. INTRODUCTION

Trust as a cultural factor is a central topic of consideration for theoretical and empirical research, and has a rich tradition in philosophy, psychology, sociology, and other social sciences. Since the end of the 1980s, the issue of trust in organisational and intra-organisational contexts has attracted significant research interest in the fields of organisational theory and management, both as a standalone topic and as part of the study of processes, structures, and outcomes (Bachmann & Zaheer, 2006). Early studies on trust viewed it primarily as a psychological trait of the individual – a personal attitude reflecting belief in the good intentions of others, or even gullibility. This view was gradually complemented by the notion of trust as a characteristic of interpersonal relationships, shared understanding, reciprocity, and predictability of the other's actions. These two theoretical perspectives suggest different mechanisms through which trust impacts behaviours (Dirks, 2006).

Various effects of trust in the organisational context have been studied. The role of trust is enhanced in conflict situations, uncertainty about outcomes, and problem solving when it helps decrease complexity and reduce possible future developments to a manageable number (Nyhan & Marlowe, 1997). When people are in social dilemma situations and face the choice of whether to cooperate with others or not, trust is a key mechanism for reducing risks and vulnerabilities and thus enables cooperative behaviour in organisations (De Jong et al., 2017). Conversely, a lack of trust may increase intentions to quit and reduce organisational commitment. In their definition of trust, Mayer et al. (1995) underline the 'willingness to be vulnerable' instead of 'being vulnerable'. Thus, they shift the focus from a state ('being') to an attitude ('willing') to take the risk of losing something significant. Trust can be seen as an organising principle as it influences organisational properties (patterns, processes) through structuring and mobilising (McEvily et al., 2003).

Many studies explore the relationship between trust in leaders and employees' behaviours and attitudes (Yang & Mossholder, 2010). Job satisfaction is among the attitudes that have a significant impact on organisational performance and is thus well-researched. Based on a meta-analysis, Dirks and Ferrin (2002) find empirical evidence that the relationship between job satisfaction and trust in the direct leader ($r = 0.55$) is stronger than the relationship between job satisfaction

and trust in top management ($r = 0.48$). However, other studies do not find such a relationship. Pillai et al. (1999) do not find a statistically significant influence of trust in the supervisor on employee satisfaction and suggest that satisfaction relates to the perceived fairness of procedures, which in turn influences trust.

In a content analysis, De Jong et al. (2017) highlight that the impact of trust on attitudes and preferences is significantly less recognised by researchers as compared to other trust outcomes, such as employee performance. The authors find shared agreement among researchers on the need for empirical studies that take into account the specificities of the context and the generalisability of locations. The socio-cultural context in which organisations are embedded influences organisational life through shared values, attitudes, and beliefs. Trust, as well as different aspects of satisfaction (life in general, work life, personal life), cannot and should not be treated in isolation; they result from a multitude of social relationships in and outside the organisation. Trust is socially embedded (Granovetter, 1985) and varies across cultural contexts (Wicks et al., 1999).

In response to calls for more empirical evidence in different national contexts, as well as the inconclusive findings about the relationship between trust in the manager and job satisfaction, this article poses the following research question:

RQ: Is there a relationship between trust in the manager and job satisfaction of employees in a specific socio-cultural context (Bulgaria)?

The rest of this article is structured as follows. The next section presents the theoretical background, provides the working definitions used for trust in the manager and employee job satisfaction, and formulates the research hypotheses. The third section describes the materials and methods applied. The results obtained are presented in the fourth section. The fifth section discusses the findings, outlines the study implications and limitations, and suggests directions for future research. The last section concludes.

2. THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

Trust is typically studied in relation to a specific referent and does not readily transfer to other referents (Yang & Mossholder, 2010). Yang and Mossholder (2010) underline the necessity of identifying the referent, as the factors that

impact trust may differ significantly depending on the referent. Sztompka (1999) distinguishes between three dimensions of trust and suggests these should be seen as complementary, not competing: a relationship (direct or indirect exchange denoting a calculated orientation), a personality trait (trustor and trustee, denoting psychological propensity), and a cultural rule (of the social whole, applying to both trustor and trustee). Burke et al. (2007) summarise three approaches to studying trust: a trait (propensity to trust), a process (the development of trust), and an emergent state (cognitive, motivational, or affective).

Extant research findings support the conclusion that trust is important for the effectiveness of organisations and work-related outcomes (Dirks, 2006; Gopalan et al., 2023). In the organisation, those who receive trust may be an individual trustee (such as a direct supervisor) or a group (colleagues), but also an impersonal structure (the organisation as a whole). The trustor (employee) may have a direct relationship and experience with the trustee (direct supervisor), or not (top managers).

The significance of followers' trust for the effectiveness of leadership is emphasised in many leadership theories (Burke et al., 2007; Podsakoff et al., 1990). In a meta-analysis of empirical studies on leadership, Dirks and Ferrin's (2002) conclusions highlight the role of trust for many behaviours and attitudes, including job satisfaction. This is explained through the power of the leader to make decisions on issues of importance to employees; consequently, employees feel more secure when they trust their leader. This aligns with the leader-member exchange theory, which posits that leaders develop relationships of different quality with their subordinates, influence in-group members through the quality of the relationships, and thus impact job attitudes (Erdogan & Bauer, 2015). In-group members experience higher levels of mutual trust and exchange of valued resources; thus, a higher level of job satisfaction is expected among in-group than among out-group members. In their relationship with the direct supervisor, employees may or may not develop an attitude of accepting their vulnerability with regard to important issues – that is, to trust or not. Moreover, trust influences various processes, such as communication, cooperation, and information sharing (Burke et al., 2007), therefore supporting leaders in performing their roles effectively.

This article builds on the widely accepted definition suggested by Rousseau et al. (1998, p. 395), who define trust as "*a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another*". It studies trust at the interpersonal level between employees and their direct supervisors (managers). That is, trust is personal, the trustee is identified, and the trustor knows the trustee. Experiences, interactions, and context may strengthen or weaken trust (Burke et al., 2007). Therefore, trust is conceptualised as a characteristic of interpersonal relationships (dependability, shared understanding, reciprocity) that leads to the predictability of the actions of the other based on previous experience and willingness to accept one's vulnerability.

Employees' job satisfaction has been among the most widely researched workplace attitudes since the mid-1990s (Judge et al., 2017). Studies on job satisfaction usually consider two aspects – the overall assessment of the job, and the assessment of specific facets such as work tasks, workplace environment, remuneration, promotion, supervision, and colleagues (Judge et al., 2017; Wyrwa & Kaźmierczyk, 2020). Judge et al. (2017) underline that job satisfaction is tied to a specific source and should be distinguished from other general affective constructs such as moods. Although a part-whole relationship is often assumed, research has shown that the general attitude towards a job is distinct from attitudes towards its various aspects (Judge et al., 2017). Employees may have differing levels of satisfaction with the different job facets.

Job satisfaction is also discussed as a combination of cognitive components (beliefs), affective components (work experience) – both discussed by Yang & Mossholder (2010) – and behavioural components (Judge & Klinger, 2008). The humanistic perspective brings out the importance of meaning and a sense of achievement, and thus reflects the correspondence between values and job characteristics (Judge et al., 2017).

Job satisfaction is influenced by demographic characteristics, such as age and organisational tenure, individual traits, and organisational factors such as organisation type, leadership practices, pay structure, and work environment (Brush et al., 1987; Judge et al., 2004). However, studies also show that job

satisfaction is rather consistent over longer periods of time and job switches, and its sources may be both dispositional and situational (Staw, 1986).

The definition of job satisfaction used in this article borrows from Judge et al. (2017) and sees it as a subjective assessment of the favourability of one's job. Although related, the overall satisfaction may differ from an employee's satisfaction with the specific features of the job.

Employees' job satisfaction is found to contribute to performance and organisational goals. It is related to various desirable outcomes, such as sales, profits (Davis et al., 2000), customer satisfaction (Koys, 2001), and employee well-being (Judge & Klinger, 2008; Mu et al., 2024). It should be noted, however, that the relationship between job satisfaction and performance is not necessarily linear or simple (Staw, 1986), and it is contingent on different moderators in certain circumstances (Judge et al., 2017). The social exchange theoretical lens suggests that the leader-follower relationship implies more than just the standard economic contract and is operationalised through trust, goodwill, and perceived mutual obligations (Dirks, 2006). The direct supervisor shapes workplace conditions, which employees evaluate to form their subjective assessment of job favourability. Trust mediates how employees perceive organisational factors (Dirks & Ferrin, 2002) and functions as an interpretative lens. It arises from employees' experiences and judgements of these influences and develops throughout the relationship with the manager. The experience with the work environment is reflected in employees' work attitudes, including job satisfaction.

Thus, the following hypotheses are formulated:

H1: There is a statistically significant positive relationship between trust in the manager and employees' job satisfaction as measured by several specific facets.

H2: There is a statistically significant positive relationship between trust in the manager and employees' overall job satisfaction.

3. METHODOLOGY

3.1 Context

This study focuses on Bulgaria for several reasons. According to European Social Survey (ESS, n.d.) data, the country can be characterised as a comparatively low-trust society (Tilkidžiev, 2010). Bulgarians exhibit the lowest levels of social (interpersonal) trust among the European countries included in ESS, suggesting widespread suspicion and reticence towards others. Tilkidžiev (2010) notes similarities with other Eastern and Southern European countries characterised by low levels of trust, and dissimilarities with Western European countries, where more balanced and positive attitudes prevail. Low trust in institutions, the state of the economy, and democratic processes translates into general dissatisfaction with life (Tilkidžiev, 2010).

Against this social backdrop of low trust – both in other people and the way the government functions – and low levels of general satisfaction with life, this article explores a less-studied, specific area (work-life).

3.2 Constructs and indicators

Based on the literature review and the working definition employed, three new indicators to measure trust in the manager are developed and tested. They assess trust as a relationship and its three characteristics – dependability, reciprocity, and shared understanding.

To measure job satisfaction, twenty-two indicators used in previous studies are adopted. The first group of twenty-one indicators assesses specific facets of job satisfaction. It includes fourteen items adopted from Hofstede (2001) and measures five dimensions of work goals (job content, reward, interpersonal relations, security, and comfort). Seven items (working hours, work-life balance, influence, job position, rules, planning, and tasks) are added to cover more comprehensively the important aspects of the work environment (Davidkov, 2019). The second group includes one indicator that measures overall job satisfaction and is also adopted from Hofstede (2001).

All indicators are self-assessed using a 5-point Likert scale where 1 = strongly agree/completely satisfied and 5 = strongly disagree/not satisfied at all (Table 1).

Table 1: Constructs and indicators, descriptive statistics (N = 591)

Construct and indicators		M (SD)
Trust in the manager (TM)		
TM1	I can always rely on my direct manager	2.0677 (1.15369)
TM2	My manager and I trust each other	2.1337 (1.10503)
TM3	We get on with my direct manager easily	1.9459 (1.06585)
Job satisfaction, specific facets (SF)		
SF1	Have challenging work to do – work from which you can get a personal sense of accomplishment	2.1675 (0.97461)
SF2	Have the opportunity to live in an area desirable to you and your family	1.8883 (1.07721)
SF3	Have an opportunity for high earnings	2.4653 (1.10395)
SF4	Work with people who cooperate well with one another	2.0881 (1/03538)
SF5*	Have training opportunities (to improve your skills or to learn new skills)	2.2775 (1.15016)
SF6	Have good fringe benefits	2.0491 (1.09202)
SF7	Get the recognition you deserve when you do a good job	2.2475 (1.08381)
SF8	Have good physical working conditions (good ventilation & lighting, adequate workspace, etc.)	1.9966 (1.03825)
SF9	Have considerable freedom to adopt your own approach to the job	1.8985 (0.95483)
SF10	Have the security that you will be able to work for your company for as long as you want to	1.9932 (1.01845)
SF11	Have an opportunity for advancement to higher-level jobs	2.4518 (1.16763)
SF12	Have a good working relationship with your manager	1.8409 (1.05369)
SF13	Fully use your skills and abilities on the job	2.1186 (1.03233)

SF14	Have a job which leaves you sufficient time for your personal or family life	2.0085 (1.04877)
SF15	Working hours and flexibility to be absent if necessary	1.8274 (1.01714)
SF16	Possibility to balance work and private life	1.9205 (0.96486)
SF17	Possibility to influence the issues that are important to you	2.2386 (1.02623)
SF18	The job position you currently hold	2.0948 (1.02403)
SF19	Rules in the organisation	2.3655 (1.11921)
SF20	The way work is planned and organised	2.2961 (1.06975)
SF21	Work tasks	2.1861 (0.97209)
Job satisfaction, overall (SO)		
SO	How would you rate your overall satisfaction with your job in this organisation	2.2453 (0.95085)

Note: M and SD represent mean value and standard deviation, respectively. * Item excluded from subsequent analyses due to low correlation.

3.3 Sample

The results reported in this article are part of a larger study on organisational cultures in Bulgaria. Data were collected during April–June 2024 using a standardised questionnaire from employees and managers in Bulgaria. Respondents were selected using convenience and snowballing methods. 591 valid questionnaires were used in the subsequent analysis. Table 2 presents the demographic characteristics of the sample.

Table 2: Demographic characteristics of the sample (N = 591)

	Number	Percentage
Gender*		
Male	199	34%
Female	391	66%
Age		
≤ 30	268	45%
31–40	172	29%
41–50	86	15%
≥ 51	65	11%
Education		
Primary	6	1.0%
Secondary	90	15.2%
College	31	5.2%
University	419	70.9%
Higher (PhD)	44	7.4%
Marital status*		
Married	289	49%
Not married	301	51%
Work experience, total (years)		
≤ 5	212	36%
6–10	120	20%
11–20	155	26%
≥ 21	104	18%
Job position*		
Employee	468	79%
Manager	106	18%
Other	16	3%
Sector		
Manufacturing	41	7%
Commerce	73	12%
Services	370	63%
Governmental sector	107	18%
Location*		
Sofia	502	85%
Regional centre	60	10%
Small town/village	27	5%

Note: * – missing values.

3.4 Analytical procedure

Data were analysed with SPSS 30. First, the reliability and validity of the composite variables TM and SF were assessed. Correlation analyses were applied to test the hypotheses.

Second, cross-tabulation analyses were performed to assess the relationships between each of the TM and SF/SO indicators, and the strength of the relationship was used to deepen the explanatory power of the results obtained. For this purpose, the measurement scales were restructured to allow better interpretation of the relationships and the trends they illustrate. Responses to the TM items were recoded into two categories: 1 = 'strongly agree'/'rather agree'; 2 = 'I agree as much as I disagree'/'rather disagree'/'strongly disagree'. SF and SO indicators were collapsed into three categories: 1 = 'completely satisfied'; 2 = 'rather satisfied'; 3 = 'I am satisfied as much as I am not'/'rather not satisfied'/'not satisfied at all'. Then, the strength of the relationships between each TM indicator and each SF and SO indicator, as measured by Cramer's V, was used to rank and compare the associations.

Several indicators (such as gender, education) had missing data; however, the proportion was below 10% and thus considered low enough not to affect the results (Hair et al., 2019). Missing values were replaced by the mean value of the respective indicator. There were no statistically significant relationships between trust indicators and demographic characteristics.

4. RESULTS

The validity and reliability of the two composite factors – trust in the manager and job satisfaction (specific facets) – were satisfactory with Cronbach's alpha ranging from 0.7 to 0.95, item-total correlation exceeding 0.3, and inter-item correlations above 0.2 (Clark & Watson, 2016; Everitt, 2002; Hair et al., 2019; Nunnally, 1967) (Table 3). One item (SF5) was excluded due to low correlation with the rest of the items. Two new composite variables were calculated as the mean value of the respective indicators.

Table 3: Descriptive statistics, reliability and validity – trust in the manager and job satisfaction (specific facets)

Construct	M (SD)	No. of items	Corrected item-total correlation	Range of inter-item correlations	Cronbach's alpha
TM	2.0491 (1.01868)	3	0.806–0.822	0.760–0.782	0.908
SF	2.1071 (0.71019)	20	0.402–0.741	0.204–0.780	0.939

Note: M and SD represent mean value and standard deviation, respectively.

The Kolmogorov–Smirnov and Shapiro–Wilks test results showed that the data were not normally distributed (Lilliefors Sig.<0.001 for all indicators and composite variables); therefore Spearman's rank-order correlation was applied. Examination of Spearman's rho correlation coefficients indicated there were statistically significant relationships between TM, SF, and SO (Table 4). As expected, the correlation coefficient between SO and SF indicated the strongest relationship ($r_s = 0.687$). TM also showed strong associations with SO ($r_s = 0.588$) and with SF ($r_s = 0.620$).

Table 4: Spearman's rho correlation coefficients

	SF	SO	TM
SF	1		
SO	.687**	1	
TM	.620**	.588**	1

Note: ** Correlation is significant at the 0.01 level (two-tailed).

The correlation analysis results confirmed the formulated hypotheses. There is a statistically significant and strong relationship between trust in the manager and specific facets of job satisfaction (H1). The relationship between trust in the manager and overall job satisfaction is also statistically significant, strong, and positive (H2).

In order to gain a better understanding of the relationships between the trust in the manager indicators and those measuring job satisfaction (overall and specific facets), additional cross-tabulation analyses were performed with the

restructured scales. The results are summarised in Table 5. The analysis of the results suggests certain insights about the significance of these relationships.

Table 5: Strength of relationships between TM, SF, and SO indicators (restructured scales)

	TM2	TM1	TM3
	Cramer's V (rank position)		
SF12	0.566 (1)	0.606 (1)	0.636 (1)
SF7	0.448 (2)	0.472 (2)	0.464 (2)
SF20	0.406 (3)	0.419 (3)	0.427 (4)
SF4	0.388 (4–5)	0.380 (4)	0.384 (6)
SF13	0.388 (4–5)	0.355 (10)	0.349 (12)
SF17	0.386 (6)	0.348 (12)	0.387 (5)
SF11	0.383 (7)	0.345 (13)	0.323 (16)
SF1	0.369 (8)	0.373 (5-6)	0.367 (11)
SF9	0.355 (9)	0.371 (7)	0.436 (3)
SF10	0.347 (10)	0.373 (5-6)	0.372 (10)
SF5	0.344 (11)	0.361 (9)	0.295 (18–19)
SF19	0.338 (12)	0.367 (8)	0.378 (9)
SF18	0.333 (13)	0.329 (14)	0.304 (17)
SF6	0.321 (14–15)	0.324 (15)	0.338 (15)
SF21	0.321 (14–15)	0.349 (11)	0.379 (8)
SF16	0.297 (16)	0.305 (16)	0.339 (14)
SF3	0.291 (17)	0.255 (20)	0.257 (20)
SF14	0.290 (18)	0.277 (19)	0.342 (13)
SF15	0.287 (19)	0.327 (18)	0.383 (7)
SF8	0.258 (20)	0.303 (17)	0.295 (18–19)
SF2	0.169 (21)	0.198 (21)	0.217 (21)
SO	0.497	0.536	0.517

Notes: * Sig = .000 for all relationships in the table

The relationship between all three TM indicators and three of the SF indicators – working relationship with the manager (SF12), recognition (SF7), and work planning and organising (SF20) – indicate relatively strong associations (Rea & Parker, 2012). Two of the job satisfaction indicators (SF12, SF7) retain the two highest positions when their associations with TM2, TM1, and TM3 are ranked.

The rank positions of TM2, TM1, and TM3 with overall job satisfaction (SO) indicate these associations are also relatively strong (Rea & Parker, 2012).

A similar pattern is observed at the end of Table 5: the indicator for desirable area to live (SF2) has the lowest rank. The association of SF2 with TM3 is moderate, while the associations with TM1 and TM2 are weak.

The middle category includes seventeen SF indicators whose association with the three TM indicators is moderate. Rankings within this category vary based on the strength of the associations with TM1, TM2, and TM3.

5. DISCUSSION

5.1 Examination of trust in the manager and employee job satisfaction in Bulgaria

The research question that guided this study was to explore the relationship between trust in the manager and employee job satisfaction in a specific socio-cultural context (Bulgaria). Its findings complement extant research and broaden the scope of understanding of the national context under study. The relatively low mean values for both constructs – trust in the manager (M = 2.05) and specific facets of job satisfaction (M = 2.11) – are noteworthy. The mean value of overall job satisfaction is slightly higher (M = 2.25), yet still falls in the low-satisfaction category. These findings regarding trust (in the manager) and job satisfaction (specific facets and overall) in the organisational context align with the results from sociological studies on trust (towards other people) and satisfaction (with life in general and with the country's development) discussed above (Tilkidžiev, 2010). This is not unexpected – extant research points to significant relationships between job satisfaction and life satisfaction (Judge & Klinger, 2008; Loscocco & Roschelle, 1991). Trust in the specific referent studied here (manager) can be viewed in relation to the individuals' general experience with other specific or non-specific trust referents in their social interactions. Although this study conceptualises trust as a characteristic of interpersonal relationships (dependability, shared understandings, reciprocity), and not of the trustor (psychological propensity, gullibility), the levels it obtains are similar to the levels towards other referents in this national context. The question arises as to the extent to which these similar results regarding trust and satisfaction with public/social life, on the one hand, and with organisational life, on the other, can

be considered separately. Extant research points to several possible mechanisms for the relationship between job satisfaction and life satisfaction, such as spill-over, segmentation, and compensation (Judge & Klinger, 2008). Judge and Watanabe (1993) find spill-over relationships are predominant amongst employees in the US – a high-trust society (Füzér et al., 2020), followed by segmentation and compensation. Further research could test these relationship mechanisms in low-trust societies.

Similarly, it is unclear to what extent individuals rationally and objectively evaluate each subsequent referent (of trust) without transferring their previous experience from other areas. Alternatively, they may apply heuristic methods to subsequent situations, generalising their past experience and approaching a new relationship with a preconceived mindset. However, such a notion should be differentiated from a dispositional interpretation. The embeddedness perspective offers a more comprehensive approach, as studying the employee–manager dyadic relationship in isolation does not consider the different dynamics of trust development in wider, relevant social networks.

The relatively low levels of trust reported here can also be interpreted in relation to the connected construct of distrust. This raises the question of whether lack of trust means distrust or whether the two constructs are related but distinct concepts with different characteristics, referring to different relational aspects (Six & Latusek, 2023). Expanding the scope of this research to assess levels of distrust would help diagnose and possibly differentiate the sources of trust and distrust more clearly. According to Six and Latusek (2023), although trust and distrust are different concepts, they follow a similar process based on an assessment of the other party's (un)trustworthiness, which leads to a (dis)trust-informed action. In the context of relatively low levels of trust in the organisation, more comprehensive research into the characteristics and mechanisms of trust and distrust would help formulate appropriate strategies for restoring and increasing trust (Kähkönen et al., 2021).

Power distance is another important reference point for a more comprehensive understanding of the trust-satisfaction relationship in the studied socio-cultural context (Davidkov, 2019; Hofstede, 2001). The work culture in Bulgaria is characterised by large power distance (Davidkov, 2010; Davidkov, 2019, p. 75). It

is difficult to build relationships of trust when there is a large power distance between those with more power (manager) and those with less power (the managed). Since a serious deficit of trust is the general norm (Davidkov, 2010), it may be argued that cases in which trust is present are even more valuable for the parties.

Despite the slow increase in the individualism index (Davidkov, 2019, p. 64), most researchers assume that Bulgarians are generally more collectivist and conservative. Thus, individuals trust primarily members of their in-groups – family, relatives, friends (Hofstede, 2001) – while trust in non-members of in-groups is generally weaker. At the same time, for a significant proportion of Bulgarians, the organisation represents an extension of the family – in many cases, the values and relationships that are characteristic of the family are transferred to the organisational context. In the context of markedly low levels of trust in institutions (legislative and executive branches, police, media, judicial system, etc.), this transfer can be seen as a mechanism through which people seek to expand the perimeter of their trust relationships.

5.2 Examination of the relationships between trust in the manager and employee job satisfaction indicators (specific facets and overall)

The analyses provide evidence of statistically significant positive relationships between TM and SF (H1) and SO (H2), consistent with previous research (Guinot et al., 2014; Robertson et al., 2012). Although the hypotheses were confirmed, the correlation analysis employed does not allow for a claim of causality. Testing causality was beyond the scope of this study. Although extant literature has largely demonstrated a positive effect of trust on job satisfaction, there are arguments supporting the reverse relationship. Specifically, job satisfaction may be conceptualised as an antecedent of trust, as employees with a positive assessment of their workplace may partially see their manager as responsible for the satisfying conditions, and as a result tend to trust the manager. Thus, the state of each phenomenon – trust in the manager and job satisfaction – may be conceptualised as both an antecedent and an outcome of the other.

The detailed examination of the relationships between each TM indicator and each SF and SO indicator highlights certain mechanisms of mutual influence and provides arguments for more nuanced research on their interaction. The

substantial (albeit differing) relationships between a large number of the job satisfaction indicators and trust in the manager can be explained based on the essence of leadership – the leader is authorised to exercise power to achieve the organisational goals through managing human and material resources (Fleishman et al., 1991). By fulfilling multiple roles, such as interpersonal, information-processing, and decision-making (Mintzberg, 1973), the manager significantly influences the work environment: working conditions, distribution of work tasks, interpersonal relationships, the official and unofficial status of the managed, etc.

SF indicators are grouped into three categories based on the strength of their relationship with the trust-in-the-manager indicators measured by Cramer's V. This ranking allows for outlining different levels of the relationship between TM and SF.

The reciprocity trust indicator (TM2) shows the strongest relationship with three specific facets of job satisfaction: relationship with the manager (SF12), recognition (SF27), and planning/organising (SF20). Similarly, Liu and Ren (2022) find empirical evidence that perceived leader trust positively affects employee work performance (work meaning, ability, autonomy) and influence department functioning. Dalati and Alchach (2018) also find a relationship between trust in the manager and satisfaction and its indicators, including recognition and industrial relations.

The relationship TM2–SF20 can be interpreted through the prism of the relationship between leadership styles and trust. The participative leadership style encourages subordinates to participate in decision-making and promotes a sense of ownership; it is based on trust (Paunov, 2001; Wang et al., 2022). A possible conclusion from this study is that the presence of trust facilitates open expression and protection of subordinates' interests. Employee participation in problem solving and decision making is a mechanism with significant motivational potential. Participation is a prerequisite for higher self-esteem, sense of responsibility, self-identification with the organisation, commitment and organisational citizenship behaviour. Trust enhances the employees' response to participative supervisor behaviour in the case of a social exchange over an extended period of time (Miao et al., 2014).

Satisfaction with the facets cooperation (SF4), skills (SF13), and influence (SF17) is also strongly related to TM2. The ability to influence suggests participation in managing and the decision-making process. Cooperation and trust also imply each other: high levels of trust favour cooperation (both between peers and between managers and subordinates). The opportunity to fully utilise one's skills and abilities manifests in access to suitable work, support, favourable conditions, and motivation. Trust in the manager can organically underpin each of these factors. Other studies use similar job satisfaction indicators to find relationships with trust in the manager (Dalati & Alchach, 2018).

Although work environment factors generally depend strongly on the manager, for various reasons not all factors are equally subject to the manager's will and behaviour. This might explain the observed result that the relationships between different job satisfaction facets and trust in the manager vary in strength. Managers and subordinates can be viewed as connected vessels; they are mutually dependent. Although to an unequal extent, the behaviour of the manager also depends on the behaviour of the subordinate.

Trust, measured as reliability (TM1) and shared understanding (TM3), shows similar relationships with the job satisfaction indicators; i.e., trust in the manager is related to SF and can be assigned to three groups according to their rank. Despite certain (inevitable) differences, all three trust indicators arrange the relationships in a similar manner. This is particularly evident for the strongest and weakest relationships. Moreover, the intervals between the highest and lowest Cramer's V values for each of the three TM indicators are similar in size, that is, each of the trust indicators differentiates the relationships into comparably sized intervals.

It should also be noted that within this general pattern, the three TM indicators may exhibit different behaviour with respect to the SF indicators. For example, satisfaction with working hours and flexibility of being absent if necessary (SF15) correlates much more weakly with TM2 than with TM3. In this case, trust in the manager, measured by the indicator of shared understanding, has a greater explanatory power for describing this job satisfaction facet compared to TM1 and TM2. Similar observations can be made when comparing the relationships with SF9, among others.

The above suggests that when researching trust in the manager, it may be more appropriate to use a wider set of indicators. Such an approach could provide nuanced evidence to reveal attitudes and relationships and offer a more comprehensive perspective.

5.3 Theoretical and practical contributions

In response to the research gaps identified and the research question formulated, this study makes several contributions to theory. First, the research perspective presented contributes to a more systematic understanding of trust in the context of interpersonal relationships in the organisation. This study's findings add to existing empirical evidence in support of the relationship between trust (in the direct supervisor) and job satisfaction in different organisational and cultural contexts (Dalati & Alchach 2018; Gilstrap & Collins 2012; Håvold et al. 2021), thus contributing to the advancement of theoretical knowledge across cultural boundaries. Wicks et al. (1999) highlight that the level of trust cannot be interpreted unambiguously. In certain cultures, high trust may be seen as unwise and this will lead to alternative arrangements that are less visibly trusting. An employee's decision whether to trust will depend on previous experience, organisational history, and the surrounding environment, such as the broader cultural, industry or institutional settings (Wicks et al., 1999). Huff and Kelley (2003) find higher levels of both internal trust (within the organisation) and external trust (the organisation's trust in suppliers, customers, etc.) in individualist societies (e.g., the US) than in collectivist societies (e.g., Asia). Pučėtaitė et al. (2010) examine organisational trust in a post-socialist context (Lithuania), which is also characterised by a low-trust societal context. They find empirical evidence of the impact of ethical organisational practices on organisational trust, and point out that declared principles and values in post-socialist societies are perceived as relative, and employees seek evidence of value realisation in the actions of managers (Pučėtaitė et al., 2010). The results obtained here, thus, support similar findings in other low-trust societies. The findings highlight the relatively low levels of trust and job satisfaction in the national context under study. While the existence of the relationship between the two constructs is found in different cultural contexts, and confirmed here, its psychological weight may be amplified in cultures where trust is a scare resource. However, more nuanced interpretations are required, as discussed above. A comprehensive approach in assessing the relationships of individual indicators of

the two constructs enhances their explanatory power and can be viewed in reference to the manager's influence (direct or indirect) on specific work environment factors. This aligns with a fundamental principle that organisational members' behaviour is strongly motivated by the way they perceive and interpret what happens in the organisation.

Second, this study provides guidelines for understanding the complex and multi-layered phenomenon of trust itself and its role in interpersonal relationships. Trust in the manager is conceptualised as a characteristic of interpersonal relationships, and a scale of three indicators (dependability, shared understandings, reciprocity) is constructed and validated in a cross-sectional, national context. The accumulation of empirical evidence on trust makes it possible to verify the methodology and performance of specific indicators (newly tested and already used).

The study results have practical implications as well. Its conclusions highlight the need for managers to be more sensitive to the levels of trust among their subordinates. There is a need for a more comprehensive understanding of trust, its sources, and the mechanisms through which it shapes the organisational context and outcomes, especially in low-trust societies. This would be particularly helpful for organisations in achieving their goals and improving performance.

5.4 Limitations and directions for future research

This study has its limitations, which should be taken into account. First, it is cross-sectional and therefore limited to interpreting correlations between the variables, which hinders inferences about the direction of causality (Dirks, 2006). Although much of the published empirical research finds (or rejects) an influence of trust on satisfaction, there are arguments in favour of the opposite direction of influence, or at least a strengthening of the effect. On the other hand, neither trust nor satisfaction is static. The duration of the relationship with the manager affects trust, and various moderators can strengthen or reduce trust levels (Vanneste et al., 2014). Understanding such relationships and mechanisms of (mutual) influence would require a longitudinal research setting that emphasises the dynamic nature of trust (Burke et al., 2007), job satisfaction, and their relationship.

Second, the level of analysis employed is individual. An analysis at the organisational level would allow for using additional factors that may have an important influence on the relationship under study, such as the cultural context, or the history of the organisation, among others. This would be particularly relevant for organisations in a post-socialist context, and specifically (former) state-owned enterprises. Building on Wicks et al.'s (1999) proposed optimal level of trust, it would be of practical and scientific value to define such a level for the specific cultural and organisational context. This could help formulate practical recommendations and strategies. Furthermore, exploring the mutuality of trust between employees and managers could provide valuable insights and warrant a study within specific organisations. While certain satisfaction perceptions are associated with trust in peers, they must also be supported by positive relationships with supervisors (Han, 2010). Thus, studying trust would benefit from extending beyond the dyadic manager–employee relationship (Burke et al., 2007).

Third, including additional factors in the research model would allow for interpretation of the mechanisms through which trust and satisfaction interact, as well as the impact on dependent variables such as organisational performance, innovativeness, and competitiveness, which are of interest when making managerial decisions. Often, trust is not a factor that directly influences given outcomes, but rather moderates the effect of causal factors by influencing the way individuals interpret past actions and evaluate future actions of the other party (Dirks, 2006). Tan and Tan (2000), for example, find empirical confirmation that a different set of outcomes is associated with trust in the manager (e.g., innovative behaviour) and trust in the organisation (higher organisational commitment and lower intention to leave). Investigating the relationship between trust in different organisational referents and behaviours that influence organisational outcomes in contexts with varying general levels of trust (i.e., low- and high-trust societies) would help identify and better understand these mechanisms.

Fourth, this study aims to deepen understanding of the researched phenomena in a specific socio-cultural context. A comparison of these findings with those of other low-trust societies would provide an opportunity to analyse similarities and differences, thus helping better understand the mechanisms of interaction.

6. CONCLUSIONS

This article investigates the relationship between trust in the manager and employee job satisfaction in the Bulgarian socio-cultural context. Trust is conceptualised as a characteristic of interpersonal relationships that leads to the predictability of others' actions based on previous experience and acceptance of one's vulnerability. It is measured by three indicators: dependability, shared understandings, and reciprocity. The trust referent is the direct supervisor/manager. Employee job satisfaction is defined as a subjective assessment of the favourability of one's job, assessed both overall and across several specific facets.

The analysis results support the hypotheses regarding the relationship between trust in the manager and employee job satisfaction (specific facets and overall). The relatively low levels of trust in the manager and job satisfaction obtained here align with conclusions of other studies in Bulgaria. The findings of this study contribute to understanding trust in one's manager and its interaction with one attitudinal outcome, job satisfaction, in low-trust societies. Adopting a cultural perspective strengthens the interpretation of the results. Further research to extend the scope could enhance explanatory power and provide a basis for tailored recommendations to managers and organisations.

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As a rule, submitted articles should not exceed 8,000 words. All pages apart from the first one should be numbered. Subtitles should be concise, clearly marked in bold, and numbered (up to two levels of numbering). No other entries should be bolded. Formulae should be numbered on the right-hand side of the page. In case of long proofs, these should be inserted in a separate Appendix, following the References. Tables and Figures must not use colour, and should be in a format easy to edit, for instance they should take half a page (or a full page) within the indicated margins. They should be clearly labelled at the top, with a legend at the bottom, and should be logically ordered, using Arabic numerals. Sources of the data should be given below tables and figures.

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• Article in journals

Author surname(s), initial(s). (Year). Article title. Journal, Volume number (issue or part number, optional), page numbers. DOI.

Rodrik, R., Subramanian, D., & Trebbi, F. (2004). Institutions rule: the primacy of institutions over geography and integration in economic development. *Journal of Economic Growth*, 9(2), 131-165.

https://DOI: 10.1023/B:JOEG.0000031425.72248.85.

• Books

Author surname, initial(s). (Year). *Title*. Publisher location: Publisher

De Grauwe, P. (2020) *Economics of Monetary Union* (13th ed.). Oxford: Oxford University Press.

• Edited Book

Author surname, initial(s). (Ed(s).). (Year). *Title*. Publisher location: Publisher

Baltagi, B.H. (Ed.). (2003). *A Companion to Theoretical Econometrics*. Oxford: Blackwell

• Book with several authors

When there are multiple authors, list them all, with the addition of ampersand (&) before the last surname. If there are more than seven authors, list the first six, then write three full stops (…), and at the end write the last author.

Acemoglu, D., & Robinson, J.A. (2006). *Economic Origins of Dictatorship and Democracy*. Cambridge: Cambridge University Press.

Baumol, W. J., Panzar, J. C., & Willig, R.W. (1982). *Contestable Markets and the Theory of Industry Structure*. New York: Harcourt, Brace, Jovanovich, Inc.

• Chapter in Book

Last name of the chapter author, initial(s). (Year). Chapter title. In editor initial(s), surname (Ed.). *Title* (ed., pp.). Publisher location: Publisher

McMillan J., & Woodruff C. (2003) The central role of entrepreneurs in transition economies. In G. S. Fields, & G. Pfefferman (Eds.). *Pathways Out of Poverty* (pp. 105-121). Dordrecht: Springer. https://doi.org/10.1007/978-94-010-0009-3_6.

• E-Book

Author surname, initial(s). (Year). *Title*. URL

Perry, R.B. (1909). *The Moral Economy*.

https://manybooks.net/book/137844/read#epubcfi(/6/2[id00000]!/4/2[id00000]/1:0)

• Technical Reports or Working Papers

Individual authors

Author surname, initial(s) or corporate name. (Year). *Title*. (Report or Working Paper No.). URL.

Cătuți, M., Kustova, I. and Egenhofer, C. (2020) *Delivering the European Green Deal for Southeast Europe: Do we need a regional approach?* (CEPS Research Report No.2020/1). https://www.ceps.eu/wp-content/uploads/2020/06/RR_2020-01_European-Green-Deal-for-South-Eastern-Europe.pdf.

Corporate authors

American Psychological Association, Task Force on the Interface Between Psychology and Global Climate Change. (2009). *Report of the APA Task Force on the Interface Between Psychology and Global Climate Change*.

http://www.apa.org/science/about/publications/climate-change.aspx

• Newspaper Articles

Author surname, initial(s). (Year, Month Day). Title. *Title of Newspaper*, p. or pp. URL*

*only include if the article is online.

Note: the date includes the year, month and date.

Smialek, J. (2020, May 2). Hotel Group Will Return Tens of Millions in Small Business Loans. *The New York Times*, pp. 10.

https://www.nytimes.com/2020/05/02/business/economy/ashford-hotels-virus-monty-bennett.html

• Website

Author surname, initial(s). (Year, month day). *Title*. URL

Mitchell, J.A. (2017, May 21). *How and when to reference*.

https://www.howandwhentoreference.com