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CONTENTS

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CONTENTS

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Editorial introduction

In every developed scientific discipline, scholars tend to focus on narrow, specialist topics and are somewhat confined by the practices in their scientific communities. The impact of such specialisation on the discipline's development is ambiguous. On the one hand, it helps to refine existing evidence; on the other, it risks overlooking potentially relevant mechanisms or perspectives developed by other scientists. This is why significant progress in particular areas of the social sciences is often achieved when researchers look beyond their field and explore its interconnections with other topics and communities of practice. This issue of *Economics and Business Review* highlights the strength of this approach, presenting eight articles which collectively show how topics in economics and finance are closely interconnected, as well as being linked to other areas of the social science. This collection has been prepared by twenty-four authors who work in France, Mexico, Morocco, Poland, Türkiye and Vietnam.

The opening article **Spillover effects of remittances on local public spending in developing economies**, written by Raúl Alberto Ponce Rodríguez, Benito Alán Ponce Rodríguez and Juan Carlos Medina Guirado, develops a political economy model to examine how remittances impact local public goods and their spatial spillover effects in developing economies. Using a theoretical framework, the study identifies asymmetric spillovers influenced by the degree of externalities, inter-regional income inequality, and the nature of public goods (complementary or substitutes). Their findings highlight that the spillover effects of remittances on local public spending are complex and asymmetric. When public goods are complementary, remittances enhance welfare across regions without affecting spending in neighbouring areas. However, with substitutable public goods, remittances in one region can crowd out spending in others, with outcomes heavily influenced by inter-regional income inequality and the extent of public good externalities. These results are particularly relevant for policymakers, development practitioners, and researchers focused on fiscal decentralisation and inter-regional equity.

Fatma Türken and Mustafa Ozan Yildirim's article entitled **Second-round effects of food prices on core inflation in Turkey** investigates how food price shocks influence core inflation using Bayesian Structural VAR analysis on data from 2013 to 2024. Their findings reveal that both domestic and global food price shocks significantly impact core inflation and inflation expectations in Türkiye, with effects being especially persistent post-COVID-19. These second-

round effects arise as food price increases amplify inflation expectations, influencing wage and price-setting behaviours. The study highlights the heightened sensitivity of Türkiye's economy to food price fluctuations due to the large share of food in household expenditures and weakly anchored inflation expectations. The findings might be useful to policymakers, central bankers, and economic analysts focused on inflation dynamics and monetary policy in emerging markets.

The third article, entitled **Analysis of the impact of financial inclusion and FinTech on youth labour force participation in the MENA region**, is written by Hanane Elmasmari and Jabrane Amaghouss. The study examines the relationship between financial inclusion and labour market participation among young people in the MENA region. It utilises the World Bank's *Global Findex 2021* database and employs probit estimations with propensity score matching. The findings indicate that young people with higher levels of education, better incomes, and access to mobile phones and the Internet are more likely to participate in both traditional and digital financial systems. Furthermore, the analysis reveals that financial inclusion is a strong predictor of young people's labour market participation.

The subsequent article entitled **Role of subjective norms in shaping entrepreneurial intentions among students** and written by Karolina Nessel, Szczepan Kościółek and Anna Leśniak also deals with the topic of economic activity among young people. The study focuses on entrepreneurial intentions and analyses their determinants using survey data and structural equation modelling. The findings reveal that the influence of subjective norms on entrepreneurial intentions is not direct but is mediated rather by changes in attitude towards entrepreneurship and perceived behavioural control. Furthermore, it was found that students' gender and their own work or entrepreneurial experiences have no impact on these subjective norms. However, the successful entrepreneurial activity of someone close has a positive impact.

The fifth article, which deals with **Religious service attendance and consumer financial outcomes: Evidence from a longitudinal survey**, written by Andrzej Cwynar, Tomasz Potocki, Piotr Białowolski and Dorota Węziak-Białowolska, explores the relationship between religiosity and financial behaviour. The study uses data from a national survey of the socio-economic situation of households in Poland to examine how religious service attendance (RSA) affects savings rates, debt rates, and financial satisfaction. It finds that RSA is positively associated with savings and financial satisfaction, and negatively linked to debt. The research identifies social contacts as a key mediator between RSA and savings. However, no significant mediation effects were found for risk tolerance or trust. These results suggest that religiosity influences financial behaviour through social networks rather than individual financial traits. The findings offer valuable insights for policymakers and financial educators seeking to promote financial well-being.

The sixth paper, entitled **The effects of technology and innovation adoption on firm performance among small and medium enterprises: Evidence from Vietnam's logistics sector,** written by Thanh Tuan Nguyen and colleagues, investigates how technology adoption and innovation affect SME performance in Vietnam's emerging logistics market. Through an analysis of 11,630 SMEs, they find that basic digital technologies like internet access and software usage consistently enhance firm performance, while more advanced automation reveals mixed effects. The study also reveals that organisational innovation has more significant positive impacts than other innovation types. These findings provide valuable insights for understanding how different forms of technological advancement and innovation contribute to business success in developing economies.

Agnieszka Matuszewska-Pierzynka's study, titled **Relationship between corporate sustainability performance and corporate financial performance: The case of companies from the WIG-ESG Index**, examines how environmental, social, and governance (ESG) performance affects financial outcomes in Polish companies. Using data from 21 companies listed on the WIG-ESG Index across two periods (2012–2021 and 2016–2021), the research reveals that environmental sustainability performance positively influences sales revenues in the longer term, while governance practices enhance the return on sales in the shorter period. This work adds important evidence to the ongoing discourse about the financial benefits of corporate sustainability, particularly in emerging European markets.

Finally, in **Social media disagreement and financial markets: A comparison of stocks and Bitcoin** by Sergen Akarsu and Neslihan Yilmaz, the authors explore how disagreements in social media discussions impact market volatility and trading volume. Through a comprehensive analysis of Reddit communities focused on stocks and Bitcoin between 2019–2022, they reveal that social media disagreement significantly affects stock market activity but has a limited influence on Bitcoin trading. The study demonstrates that disagreement in stock-related discussions increases both market volatility and abnormal trading volume, with effects more pronounced for individual stocks than market indices. These findings provide valuable insights into how social media sentiment dispersion differently impacts traditional and digital asset markets.

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Spillover effects of remittances on local public spending in developing economies

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Juan Carlos Medina Guirado[3]

Abstract

We develop a political economy model to study spatial spillover effects of remittances on local public goods with inter-regional positive externalities. Our model postulates that spillovers of remittances are asymmetric with a complex pattern that depends on the degree of externalities of public spending, the inter-regional inequality of income, and whether local public goods are complementary or substitutes. We develop several tests to be verified empirically, for instance, our model states that if local public goods are substitutes and externalities are moderate, remittances received by households in one locality increase government spending in that locality but reduce spending in other districts. If externalities are significant, remittances affect local public spending in high-income localities but do not affect spending in low-income localities.

Keywords

- remittances
- local public goods
- spillovers
- inter-regional inequality
- state and local government

JEL codes: D63, F24, H7, H41

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Introduction

According to the World Bank Report (2023), remittances to developing countries reached $669 billion in 2023. These private transfers from migrants to economic agents or relatives in their home country, are an important source of income for national households in countries such as India, China, Mexico, Egypt, and others. In the case of Mexico, data from the central bank of Mexico shows that remittances as a percentage of gross domestic product (GDP) have increased from 0.13% of GDP in 1979 to 4.3% in 2021, and at the subnational level, remittances could represent up to 10% of per capita income in several states of Mexico, such as Guerrero, Michoacan and Zacatecas. Other countries receiving considerable amounts of remittances, for example, China and India, also show that remittances have become increasingly important over time and heavily concentrated in some regions of the country. For instance, in the case of India, these international transfers are heavily concentrated in states such as Kerala, Maharashtra, and Uttar Pradesh, while in China, the provinces receiving most remittances are those with significant emigrants sending money back to their families.

The literature has recognised that remittances improve human capital (Salas, 2014), affect consumption and savings, and influence economic growth and development (Benhamou & Cassin, 2021), and change the inequality of distribution of income and poverty (Azizi, 2021). More recently, scholars have become interested in studying the effects of remittances on government spending (see Adida & Girod, 2011). However, most studies have focused on the effect of remittances on public spending by central government (see Kochi & Ponce-Rodríguez, 2010; Ponce-Rodríguez & Ponce-Rodríguez, 2022, among other works). Since local public spending can affect the well-being and economic development of communities, it is relevant to ask: What is the effect (if any) of remittances on local public goods in developing economies? In addition, to the best of our knowledge, we are the first to analyse the possibility of spillover effects of remittances on local public spending. Hence, we seek to contribute to the literature by considering a theoretical model that leads to empirically verifiable tests about the spatial effects of remittances on the provision of local public goods and its impact on the welfare of households.

To study this issue, we develop a model of electoral competition based on the work of Wittman (1983), in which politicians provide public goods with positive externalities, for instance, roads, highways, health services, and public safety (see Easton & Montinola, 2017). In a model with two localities, households receive remittances that affect tax revenue and spending. If local public goods show positive externalities, then remittances received in one locality might have spillover effects in other localities (see Hankla et al., 2019). In this context, our analysis suggests that remittances received in one

district might affect government spending and the welfare of households in other districts and that this spillover effect is asymmetric with a complex spatial pattern that depends on the degree of externalities of public spending, the inter-regional inequality of income, and whether local public goods are complementary or substitutes.

In cases where local public goods are complementary, remittances received in one locality do not affect government spending in other localities but increase the welfare of residents in other districts. However, if local public goods are substitutes and the size of externalities of public goods are moderate then remittances received by households living in one locality increase government spending in that district but reduce public spending in other localities. In this case, the reaction function of remittances in the government spending of other localities is negative because externalities of local public spending create an interdependence in the supply of local public goods across localities.

Our model also states that if the size of externalities is high, and the regional distribution of income is highly unequal, then remittances have a complex asymmetric spatial effect. For this case, the jurisdiction with high income and high demand for public spending provides a public good but the jurisdiction with low income and low demand for public spending behaves as a free rider and does not provide a public good. Hence, remittances received in a locality with high income increases government spending only in that locality but have a positive effect on welfare of residents of all localities. However, remittances received in a locality with low income do not increase government spending in any locality and do not affect a welfare of residents of any locality through a channel of government spending.[4]

In other words, remittances have an asymmetric spatial effect depending on the relative demand for public spending in each locality and only remittances received in the district with high demand for public spending would lead to positive spatial effects in the welfare of residents of other localities. Another interesting finding is that high inter-regional inequality in the distribution of income makes this last outcome more likely.

The paper is structured as follows: Section 1 describes the literature review; Section 2 discuss the type of public goods provided in modern economies that we consider in our model and some of the issues to be studied in this paper; Section 3 considers a model of spatial spillovers of remittances with complementary local public goods; Section 4 incorporates a model with homogeneous local public goods; Section 5 discuss our findings; last Section concludes.

[4] Remittances affect the welfare of households by changing their consumption set but do not affect government spending in low-income localities, and in this sense, remittances do not have an additional welfare effect through government spending.

1. Literature review

Given the importance of local public goods in the well-being of citizens and economic outcomes, it is relevant to understand its determinants. The normative literature on public economics has recognised that local public goods are determined by the socio-demographic characteristics of local residents, such as income, preferences, and taxes that explain the demand of households for local public goods (see Scotchmer, 2002).

In contrast to normative models, political economy models have emphasised how economic policies are likely to reflect the fact that policy makers are elected in democracies and local government spending is influenced by electoral competition and political institutions (see Hankla et al., 2019, among many other authors). For instance, Hankla et al. (2019) provides an analysis of the influence of elections, parties, and electoral systems in the provision of local public goods.

In addition, there are few studies that seek to analyse systematically the impact of remittances on government spending but most of these studies focus on the central government. For instance, Johansson (1997) explores how inter-family private transfers affect Pigouvian taxes, Kochi and Ponce-Rodríguez (2010) analyse the impact of remittances on universal and focalised welfare programs, and Page and Plaza (2006) study the government's response to remittances such as the 3 × 1 matching grants program in Mexico to attract funding for specific community projects. In an interesting paper, Abdih et al. (2012) studies how remittance can deteriorate the institutional quality of governments by increasing the share of funds diverted by the government for its own purposes.

In this paper, we consider a political economy model to show how subnational governments respond to changes in the perceived demand of public goods of residents. To the best of our knowledge, we are the first to analyse the possibility of spillover effects of remittances on local public spending. Hence, we seek to contribute to the literature by considering a theoretical model that leads to empirically verifiable tests about the spatial effects of remittances on the provision of local public goods and its impact on the welfare of households.

2. Local public goods and some stylised facts to model

Modern economies provide many local public goods with inter-regional externalities. For instance, spending in public safety (police) in one jurisdiction could have positive externalities on other jurisdictions, as criminal or-

ganizations might have members and activities that cross the geographical boundaries of local governments.[5] If one district increases spending in public safety and reduces criminal activity in that jurisdiction, this could increase local safety in neighboring districts (by weakening criminal organisations that operate in different jurisdictions). In this case, spending on local public safety has positive externalities on residents of other districts. Other local public goods with positive inter-regional externalities recognised in the literature include public spending on education, health services, infrastructure (roads connecting cities from different regions), local environmental policies, etc.

The mobility of households and firms across jurisdictions also leads to positive inter-regional externalities of local public goods. A household travelling to another jurisdiction might enjoy parks, museums, and local safety without necessarily paying for those goods. In this case, these public goods are complementary in the utility function of residents (in other words, a resident of district 1 can benefit from local public goods provided by jurisdictions 1 and 2). We analyse this case and its welfare effects on propositions 1 to 3 of section 4, although, for the simplicity of the model, we do not study the mobility decisions of households and firms.[6]

Instead of the property of complementary, other local public goods might show some degree of homogeneity and might be considered substitute goods. In this case, the supply of local public goods in locality 1 reduces the marginal utility of providing a local public good in locality 2 due to marginal decreasing returns of the consumption of public goods in both localities. An empirical example of this type of public good could be public safety and education. For instance, if district 1 increases spending in public safety and reduces criminal activity in jurisdictions 1 and 2, this would increase local safety in district 2 and the net marginal benefit of spending an additional $1 in public safety in that district falls. In other words, there could be a crowding-out effect in the supply of a public good from one district to others, and we analyse whether this crowding-out effect could create incentives in some local governments to free ride in their supply of these types of public goods in section 5.

Another issue of interest is the large body of literature showing that public goods are explained by the income and sociodemographic characteristics of residents (such as age and gender), which are related to the demand of pub-

[5] Local public goods are goods provided in some jurisdiction that are non-exclusive, non-rival and their benefits extend to other jurisdictions.

[6] We do not model mobility because it significantly complicates the model. In a political economy model, mobility of households could affect local elections, having the effect that politicians could consider how local public goods and taxation could attract and deter certain types of constituencies in the locality. Mobility also might lead to tax and expenditure competition. Hence, the complexities arising from these issues are beyond the scope of this paper. The interested reader on the effect of mobility of local public goods can consult Myers (1990) and Wellisch (1994).

lic spending. The literature also shows that elections, electoral competition, political institutions, and other incentives of policy makers are correlated with the supply side of public goods in modern democracies (for a comprehensive empirical study of demand and supply side issues taking in many countries over several decades, see Hankla et al., 2019). In the context of local public goods with inter-regional externalities, it is plausible that the income and sociodemographic characteristics of residents of that district and residents of other districts could explain the equilibrium levels of local education, public safety, public infrastructure, etc. But if this is the case, how could changes in income and preferences for public goods of residents of neighboring districts affect the supply of local public goods? In this paper we address this issue in propositions 4–7 in section 4.

3. Effects of remittances when local public goods are complementary

Consider an economy with two localities indexed by $q = i, j$. Each locality has a local government that provides a public good paid by local income taxes. The government in each locality is selected by a public election and there are two parties indexed by $p = L, R$. Each locality is constituted by $h = 1, 2, ..., H_q$ voters-households, who decide their private consumption, pay taxes, and vote in their local election. In this economy, the local election is determined as follows: in the first stage, parties select a policy platform constituted by a local public good determined by g_{pq} and the corresponding tax τ_{pq}. In the second stage, voters observe the parties' policies and vote for the policy that is closest to the voters' own interests on policy. In the third stage, votes are counted and the party with the most votes wins the election and implements policy.

In this economy, parties have preferences over policies. Wittman (1983) is the first to identify that parties might have preferences over policies because parties represent the preferences of a coalition of voters in the electorate over public policies. In our economy, the preferences of those voters controlling party p of locality i are given by a representative utility function given by $\mu_{pi} = \alpha_{pi} \ln(x_{pi}) + \beta_{pi} \ln(g_{pi}) + k_j \psi_{pi} \ln(g_{pj})$, where x_{pi} is a private good, g_{pi} is a public good provided by some party p in locality i, and g_{pj} is the public good provided by some party p in locality j.

Parameters $\alpha_{pi}, \beta_{pi}, \psi_{pi}$: $\alpha_{pi} + \beta_{pi} + \psi_{pi} = 1$ reflect the intensity of preferences of the party for the private good and local public goods provided by localities i and j, while $k_j \in [0,1]$ reflects whether the public good of locality j has positive externalities on residents of locality i. If $k_j = 0$, there is no positive externality of the local spending of the locality j on households living in lo-

cality i (in other words, public spending of locality j does not affect the welfare of residents of locality i), and on the other extreme, if $k_j = 1$, the public good of locality j is a nationwide pure public good. If $k_j > 0$, then any positive size of public spending of locality j affects positively the welfare of residents of locality i.

The budget constraint of the representative group of voters controlling party p in locality i is $x_{pi} = (e_{pi} + \omega_{pi})(1 - \tau_{pi})$, where e_{pi} is the representative endowment of the group of voters, $\omega_{pi} \geq 0$ is the amount of remittances that these voters receive, and τ_{pi} is a local income tax that finances public spending by the government of locality i.[7] In addition, the indirect utility function for each party is given by $v_{pi}(e_{pi}, \omega_{pi}, g_{pi}, g_{pj}, \tau_{pi})$, where $v_{pi}(e_{pi}, \omega_{pi}, g_{pi}, g_{pj}, \tau_{pi}) = \alpha_{pi} \ln((e_{pi} + \omega_{pi})(1 - \tau_{pi})) + \beta_{pi} \ln(g_{pi}) + k_j \psi_{pi} \ln(g_{pj})$ for $p = L, R$ in locality i. A similar indirect utility function is defined for parties in locality j, which is given by $v_{pi}(e_{pj}, \omega_{pj}, g_{pj}, g_{pj}, \tau_{pj})$.

In what follows, we describe the preferences and constraints for each voter in locality i. As we mentioned before, there are $h = 1, 2, \ldots, H_q$ voters in each locality $q = i, j$. Each voter has preferences given by $\mu_{hi} = \alpha_{hi} \ln(x_{hi}) + \beta_{hi} \ln(g_{pi}) + k_j \psi_{hi} \ln(g_{pj})$ and the voter's budget constraint is $x_{hi} = (e_{hi} + \omega_{hi})(1 - \tau_{pi})$ for all $h = 1, 2, \ldots, H_q$, where e_{hi} is the voter's endowment, $\omega_{hi} \geq 0$ is the amount of remittances that the voter type h receives, and τ_{pi} is the income tax rate that the voter pays to the local government of the jurisdiction. In this economy, there is heterogeneity of preferences, endowments, and remittances that explain the distribution of ideal policies for the local spending of each household. In other words, some voters would prefer high local spending and taxes, while others prefer low spending and taxation.

The welfare of each voter depends on the tax and spending policies adopted by parties L or R, depending on which party wins the local election. Hence, the welfare of a voter living in locality i with endowment e_{hi} under the policies of party L, g_{Li}, τ_{Li} is given by the indirect utility function $v_{hi}(e_{hi}, \omega_{hi}, g_{Li}, g_{pj}, \tau_{Li})$ and under the policies of party R, g_{Ri}, τ_{Ri} is given by $v_{hi}(e_{hi}, \omega_{hi}, g_{Ri}, g_{pj}, \tau_{Ri})$. In the second stage of the electoral game, the choice of the vote for a voter type e_{hi} is given by $\Psi_{hi} = v_{hi}(e_{hi}, \omega_{hi}, g_{Li}, g_{pj}, \tau_{Li}) - v_{hi}(e_{hi}, \omega_{hi}, g_{Ri}, g_{pj}, \tau_{Ri})$. If $\Psi_{hi} \geq 0$, the voter votes for party L, otherwise he or she votes for party R.

In the third stage, the party with the majority of the votes wins the local election: if party L wins, then policies g_{Li}, τ_{Li} are implemented, otherwise the ideal policies of party R, g_{Ri}, τ_{Ri} are implemented. The median voter in locali-

[7] For mathematical simplicity we have chosen an income tax on the full income of households, which is the household's endowment and transfers from remittances. It is well known that a universal income tax is equivalent to a consumption tax. Although remittances do not pay income taxes in many economies, households use their full income to consume, and therefore, households pay consumption taxes. Given the equivalence between income and consumption taxes in our model, the results of this analysis are equivalent to those we would obtain if we had assumed an economy with consumption taxes.

ty i determines the majority of the votes in the local election. Following the same logic as before, $\upsilon_{mi}(e_{mi}, \omega_{mi}\, g_{Li}, g_{pj}, \tau_{Li})$ and $\upsilon_{mi}(e_{mi}, \omega_{mi}, g_{Ri}, g_{pj}, \tau_{Ri})$ represent the indirect utility functions of the median voter in locality i under policies of parties L and R and the choice of the vote of the median voter is given by $\Omega_{mi} = \upsilon_{mi}(e_{mi}, \omega_{mi}\, g_{Li}, g_{pj}, \tau_{Li}) - \upsilon_{mi}(e_{mi}, \omega_{mi}, g_{Ri}, g_{pj}, \tau_{Ri})$. If $\Omega_{mi} \geq 0$ then party L in locality i wins the election and implements g_{Li}, τ_{Li}, otherwise party R wins the election and implements policies g_{Ri}, τ_{Ri}. A similar local election in locality j takes place simultaneously and determines taxes and local public spending in that locality.

The budget constraint of the local government in each locality is given by $g_{pq} = \tau_{pq} \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq})$, where $\tau_{pq} \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq})$ is tax revenue of localities $q = i, j$. Note that the locality's aggregate income I_q is constituted by the sum of endowments and remittances of all residents of locality q, which is given by $I_q = \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq})$.

For this economy, the politico-economic equilibrium is shaped by the parties' policy platforms, $g^{\star}_{pq}, \tau^{\star}_{pq}$ for parties $p = L, R$ in localities $q = i, j$, the choices of the vote of households-voters, and the implementation of local spending and taxation in each locality (see the formal definition in proposition 1).

Proposition 1. *For this economy, the politico-economic equilibrium is constituted as follows:*

1) In the first scenario, parties $p = L, R$ propose policies $g^{\star}_{pq}, \tau^{\star}_{pq}$ in localities $q = i, j$ such that:

$$g^{\star}_{pq}, \tau^{\star}_{pq} \in \arg\max \upsilon_{pq}(e_{pq}, \omega_{pq}, g_{pq}, \tau_{pq}) \;\; st: \;\; g_{pq} = \tau_{pq} \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq}) \qquad (1)$$

2) In the second stage, voters in locality $q = i, j$ vote for party L if:

$$\Psi_{hq} = \upsilon_{hq}(e_{hq}, \omega_{hq}, g^{\star}_{Lq}, \tau^{\star}_{Lq}) - \upsilon_{hq}(e_{hq}, \omega_{hq}, g^{\star}_{Rq}, \tau^{\star}_{Rq}) \geq 0 \qquad (2)$$

Otherwise, they vote for party R.

3) The choice of the vote of the median voter is given by Ω_{mq} in each locality $q = i, j$ as follows:

$$\text{if} \qquad \Omega_{mq} = \upsilon_{mq}(e_{mq}, \omega_{mq}, g^{\star}_{Lq}, \tau^{\star}_{Lq}) - \upsilon_{mq}(e_{mq}, \omega_{mq}, g^{\star}_{Rq}, \tau^{\star}_{Rq}) \geq 0 \qquad (3)$$

Then party L in locality $q = i, j$ wins the election and implements $g^{\star}_{Lq}, \tau^{\star}_{Lq}$. Otherwise, party R wins the election and implements $g^{\star}_{Rq}, \tau^{\star}_{Rq}$.

In what follows, proposition 2 characterises the size of local spending and taxation in each locality of this economy.

Proposition 2. Local elections lead to an equilibrium size of government spending in localities $q = i, j$ given by:

$$g_{pq}^{\star} = \left(\frac{\beta_{pq}}{\alpha_{pq} + \beta_{pq}} \right) \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq}) \tag{4}$$

Proof
See the Appendix.

Proposition 2 says that government spending in each locality is determined by the relative ratio of intensity of preferences for public goods vis-à-vis private goods of the representative voter controlling the party that wins the election in each locality $q = i, j$. This ratio is given by $\frac{\beta_{pq}}{\alpha_{pq} + \beta_{pq}}$. Government spending in each locality is also determined by the locality's aggregate income I_q, which is the sum of endowments and remittances of all residents of the locality and given by $I_q = \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq})$. To simplify notation, we define the equilibrium size of local spending in each locality in (4) by the function $g_{pq}^{\star} = g_{pq}^{\star}(I_q, \beta_{pq}, \alpha_{pq})$. Note that increases in the locality's aggregate income and the relative ratio of intensity of preferences for public goods of the representative voter controlling party p in each locality $q = i, j$ lead to increases in the size of government spending $g_{pq}^{\star}$.

For the analysis that follows, we consider the effects of the government's spending on the welfare of the society. In our economy, the welfare of the society is represented by the egalitarian social welfare function defined by $SW_q = \sum_{h=1}^{H_q} \upsilon_{hq}$, which is the linear sum of the well-being of all residents of the locality. As stated in proposition 2, local public spending is determined by the aggregate income of residents and the preferences for private and public goods of the representative coalition of voters controlling the party that is elected in each locality. This implies that remittances received in each locality affect the size of local public spending and the welfare of residents in each locality.

In what follows, proposition 3 says that in the event of local public spending showing positive externalities, then an increase in the size of remittances received by residents of locality j have a positive effect on the welfare of residents of locality i, because remittances received in locality j, affect positively the size of local spending in that locality and have spillover effects that not only determine the well-being of residents of locality j but also the welfare of residents of neighbor jurisdictions. Proposition 3 shows this outcome directly by substituting the equilibrium size of local public goods in localities i and j and the private goods consumed by residents of locality i.

Proposition 3. The welfare of all residents in each locality is given by $SW_q = \sum_{h=1}^{H_q} \upsilon_{hq}$.

In locality i

$$SW_i = \sum_{h=1}^{H_i} \alpha_{hi} \ln(x_{hi}^{\star}) + \sum_{h=1}^{H_i} \beta_{hi} \ln(g_{pi}^{\star}) + k_j \sum_{h=1}^{H_i} \psi_{hi} \ln(g_{pj}^{\star}) \tag{5}$$

where

$$x_{hi}^{\star} = \left(\frac{\alpha_{pi}}{\alpha_{pi} + \beta_{pi}} \right) (e_{hi} + \omega_{hi}) \qquad \forall h = 1, 2, \ldots, H_i \tag{6}$$

and

$$g_{pq}^{\star} = \left(\frac{\beta_{pq}}{\alpha_{pq} + \beta_{pq}} \right) \sum_{h=1}^{H_q} (e_{hq} + \omega_{hq}) \quad \text{for} \quad q = i, j \tag{7}$$

Proposition 3 shows that remittances received in locality i only affect the production of public goods of locality i positively. Similarly, remittances received in locality j positively only affect the production of public goods of locality j positively. However, proposition 3 also shows that remittances received by residents of locality j have spillover effects in the welfare of residents of locality i if $k_j > 0$ (and remittances received by residents of locality i have spillover effects in the welfare of residents of locality j if $k_i > 0$). To see this, note that an increase in remittances received by households living in locality j increases the revenue and spending of that locality, and therefore the welfare of residents of locality i. The marginal effect of an increase in the aggregate amount of remittances received by households living in locality j in the welfare of all residents of locality i is given by $\frac{\partial \Psi_i}{\partial \sum_{h=1}^{H_j} \omega_{hj}} = \frac{k_j \sum_{h=1}^{H_i} (\psi_{hi})}{\sum_{h=1}^{H_j} (e_{hj} + \omega_{hj})} > 0$.

The spillover effect that remittances received in locality j have on locality i depends positively on the extent of externalities of the local public good supplied in locality j, k_j, and the aggregate intensity of preferences of residents of locality i for the public good provided by locality j, given by the parameter $\sum_{h=1}^{H_i} (\psi_{hi})$.

To summarise our findings from this section, Table 1 shows the case for complementary local public goods and assumes an increase in remittances received in localities i and j. It also presents the reaction function of government spending in all localities, the net consumption of local public goods (for the case of locality i the net consumption is given by $g_i + k_j g_j$ and for locality j

Table 1. Spatial effects of remittances with complementary local public goods

Moderate and large spillovers: $k_i > 0$ and $k_j > 0$	**Production of g_i or reaction function of government spending of locality *i***	**Production of g_j or reaction function of government spending of locality *j***	**Net consumption of local public goods by residents of locality *i*, given by $g_i + k_j g_j$**	**Net consumption of local public goods by residents of locality *j*, given by $g_j + k_i g_i$**	**Effect on welfare of residents of locality *i***	**Effect on welfare of residents of locality *j***
An increase in remittances in locality *i*	leads to an increase in g_i	no effect on g_i	increase	increase	positive	positive
An increase in remittances in locality *j*	no effect on g_i	leads to an increase of g_i	increase	increase	positive	positive

Source: own work.

is given by $g_j + k_i g_i$), and welfare effects of remittances. Table 1 shows that regardless of whether the externalities of local public goods are moderate or large, an increase in remittances received by households living in locality *i* increases the size of government spending in that locality but does not affect the level of public spending in district *j*. However, because of the complementarity of local public goods and its inter-regional positive externalities, an increase in remittances received by residents of locality *i* increase he welfare of residents in localities *i* and *j*. Similar findings hold for an increase in remittances received by households living in locality *j*.

4. Spatial effects of remittances with homogeneous public goods

In the last section, local public goods are complementary in the utility function. Here we assume local public goods have some degree of homogeneity. The main distinction between the two sections is that the supply of local public goods in locality *j* reduces the marginal utility of a local public good in locality *i* due to marginal decreasing returns of consumption of public goods in both localities. In this case, the structure of preferences of the representative coalition of voters controlling party *p* is given by $\mu_{pi} = \alpha_{pi} \ln(x_{pi}) + \beta_{pi} \ln(g_{pi} + + k_j g_{pj})$, where x_{pi} is the private good, g_{pi} is the public good provided by some party *p* in locality *i*, g_{pj} is the public good provided by some party *p* in locality *j*, and $g_{pi} + k_j g_{pj}$ is the aggregate consumption of local public goods of a res-

ident in locality i. Similarly, the aggregate consumption of local public goods of a resident in locality j is $g_{pj} + k_i g_{pi}$.

As before, parameters α_{pi}, β_{pi} reflect the intensity of preferences of the private good, the local public good in locality i, and the public good of locality j. We assume $\alpha_{pi} + \beta_{pi} = 1$, while $k_j \in [0, 1]$ is a parameter that reflects whether the public good of locality j has positive externalities on residents of locality i. Similarly, the preferences of voters in locality i are $\mu_{hi} = \alpha_{hi} \ln(x_{hi}) + \beta_{hi} \ln(g_{pi} + k_j g_{pj}) \; \forall \; h = 1, 2, ..., H_i$ and for voters of locality j are $\mu_{hj} = \alpha_{hj} \ln(x_{hj}) + \beta_{hj} \ln(g_{pj} + k_i g_{pi}) \; \forall \; h = 1,2, ..., H_j$.

As in the previous section, the political process forming local governments is the same as before: in the first scenario, parties select a policy platform constituted by the public good g_{pq} and the corresponding tax τ_{pq}. In the second stage, voters observe the parties' policies and vote. In the third stage, votes are counted, and the party with the majority of votes takes all and implements their policy.

In what follows, proposition 4 describes the size of local spending and the spatial effects of remittances. To distinguish the results of this section with our analysis in the previous section, we define the equilibrium local public goods by $\tilde{g}_{pq}$ for $p = L, R$ and $q = i, j$.

Proposition 4. Local elections lead to an equilibrium size of government spending $\tilde{g}_{pq}$ for $p = L, R$ as follows.

For locality i:

$$\tilde{g}_{pi} = \frac{\beta_{pi}\left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi}\right) - k_j \alpha_{pi} \beta_{pj}\left(\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj}\right)}{1 - k_i k_j \alpha_{pi} \alpha_{pj}}$$

and for locality j:

$$\tilde{g}_{pj} = \frac{\beta_{pj}\left(\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj}\right) - k_i \alpha_{pj} \beta_{pi}\left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi}\right)}{1 - k_j k_i \alpha_{pj} \alpha_{pi}}$$

Proof

See the Appendix.

Proposition 4 shows that the equilibrium level of $\tilde{g}_{pi}$ depends positively on the structure of preferences for public goods of the coalition controlling the party in office in locality i, α_{pi}, β_{pi}, and locality j, α_{pj}, β_{pj}, the aggregate income of locality i, $\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi}$ and locality j $\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj}$, and the distribution of

spillovers k_i and k_j. Spillovers of public spending create an interdependence in the supply of local public goods across localities, that is, an increase in $\tilde{g}_{pj}$ reduces the marginal benefits of producing $\tilde{g}_{pi}$ and vice versa. This outcome follows from the fact that the marginal utility of consuming local public goods decreases with increases in $\tilde{g}_{pi}$ and $\tilde{g}_{pj}$, since the overall consumption of local public goods for a resident of locality *i* is equal to $\tilde{g}_{pi} + k_j \tilde{g}_{pj}$.

Proposition 4 also shows that the greater the extent of spillovers of $\tilde{g}_{pi}$ on locality *j*, that is the higher k_i, the higher the $\tilde{g}_{pi}$ at the political equilibrium. This is not for altruism, or because the party in locality *i* considers the preferences of residents of locality *j*, but because of a crowding-out effect of $\tilde{g}_{pi}$ on the supply of $\tilde{g}_{pj}$. To see this, note that an increase in $\tilde{g}_{pi}$ reduces the supply of $\tilde{g}_{pj}$ and the nationwide consumption of public goods for the party in locality *i*, which is given by $\tilde{g}_{pi} + k_j \tilde{g}_{pj}$. To compensate for this crowding-out effect, $\tilde{g}_{pi}$ goes up with increases in k_i.

In proposition 5, we provide some comparative analysis of the response of $\tilde{g}_{pi}$ to changes in the elasticity of the utility function of the party and the public good of locality *j*, that is β_{pj}, with respect to changes in the elasticity of the utility of the party and private goods of locality *j*, that is α_{pj}, and with respect to changes in the extent of spillovers from the public good of locality *j*, that is k_j.

Proposition 5. The comparative analysis of $\tilde{g}_{pi}$ implies that:

$$1)\ \frac{\partial \tilde{g}_{pi}}{\partial \beta_{pj}} < 0,\ 2)\ \frac{\partial \tilde{g}_{pi}}{\partial \alpha_{pj}} > 0, \text{ and } 3)\ \frac{\partial \tilde{g}_{pi}}{\partial k_j} \gtrless 0$$

Proof
See the Appendix.

Proposition 5 states that an increase in β_{pj} indicates that the marginal utility of the party and the local public good in locality *j* is higher, which increases its demand in locality *j*. The government of that locality increases $\tilde{g}_{pj}$, which also increases the size of positive externalities of $\tilde{g}_{pj}$ on locality *i* and leads to a reduction in the marginal utility of public goods in locality *i* and reduces the supply of $\tilde{g}_{pi}$. In addition, an increase in α_{pj} means that private consumption is more attractive relative to public goods for the party in locality *j*. The government in that locality reduces $\tilde{g}_{pj}$, which in turn reduces the positive externalities of $\tilde{g}_{pj}$ on locality *i* and, as a response, the local government in locality *i* increases $\tilde{g}_{pi}$. Finally, an increase in k_j leads to an ambiguous effect on $\tilde{g}_{pj}$ because higher externalities from $\tilde{g}_{pj}$ increase consumption of local public goods in locality *i*, and reduce the marginal electoral benefit of producing $\tilde{g}_{pi}$. Hence, an increase of k_j tends to lead to a reduction in $\tilde{g}_{pi}$. However, an increase in k_j reduces the slope of the reaction function of $\tilde{g}_{pi}$ to changes in $\tilde{g}_{pj}$, making $\tilde{g}_{pi}$ less sensitive to changes in k_j, which explains the ambiguous effect of k_j on $\tilde{g}_{pi}$.

In what follows, propositions 6, 7, and 8 characterise the spatial distribution of public goods and the effect of remittances for an economy with homogeneous public goods for different levels of interjurisdictional spillovers, that is, for different values of k_i and k_j.

Proposition 6. The case of no externalities of public goods and no spillover effects of remittances. If local spending does not show spillovers, that is, if $k_i = k_j = 0$, the spatial distribution of government spending for localities $q = i, j$, $\tilde{g}_{pq}$ is given by:

$$\tilde{g}_{pq} = \beta_{pq}\left(\sum_{h=1}^{H_q} e_{hq} + \sum_{h=1}^{H_q} \omega_{hq}\right) \tag{10}$$

In this case, remittances received by households in locality j do not have spillover effects on public spending of locality i, and vice versa.

Proof

It follows trivially from proposition 4.

Proposition 6 shows the spillover effects of remittances through its impact on the size of local public spending of localities i and j. In the absence of externalities of public goods across localities, that is, for the case in which $k_i = k_j = 0$, remittances do not have spatial effects, since local spending only depends on the aggregate income of the locality constituted by the endowments plus remittances that households in that locality receive. Local spending also depends on the preferences of the coalition of voters controlling the party. Hence, remittances received in locality j do not affect the size of government spending enjoyed by residents of locality i and vice versa.

Proposition 7. Moderate externalities of local public spending: If local public spending shows "moderate" spillovers, that is, if:

$$k_i > 0, k_j > 0 : 0 < k_i < \left(\frac{1}{\alpha_{pj}}\right)\left(\frac{\beta_{pj}}{\beta_{pi}}\right)\left(\frac{\sum_{h=1}^{H_j}(e_{hj} + \omega_{hj})}{\sum_{h=1}^{H_i}(e_{hi} + \omega_{hi})}\right)$$

and

$$0 < k_j < \left(\frac{1}{\alpha_{pi}}\right)\left(\frac{\beta_{pi}}{\beta_{pj}}\right)\left(\frac{\sum_{h=1}^{H_i}(e_{hi} + \omega_{hi})}{\sum_{h=1}^{H_j}(e_{hj} + \omega_{hj})}\right)$$

then the spatial distribution of government spending for localities, $\tilde{g}_{pi}$ and $\tilde{g}_{pj}$, is given as follows:

In locality i:[8]

$$\tilde{g}_{pi} = \frac{\beta_{pi}\left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi}\right) - k_j\,\alpha_{pi}\,\beta_{pj}\left(\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj}\right)}{1 - k_i\,k_j\,\alpha_{pi}\,\alpha_{pj}} \tag{11}$$

and for locality j:

$$\tilde{g}_{pj} = \frac{\beta_{pj}\left(\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj}\right) - k_i\,\alpha_{pj}\,\beta_{pi}\left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi}\right)}{1 - k_j\,k_i\,\alpha_{pj}\,\alpha_{pi}} \tag{12}$$

In this case, remittances in locality j have "negative" spillover effects on public spending in locality i and vice versa.

Proof

It follows trivially from proposition 4.

Proposition 7 shows that the equilibrium level of $\tilde{g}_{pi}$ depends positively on the structure of preferences for public goods of the coalition controlling the party in office in locality i, α_{pi}, β_{pi}, and the aggregate income of that locality. In addition, $\tilde{g}_{pi}$ depends negatively on those factors that increase the supply of the local public good in locality j, such as the extent of spillovers of $\tilde{g}_{pj}$ on locality i, the intensity of preferences of the coalition of voters controlling the party in locality j, β_{pj}, and the size of endowments and remittances of locality j, $\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj}$, because these factors increase local public goods in locality j and reduce the marginal benefits of providing public goods in locality i. As a result, parties in locality i recognise that their electoral benefits increase if they reduce the size of $\tilde{g}_{pi}$.

In this case, spillovers of local public spending create an interdependence in the supply of local public goods across localities, that is, an increase in remittances received by residents of locality j increase the supply of $\tilde{g}_{pj}$, which in turn reduces the marginal benefits of producing $\tilde{g}_{pi}$ in locality i and vice versa. In other words, remittances received in locality j have a crowding-out effect on the provision of public goods in locality i. This outcome follows from the fact that the marginal utility of consuming local public goods decreases with increases in $\tilde{g}_{pi}$ and $\tilde{g}_{pj}$, since the overall consumption of local public goods is equal to $\tilde{g}_{pi} + k_j\,\tilde{g}_{pi}$. If this crowding-out effect is strong enough, then the marginal utility of consuming a local public good in locality i could be driven to

[8] A similar condition is characterised for locality j.

zero, and it could create incentives for locality i to free ride and not provide a local public good in its locality.

In this case, the expected sign of increases in remittances in locality j on welfare of residents of locality i could be negative. This contrasts with our prediction of the spatial effect of remittances for the case in which local public goods are complementary. In the latter case, the expected impact on welfare of residents of locality due to increases in remittances received by households in locality j is positive.

Proposition 8. Case of Large Externalities of Local Public Spending: If local spending shows "high" spillovers in the locality with high demand for public spending, that is, if $\tilde{g}_{pi} > \tilde{g}_{pj}$ and:

$$k_i > 0, k_j \geq 0 : k_i \geq \left(\frac{1}{\alpha_{pj}}\right)\left(\frac{\beta_{pj}}{\beta_{pi}}\right)\left(\frac{\sum_{h=1}^{H_j}(e_{hj}+\omega_{hj})}{\sum_{h=1}^{H_i}(e_{hi}+\omega_{hi})}\right)$$

then the spatial distribution of government spending for localities i and j is given as follows:

$$\tilde{g}_{pi} = \beta_{pi}\left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi}\right) \quad \text{and} \quad \tilde{g}_{pj} = 0 \tag{13}$$

In this case, spillovers from remittances are spatially asymmetric. That is, remittances in locality i have a positive spillover effect on public spending of locality j but remittances in locality j do not have spillovers on public spending of locality i.

Proof

It follows from proposition 4.

Proposition 8 shows that if externalities from the locality with high demand for public spending are significant, and or the distribution of regional income is highly unequal, then remittances have an asymmetric spatial effect depending on the relative size of the demand for public spending in each locality. Remittances received in locality i have a spillover effect on residents of locality j, but remittances received in locality j do not have a spillover effect on residents of locality i.

To see this, note that for this case, local public goods might be positive in the locality with high demand for public spending, which in our case, by assumption, is locality i, while the supply of local public goods in locality j would be zero, that is, $\tilde{g}_{pi} > 0$ and $\tilde{g}_{pj} = 0$. The reason for this outcome is that the size of government spending in locality i is high enough to drive to zero the mar-

ginal utility of consuming this local public good in locality j. Therefore, the party winning the local election in locality j has political incentives to free ride and does not provide a local public good in its locality.

Hence the consumption of public goods in locality j is given by $\tilde{g}_{pj} + k_i \tilde{g}_{pi} = k_i \tilde{g}_{pi} = k_i \beta_{pi} \left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi} \right)$, therefore an increase of \$1 in remittances received in locality i increases the overall consumption of public goods of residents of locality j by an amount equal to $k_i \beta_{pi} > 0$. However, increases in remittances received in locality j do not affect the consumption of public goods of residents of locality i because the consumption of public goods by their residents is expressed by $\tilde{g}_{pi} + k_j \tilde{g}_{pj} = \tilde{g}_{pi} = \beta_{pi} \left(\sum_{h=1}^{H_i} e_{hi} + \sum_{h=1}^{H_i} \omega_{hi} \right)$, and therefore an increase in remittances in locality j does not affect the overall consumption of public goods of residents of locality i.

In this case, remittances received by locality i affect government spending in locality i and would have a positive effect on the welfare of residents in locality j, but remittances received in locality j would not affect government spending in any locality, nor would they influence the welfare of residents of any locality. In other words, remittances have an asymmetric spatial effect depending on the relative demand for public spending in each locality and only remittances received in a locality with high demand for public spending would lead to positive spatial effects in the other locality.

It is relevant to point out that the outcome in proposition 7 is more likely when the inequality of income across localities is significant. Note that for proposition 7 to hold, the extent of spillovers in the high-income locality, given by k_i, must satisfy the following condition:

$$k_i \geq \left(\frac{1}{\alpha_{pj}} \right) \left(\frac{\beta_{pj}}{\beta_{pi}} \right) \left(\frac{\sum_{h=1}^{H_j} (e_{hj} + \omega_{hj})}{\sum_{h=1}^{H_i} (e_{hi} + \omega_{hi})} \right)$$

and this is more likely if the ratio between aggregate income in the low- and high-income localities, expressed by the term:

$$\frac{\sum_{h=1}^{H_j} (e_{hj} + \omega_{hj})}{\sum_{h=1}^{H_i} (e_{hi} + \omega_{hi})}$$

is sufficiently low. In this case, the inter-regional inequality of income leads to a significant disparity between the demand for public goods of high- and low-income localities, and the high-demand locality might drive to zero the

marginal utility of providing public goods in the low-demand locality, which might explain why in the equilibrium the corresponding supply of localities i and j would be $\tilde{g}_{pi} > 0$ and $\tilde{g}_{pj} = 0$.

5. Discussion of findings

In this section, we discuss the findings of our model. As mentioned before, Table 1 shows the case for complementary local public goods and Table 2 the case for local public goods with substitutability. We consider the effect of an increase in remittances received in localities i and j, the reaction function of government spending in all localities, the net consumption of local public goods (for the case of locality i the net consumption is $g_i + k_j g_j$ and for locality j is $g_j + k_i g_i$), and welfare effects of remittances.

Table 1 demonstrates that regardless of whether the externalities of local public goods are moderate or large, an increase in remittances received by households living in locality i increases the size of government spending only in that locality but does not affect public spending in locality j. Because of the complementarity of local public goods and their inter-regional positive externalities, an increase in remittances received by residents of locality i boosts the welfare of residents in localities i and j. Similar findings hold for an increase in remittances received by households living in locality j.

Table 2 shows a more complex pattern of the spatial effects of remittances on government spending. In the case of moderate spillovers, an increase in remittances received by households living in locality i not only increases the size of government spending in that locality but also exerts a crowding-out effect in government spending in locality j (that is, the size of public spending in locality j falls). However, an increase in remittances received by residents of locality i has a net positive effect on the welfare of residents of localities i and j, because the net consumption of public goods in both localities rises. Our analysis shows that we can expect similar implications for remittances received by residents of locality j.

In the case of large externalities of local public spending, an increase in remittances in locality i, only increases the level of government spending in that locality and it does not affect government spending of district j. In addition, an increase in remittances received by residents of locality i increases the welfare of residents of localities i and j because the net consumption of public goods in both localities rises.

However, remittances received by households of locality j does not increase government spending in any locality because the local government of locality j free rides and does not provide a local public good. For this rea-

Table 2. Spatial effects of remittances with homogeneous local public goods

Moderate and large spillovers: $k_i > 0$ and $k_j > 0$	**Production of g_i or reaction function of government spending of locality *i***	**Production of g_j or reaction function of government spending of locality *j***	**Consumption of local public goods by residents in locality *i* $\tilde{g}_i + k_j \tilde{g}_j$**	**Consumption of local public goods by residents in locality *j* $\tilde{g}_j + k_j \tilde{g}_i$**	**Effect on welfare of residents in locality *i***	**Effect on welfare of residents in locality *j***
An increase in remittances in locality *i*	leads to an increase in $\tilde{g}_i$	leads to a reduction in $\tilde{g}_j$	increase	increase	positive	positive
An increase in remittances in locality *j*	leads to a reduction in $\tilde{g}_i$	leads to an increase in $\tilde{g}_j$	increase	increase	positive	positive
Large externalities of local public spending						
An increase in remittances in locality *i*	leads to an increase in $\tilde{g}_i$	no effect on $\tilde{g}_j$	increase	increase	positive	positive
An increase in remittances in locality *j*	no effect on $\tilde{g}_i$	no effect on $\tilde{g}_j$	no change	no change	no effect on welfare	no effect on welfare

Source: own work.

son, the reaction function of government spending and welfare of residents of both localities remains unchanged even if households of locality *j* receive more remittances.

Normative versus political economy considerations

In this section, we discuss several key differences that emerge between the outcomes of our political economy and a normative model with a central social planner. This comparison helps to put into perspective our analysis and seeks to provide insights into the role of fiscal decentralisation and political institutions in shaping local spending policy. The first key difference is that the aggregation of preferences in policy design differs significantly between our political economy model and the normative model. A central planner considers the marginal social benefits and costs of spending and taxation across all localities. In contrast, our model posits that the preferences of the ruling party dictate local spending decisions. This can lead to suboptimal levels of public goods, either exceeding or falling short of the socially optimal level, depending on the party's preferences. It also means that the marginal effect of remittances in these models is different; while increases in remittances might lead to social benefits under a social planner, it might not improve welfare of the society in our political economy model.

Secondly, the efficiency of local spending varies between the two models. A normative model ensures Pareto efficiency, while our political model does not. The degree of externalities amplifies the welfare costs of inefficient public good allocation. This inefficiency stems from decentralised decision-making and the limited consideration of externalities by parties, who prioritise the preferences of their electoral base. Fiscal decentralisation exacerbates this issue, as policymakers are incentivised to ignore the positive externalities of the effect of remittances on spending in other localities. Moreover, political incentives drive politicians to neglect the positive externalities of spending on residents outside their core voter base, which means that an income effect from remittances might only be incorporated to the extent that it affects the party in power. In our model, single-peaked preferences for local spending imply that the political inefficiency grows with the divergence between the ideal policy of the average voter and the ideal policy of the ruling party.

Finally, strategic behaviour by parties in our political economy model can lead to coordination failures and welfare losses. Parties' Cournot-Nash reaction functions result in negative externalities between localities, hindering the maximisation of gains from cooperative behaviour. In contrast, a benevolent central planner, free from such strategic considerations, can achieve optimal allocative efficiency and maximise welfare.

Conclusions

In this paper, we develop a political economy model to study the spatial spillover effects of remittances. In our economy, local governments are formed through elections, in which parties select a policy platform constituted by a local public good and a proportional income tax, voters observe the parties' policies and vote. After votes are counted, the party with the majority takes all and implements local policy. In a two-district economy, households have their own income but also receive remittances, and local governments are formed by parties with preferences over public goods. Since local public goods are normal and show positive externalities, remittances received in one jurisdiction might affect government spending in that locality, but also change the consumption of public goods of residents of other jurisdictions. Hence, remittances received on one locality might have spillover effects on the welfare of residents of other localities.

Our model shows that the spillover effects of remittances are asymmetric with a complex pattern that depends on the degree of externalities of public spending, the inter-regional inequality of income, and whether local public goods are complementary or substitutes. In the case where local public

goods are complementary, remittances received in one locality do not affect government spending in other localities but increase the welfare of residents of other localities.

However, if local public goods are substitutes (there is some degree of homogeneity) and the size of externalities of public goods are moderate, then remittances received by households living in one locality increase government spending in that locality but reduce spending in other districts. In this case, the reaction function of remittances in the government spending of other localities is negative because externalities create an interdependence in the supply of local public goods across localities, that is, an increase in remittances received by residents of one locality boosts the supply of the public good in that locality but reduces the marginal benefits of producing a public good in other districts. This outcome follows from the fact that the marginal utility of consuming local public goods decreases with increases in the provision of public goods in all localities.

Our model also shows that if the degree of externalities is high, and the distribution of regional income is highly unequal, then remittances have a complex asymmetric spatial effect. In this case, a jurisdiction with a high income and high demand for public spending provides a public good but a jurisdiction with a low income and low demand behaves as a free rider and does not provide a public good. Hence, remittances received in localities with high income would have a positive effect on the welfare of residents of all localities, but remittances received in low-income localities would not influence the welfare of residents of any locality.

In other words, remittances have an asymmetric spatial effect depending on the relative demand for public spending of each district and only remittances received in the locality with a high demand for public spending would lead to positive spatial effect in other localities. Our analysis shows that high inter-regional inequality in the distribution of total income (endowments and remittances) makes this outcome more likely.

Appendix

Proposition 2
Proof

In the first scenario, parties $p = L, R$ in localities $q = i, j$ propose policies $g^{\star}_{pq}$, $\tau^{\star}_{pq}$ such that $g^{\star}_{pq}, \tau^{\star}_{pq} \in \text{argmax}\, \upsilon_{pq}\,(e_{pq}, \omega_{pq}, g_{pi}, g_{pj}, \tau_{pq})$ *st:* $g_{pq} = \tau_{pi} \sum_{h=1}^{q}(e_{hq} + \omega_{hq})$. Assume the case of locality i, then solve the next optimisation problem:

$$\max \upsilon_{pi} = \alpha_{pi} \ln\left((e_{pi} + \omega_{pi})\left(1 - \frac{g_{pi}}{\sum_{h=1}^{H_i}(e_{hi} + \omega_{hi})}\right)\right) + \beta_{pi} \ln(g_{pi}) + k_j \psi_{pi} \ln(g_{pj}) \quad \text{(A1)}$$

Hence:

$$\frac{\partial \upsilon_{pi}}{\partial g_{pi}} = \frac{-\alpha_{pi}}{\sum_{h=1}^{H_i}(e_{hi} + \omega_{hi})\left(1 - \frac{g_{pq}}{\sum_{h=1}^{H_i}(e_{hi} + \omega_{hi})}\right)} + \frac{\beta_{pi}}{g_{pi}} = 0 \quad \text{(A2)}$$

which leads to:

$$g^{\star}_{pq} = \left(\frac{\beta_{pq}}{\alpha_{pq} + \beta_{pq}}\right) \sum_{h=1}^{H_q}(e_{hq} + \omega_{hq}) \qquad \text{for} \qquad q = i, j \quad \text{(A3)}$$

Proposition 4
Proof

In this case, the parties' problem in locality i is:

$$\max \upsilon_{pi} = \alpha_{pi} \ln\left((e_{pi} + \omega_{pi})\left(1 - \frac{\tilde{g}_{pi}}{\sum_{h=1}^{H_i}(e_{hi} + \omega_{hi})}\right)\right) + \beta_{pi} \ln(\tilde{g}_{pi} + k_j\, \tilde{g}_{pj}) \quad \text{(A4)}$$

Hence:

$$\frac{\partial v_{pi}}{\partial \tilde{g}_{pi}} = \frac{-\alpha_{pi}}{\sum_{h=1}^{H_i}(e_{hi}+\omega_{hi})\left(1-\frac{\tilde{g}_{pi}}{\sum_{h=1}^{H_i}(e_{hi}+\omega_{hi})}\right)} + \frac{\beta_{pi}}{\tilde{g}_{pi}+k_j\,\tilde{g}_{pj}} = 0 \qquad \text{(A5)}$$

In the case of parties $p = L, R$ in locality j:

$$\frac{\partial v_{pj}}{\partial \tilde{g}_{pj}} = \frac{-\alpha_{pj}}{\sum_{h=1}^{H_j}(e_{hj}+\omega_{hj})\left(1-\frac{\tilde{g}_{pj}}{\sum_{h=1}^{H_j}(e_{hj}+\omega_{hj})}\right)} + \frac{\beta_{pj}}{\tilde{g}_{pj}+k_i\,\tilde{g}_{pi}} = 0 \qquad \text{(A6)}$$

Solve the system of equations (A5) and (A6) to find that the equilibrium size of government spending $\tilde{g}_{pq}$ for $p = L, R$ is given*:*

For locality i:

$$\tilde{g}_{pi} = \frac{\beta_{pi}\left(\sum_{h=1}^{H_i}e_{hi}+\sum_{h=1}^{H_i}\omega_{hi}\right)-k_j\,\alpha_{pi}\,\beta_{pj}\left(\sum_{h=1}^{H_j}e_{hj}+\sum_{h=1}^{H_j}\omega_{hj}\right)}{1-k_i\,k_j\,\alpha_{pi}\,\alpha_{pj}} \qquad \text{(A7)}$$

and for locality j:

$$\tilde{g}_{pj} = \frac{\beta_{pj}\left(\sum_{h=1}^{H_j}e_{hj}+\sum_{h=1}^{H_j}\omega_{hj}\right)-k_i\,\alpha_{pj}\,\beta_{pi}\left(\sum_{h=1}^{H_i}e_{hi}+\sum_{h=1}^{H_i}\omega_{hi}\right)}{1-k_j\,k_i\,\alpha_{pj}\,\alpha_{pi}} \qquad \text{(A8)}$$

Proposition 5
Proof

Use condition (A8) from proposition. Note that $k_j > 0, \alpha_{pi} > 0, 1 - k_i\,k_j\,\alpha_{pi}\,\alpha_{pj} > 0$, $\sum_{h=1}^{H_j}e_{hj}+\sum_{h=1}^{H_j}\omega_{hj} > 0$. Hence:

$$\frac{\partial \tilde{g}_{pi}}{\partial \beta_{pj}} = -\frac{k_j\,\alpha_{pi}\left(\sum_{h=1}^{H_j}e_{hj}+\sum_{h=1}^{H_j}\omega_{hj}\right)}{1-k_i\,k_j\,\alpha_{pi}\,\alpha_{pj}} < 0 \qquad \text{(A9)}$$

and for the case $\frac{\partial \tilde{g}_{pi}}{\partial \alpha_{pj}}$, it is satisfied that:

$$\frac{\partial \tilde{g}_{pi}}{\partial \alpha_{pj}} = -\frac{\tilde{g}_{pj}(k_i\, k_j\, \alpha_{pi})}{1 - k_j\, k_i\, \alpha_{pj}\, \alpha_{pi}} < 0 \tag{A10}$$

$$\frac{\partial \tilde{g}_{pi}}{\partial \alpha_{pj}} = \frac{\tilde{g}_{pj}(k_i\, k_j\, \alpha_{pi})}{1 - k_j\, k_i\, \alpha_{pj}\, \alpha_{pi}} > 0 \tag{A11}$$

and finally for the case of $\frac{\partial \tilde{g}_{pi}}{\partial k_j}$

$$\frac{\partial \tilde{g}_{pi}}{\partial k_j} = \frac{\tilde{g}_{pj}(k_i\, \alpha_{pj}\, \alpha_{pi}) - \alpha_{pi}\, \beta_{pj} \left(\sum_{h=1}^{H_j} e_{hj} + \sum_{h=1}^{H_j} \omega_{hj} \right)}{1 - k_i\, k_j\, \alpha_{pi}\, \alpha_{pj}} \gtrless 0 \tag{A12}$$

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Second-round effects of food prices on core inflation in Turkey

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Abstract

Turkey has recently experienced persistently high food inflation, among the highest in emerging markets, with food accounting for a significant proportion of consumer expenditures. This study investigates the second-round effects of food price shocks on core inflation using monthly data from January 2013 to June 2024 through a Bayesian Structural Vector Autoregressive (SBVAR) model. Incorporating domestic and international macroeconomic variables, the model identifies second-round effects by imposing theory-based constraints and leveraging Bayesian methods. Results reveal that core inflation reacts strongly to food price shocks, with rising food prices worsening inflation expectations and amplifying second-round effects on overall inflation. Historical decomposition reveals a more persistent impact of food price shocks on core inflation and expectations post-COVID-19. These findings underscore the importance of closely monitoring food price dynamics to safeguard price stability in Turkey, highlighting their critical role in shaping inflationary pressures.

Keywords

- food prices
- core inflation
- second-round effects
- Bayesian Structural VAR

JEL codes: C32, E31, E50, Q10

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Introduction

What drives inflation has always been a challenging question for both academics and policymakers, but as seen in many ways in the period after 2020, commodity price increases and fluctuations are among the major factors that destabilise countries' general price levels. In particular, the increase in food prices since the mid-2000s has been of particular importance due to the welfare impact of food and has put great pressure on the inflation rate and living standards of developing countries with fragile economies (Bhat et al., 2018; Durevall et al., 2013; Mishra & Kumar, 2021). Rising food prices not only have an impact on inflation, but also create uncertainty and lead to a surge in inflation expectations. This situation generates difficulties with regard to forecasting headline inflation and achieving inflation targets.

Commodity prices shocks giving rise to a hike in inflation expectations can have an impact on price and wage-setting behaviour and can create what is known in the economics literature as second-round price effects (Galesi & Lombardi, 2009; Rangasamy & Nel, 2014; Ruch, 2016). In other ways, second-round effects may be defined as the responses of wage and price determinants to the first-round effects caused by a price shock. The attempts of economic agents to satisfy the loss of real income brought about by past inflation shocks may have an impact on inflation expectations and the behaviour of price and wage setters. As a result, a temporary price shock can become entrenched and more costly to overcome. To illustrate this point, labour, whose purchasing power has been eroded by rising oil and food prices, may be able to leverage this in wage negotiations. Consequently, wage growth can result in elevated production costs and inflationary pressures (Cavallo, 2008).

The influence of food inflation on core inflation can be attributed to the interplay between elevated inflation expectations and labour demands for wage increases (Ianchovichina et al., 2014). The rise in food prices may lead to an increase in inflationary pressures and present a challenge to macroeconomic decision-making. The propagation of food price shocks to other sectors of the economy through various channels may lead to an increase in inflation expectations. Given the high proportion of food in the consumption basket in many countries and the potential for second-round effects, domestic food inflation may exert a prolonged influence on core inflation, particularly in countries with less resilient inflation expectations. Also, workers may seek higher wage increases to offset the decline in purchasing power resulting from elevated inflation expectations, thereby intensifying the inflationary pressure on the economy (Behera & Ranjan, 2024). In general, imbalances arising from food price shocks lead to imbalances that affect macroeconomic stability over the cost, expectations, and wage-price spiral channels. As long as these instabilities do not cause a second-round effect on core inflation in the economy,

they are not eliminated by central banks through monetary policy. However, the persistence of such shocks makes it inevitable for central banks to contain inflationary expectations and costs.

For many years, policymakers have debated the strength of monetary policy in moderating food price pressures in developed and developing markets, where rising food prices are known to have a significant direct inflationary impact (De Brauw, 2011; Galesi & Lombardi, 2009; Kidane & Woldemichael, 2020). Since the design of monetary policy is primarily concerned with addressing demand-side shocks to the economy, supply-side shocks often require the use of instruments that are not available to central banks. Studies, especially in advanced economies, have generally revealed that shocks arising from food and energy prices tend to be short-lived and do not distort inflation expectations (Simbanegavi & Palazzi, 2023). However, monetary policy can help minimise the second-round effects of food and energy prices in emerging market economies (EMEs). Inflation expectations that are well anchored through monetary policy reduce fluctuations in wage/cost adjustments and thus help to break wage-price spirals (Gelos & Ustyugova, 2017; Pattanaik et al., 2020).

Several factors, including market cyclicality, determine the likelihood of second-round effects from a commodity shock. These are economic, commodity, and labour market flexibility, inflation expectations, and, above all, central bank credibility (Alp et al., 2023; Apergis, 2024; Baba & Lee, 2022; Iliyasu & Sanusi, 2024). Specifically, central bank credibility helps to reduce volatility in price / wage adjustments by preventing speculation on inflation expectations. Countries with a higher degree of central bank independence and a higher governance score seem to be in a better position to lessen the effect of these shocks (Gelos & Ustyugova, 2017). Therefore, the determination of the second-round effects takes the part of a major role in terms of ensuring the success of the monetary policy and maintaining its credibility. It is possible that failing to consider the impact of a food price shock on future inflation may result in inflation diverging from the central bank's target, thereby undermining the effectiveness of central bank monetary policy (Ginn & Pourroy, 2020).

Given all these developments, the spillover outcomes of food price increases on overall price stability, which is of great importance for macroeconomic stability, are a valuable issue for analysis. This paper contributes to the related literature by investigating the dynamics and magnitude of the second-round effect of the transition from food prices to core inflation using the Bayesian Structural VAR (SBVAR) model, which considers domestic and external shocks on core inflation, using the period from January 2013 to June 2024 of Turkish monthly data. Although many papers have analysed the link between food prices and various macroeconomic variables, this study eliminates the lack of papers examining the second-round effect of food prices on core inflation

in Turkey by employing the Bayesian techniques. It also studies the effect of food prices on overall prices through core inflation and inflation expectations. Turkey is an interesting case in point, especially given the chronic nature of high food inflation, which has registered one of the highest inflation rates in emerging economies in recent years.[3] Thus, understanding the impact of food prices is important for the success of monetary policy, macroeconomic stability, and controlling the overall level of prices.

The rest of this study is organised in the following way. Section 1 gives the literature review about the second-round effect of food prices. Section 2 introduces data and methodology. Section 3 presents the findings of the Bayesian Structural VAR estimates and robustness check results. Finally, the last Section closes the study by including policy conclusions.

1. Literature review

The impact that price increases in commodities, particularly food and energy, have on core inflation and the wider economy has been the subject of extensive research, employing a range of methodologies and focusing on diverse geographical contexts. This study divides the literature into studies based on developed countries and in developing / underdeveloped countries. Nevertheless, the findings suggest that second-round effects are more prevalent in developing / underdeveloped countries than in developed countries, although the data and methods used differ.

The increasing weight of food prices in the consumption basket in developing and less developed countries has led to the emergence of an important area of research analysing the second-round effects of food price shocks, which have recently increased in these regions. For example, Anand et al. (2014), Holtemöller and Mallick (2016), Bhattacharya and Gupta (2018), Patnaik (2019), and Behera and Ranjan (2024) all show that food prices have a second-round effect on core inflation and headline inflation in India using different models. In their studies on South Africa, Rangasamy and Nel (2014), Ruch and Du Plessis (2015), and Simbanegavi and Palazzi (2023) demonstrate that food prices exert a second-round effect on core inflation, whereby both expectations and costs are implicated. Iliyasu and Sanusi (2024) demonstrate that increases in energy and food prices have a positive and persistent effect on core inflation in Nigeria. Demeke and Tenaw (2021) establish evidence of

[3] In the report prepared by the World Bank's Food Security, Turkey ranks fourth among the 10 countries with the highest food price inflation in the May-September period of 2023, after Venezuela, Lebanon, and Argentina.

second-round effects between food and non-food prices in Ethiopia, as well as the strong and persistent impact of food prices on inflation. Nachega et al. (2024) reveal that global and domestic food prices indicate the existence of second-round effects of food prices in Gambia. To assess the second-round effects on core inflation in the Moldovan economy, Mija et al. (2013) analyse how core inflation responds to developments in oil and food prices in international markets by employing the VAR model. These findings support the idea that oil and food price movements have second-round effects on core inflation. Similarly, Ginn and Pourroy (2020) show that an international food price shock lead to second-round effects on non-food inflation in Chile.

For developed countries, Lee (2009) shows that food prices in the US have a significant impact on current core inflation and help predict future core inflation. The study also shows that there is a second-round effect stemming from the food and energy prices. Peersman and Van Robays (2009) and Peersman (2022) reveals the existence of a second-round effect of food price commodity shocks in the euro area by raising wages and inflation expectations. Studies of the period of high inflation in advanced economies after COVID-19 point to the increasing existence of a second-round effect stemming from commodity prices. Baba and Lee (2022) show that oil shocks in Europe have a strong impact on wages and core inflation. Alp et al. (2023) show that oil price increases give rise to small but non-trivial second-round effects on inflation through pass-through to food and core prices in Canada, the United Kingdom, and the euro area. The study also forecasts that second-round effects will continue to play a role in the dynamics of inflation in the coming years as well. Anderl and Caporale (2024) show that for the country groups of the US, the UK, the euro area, Canada, Japan, South Korea, Mexico and Denmark, shocks stemming from global food price averages and volatilities have a persistent second-round effect on core inflation.

Nonetheless, some studies have indicated that the second-round effect of food and energy price increases on core inflation in advanced economies is either negligible or relatively weak. Wong (2015) investigates whether oil price shocks have a second-round effect in understanding inflation dynamics by using the inflation expectations of the Michigan Survey in the US. The findings show that the second-round effect of real oil price shocks on inflation is not very strong and disappeared after the 1990s. Šoškić (2015) reveals that in Serbia the initial food price shock has no meaningful second-round effects on headline inflation. Likewise, Castro et al. (2017) show that the increase in oil price has no significant effect on non-energy price in eurozone, Germany, France, Spain and Italy. Similarly, Enders and Enders (2017) analysed the existence of a second-round effect caused by oil prices for the euro area and Germany through the wage response. Their results show no strong evidence for second-round effects due to oil prices in the euro area or even in Germany. Similarly, Conflitti and Luciani (2019) show that oil price shock has a trivial ef-

fect on core prices in both the eurozone and the USA. However, even though the relatively limited influence of oil prices in the USA, the pass-through effect was observed to be persistent, with a duration exceeding four years.

Given the impact of food price shocks on the pricing behaviour of the economy, it is also important to examine the response of monetary policy management to these shocks separately. Ginn and Pourroy (2020), on central bank attitudes to food inflation in developing countries, show that food price inflation becomes an important factor in the formulation of monetary policy in Chile. The Chilean central bank adjusts monetary policy to mitigate the second-round effects of food price shocks on non-food inflation and raises the policy rate in response to food price shocks. Ginn and Pourroy (2022) also reveal that the Reserve Bank of India does not ignore food price inflation and that the share of food price inflation in the Taylor rule is nearly equal to the share of food price inflation in the CPI.

In conclusion, the literature reviewed reveals that the likelihood of second-round effects is higher in developing countries. However, Turkey is an appropriate case study for examining second-round effects because of the high share of food in the consumption basket in developing countries and the fact that Turkey is a country that has experienced high food and overall inflation in recent years.

2. Model, data and methodology

The vector autoregression (VAR) methodology is the usual approach employed in empirical macroeconomic studies for investigating simple linear, causal, and dynamic simultaneous relationships between time series variables and forecasts (Rooj & Kaushik, 2023; Sims, 1980). In this study, we analyse the dynamic link between food prices and core inflation in determining the second-round effect of food prices in Turkey through the inclusion of several control variables, such as an external price shock and domestic macroeconomic variables. Thus, the reaction mechanism between the endogenous variables in the model can be captured using the VAR framework.

Firstly, the benchmark reduced-form VAR model estimate is as follows:

$$Y_t = c + \sum_{i=1}^{n} b_i Y_{t-i} + e_t \qquad \text{where} \qquad t = 1, 2, \ldots, T \tag{1}$$

where c represents intercepts vector, Y_t shows the endogenous variables vector, b_i denotes the autoregressive coefficients matrix of the lagged values of Y_t, i demonstrates the number of lags in the model and e_t shows the residual

vectors. To determine whether the second-round effect of food price occurs, the reduced VAR model is converted to the structural model:

$$A_0 Y_t = B_0 + \sum_{i=1}^{n} B_i Y_{t-i} + u_i \quad (2)$$

where A_0 shows the structural matrix of contemporaneous impact, B_i's represents the structural coefficient matrices of the lagged values of Y_t, and u_t, refer to the structural shocks that are uncorrelated with each other:

$$e_t = A_0^{-1} u_t \quad (3)$$

In small sample sizes, the rich parameterisation of VARs can overfit the data, potentially resulting in inaccurate conclusions and predictions. The Bayesian estimation method is useful for avoiding such overfitting and it makes use of prior information to reduce the parameters of the model down to a parsimonious benchmark, which may lead to higher accurate estimates. While too much reduction will not allow the data to 'speak', too little shrinkage will not prevent over-fitting problems (Hanck & Prüser, 2020). The basic principle of Bayesian econometrics is to treat model coefficients as conditional probabilities, not fixed parameters with 'true' values. In this approach, each parameter is considered as a random variable with a probability distribution on which it is based. Bayesian analysis involves combining the economist's prior knowledge about the distribution of the variables (i.e. the prior) including the knowledge derived empirically from the data (i.e. likelihood) to produce the revised distribution (i.e. the posterior) (Dieppe et al., 2016). The over-parameterisation problem is solved by combining the likelihood and prior to obtaining the posterior distribution for the parameters. However, to avoid misspecification that may affect the posterior distribution, the choice of prior distributions must be made carefully (Rooj & Kaushik, 2023).

2.1. Data

This study estimates a SVAR model to detect the second-round effect of food prices on core inflation in Turkey. This study is based on a monthly data set covering the period from January 2013 to June 2024. The choice of starting year depends on the availability of data. The data used in the econometric analysis are as follows: Food and Agricultural Organisation's real food price index (*fao*), Real Effective Exchange Rate (*reer*), Food Price Inflation (*foodinf*) Core Inflation C[4] (*corecinf*), Weighted Average Cost of the CBRT Funding as in-

[4] There are six different consumer price index indicators for the CPIs with specified coverage produced by Turkstat. This study prefers to use CPI_C as the core inflation indicator, as it excludes energy, food and non-alcoholic beverages, alcoholic beverages, tobacco and gold.

terest rate and Expectation of 12 Months Ahead Annual CPI[5] (%) (*expect*). The FAO food price index is collected from the Food and Agricultural Organisation of the United Nations. The remaining data are obtained from the Electronic Data Documentary System (EDDS) of the Central Bank of the Republic of Turkey (CBRT). All series except for the interest rate are transformed into their natural logarithms. Furthermore, all variables are also seasonally adjusted in accordance with the X12 CENSUS multiplicative method.

Over the past decades, Turkey has experienced a period of high inflation, one of the causes of which is the high level of food prices. The direct outcome of food prices in determining the level of inflation is an issue that should be considered for the Turkish economy. The rise in food prices in Turkey complicates inflation forecasting and may hurt inflation expectations and public confidence in the central bank, all of which are crucial for the success of inflation targeting.

Figure 1 represents the major trends in food inflation, core inflation, and headline inflation in Turkey from January 2011 to June 2024. The food inflation rate was higher and more volatile than the headline inflation rate, especially after 2018. In the November of 2022, Core_C inflation, Headline inflation, and Food inflation reached 68.91%, 84.39%, and 102.04%, respectively, the highest levels in the last 15 years. The sharp increase in food prices is also linked to factors such as the depreciation of the Turkish Lira, the ongoing increases in international agricultural commodities and food prices, and the

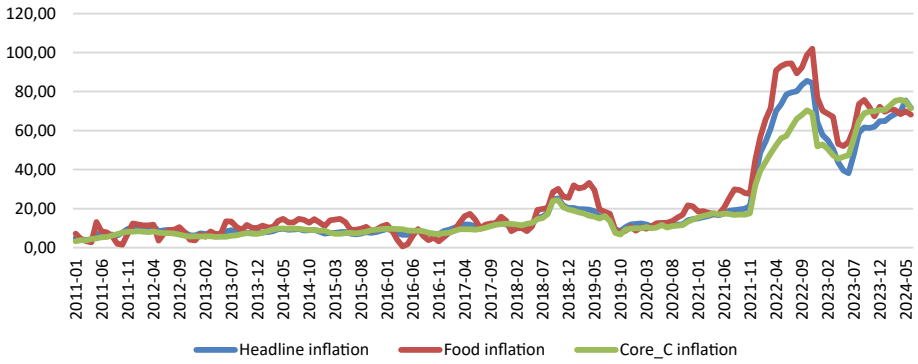

Figure 1. Monthly inflation trends in Turkey

Source: based on: (Central Bank of the Republic of Turkey, 2024).

[5] The CBRT provides the market participants survey-based data on expected inflation for Turkey, obtained from the Expectation Survey (ES) to monitor the expectations of decision makers and experts in the financial and real sectors regarding various macroeconomic variables. It is used as the 12-month ahead inflation expectation in CPI (%), in line with the studies of the Turkish economy, Bulut (2018), Alkan (2019), Gulsen and Kara (2020), and Koç et al. (2021).

agricultural drought (İnal et al., 2023). Price movements accelerated because of the COVID-19 pandemic, which caused disruptions in the supply chain and increased the cost and complexity of global food distribution.

The threat of global warming and climate change, as well as geopolitical risks, are considered among the driving forces behind the rise in food prices (Karagöl, 2023). Furthermore, the conflict between Ukraine and Russia, who are important food suppliers in the region, has brought reasonable humanitarian tragedy and political uncertainty to the global economy. As a neighbour and key regional actor, Turkey is vulnerable to market shocks due to its strong cooperation Ukraine and Russia, and its high dependence on agricultural imports from both (Ozturk & Faizi, 2023). It is worth noting the various causes responsible for food price inflation in Turkey, although the marked rise in food prices in 2022 can largely be attributed to the Russia–Ukraine conflict.[6] There is a noticeable decline in early 2023, but food prices begin to rise again in the final months of 2023. Although core inflation, headline inflation, and food price inflation have shown a significant increase recently, the rise in food prices is observed to put pressure on inflation. One reason for this is that the share of households' expenditures on food and non-alcoholic beverages in the consumption basket increased from 21.7% in 2017 to 25.4% in 2023. Hence, the price movement in this item of products has a dominant influence on the fluctuations in the general price level.

2.2. Identification of structural shocks

Structural shocks are defined using the Cholesky decomposition of the covariance matrix of the errors. The Cholesky decomposition is widely used by macroeconomic researchers, due to its simplicity and clear interpretation (Bańbura et al., 2015; Rooj & Kaushik, 2023; Urlichs, 2018). Using triangular factorisation, a recursive ordering is used to describe structural shocks. With regard to the ordering of the variables in the VAR, the general principle is that most exogenous (endogenous) variables are set first (last), and the ordering also takes into account whether the variable is fast responding or not (Doojav et al., 2024).

The model estimated is constructed to reveal a causality from food prices to core inflation, in order to show the existence of second-round effects of food prices on core inflation in Turkey. The sequence of structural shocks, and hence their impact on the other endogenous variables, can be determined from the initial order of variables in the model. This means that *fao* comes

[6] For more studies on the determinants of food prices, see Yıldırım (2021), Kutlu (2021), Orkun-Oral et al. (2023), and Inal et al. (2023).

first, followed by *reer*, *interest*, *foodinf*, *lnexpect* and *corecinf*. According to the Cholesky definition, external food price is not simultaneously influenced by any domestic variable shocks by assuming that food prices in the global economy are less influenced by how the Turkish economy and commodity markets perform. Consistent with the existing literature, i.e. Al-Shawarby and Selim (2013), Rangasamy and Nel (2014), Holtemöller and Mallick (2016), and Iliyasu and Sanusi (2024), the effect of food price shocks on core inflation is examined to evaluate whether there are long-lasting second-round effects of the initial shocks. The real effective exchange rate (*reer*) responds simultaneously only to global food prices. The interest rate (*interest*) is simultaneously affected by FAO food prices and the real effective exchange rate. Domestic food prices (*foodinf*) respond simultaneously to all variables except inflation expectation and core inflation. Inflation expectation (*expect*) responds simultaneously to all variables in the model except the core inflation. Finally, core inflation (*corecinf*) responds simultaneously to all variables in the model. The results are an illustration of the effect of a food price disturbance on core inflation and whether the second-round effect is realised. Moreover, it allows the second-round effects of food prices through the inflation expectations channel in Turkey to be analysed. The following constraints are implied by the order of the variables in the above formation:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} u^{fao} \\ u^{reer} \\ u^{interest} \\ u^{foodinf} \\ u^{expect} \\ u^{corecinf} \end{bmatrix} \begin{bmatrix} \beta_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & \beta_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & \beta_{66} \end{bmatrix} \begin{bmatrix} \varepsilon^{fao} \\ \varepsilon^{reer} \\ \varepsilon^{interest} \\ \varepsilon^{foodinf} \\ \varepsilon^{expect} \\ \varepsilon^{corecinf} \end{bmatrix}$$

In this study, the lag length of the VAR model estimate is determined using the Deviance Information Criterion (DIC). The DIC is a popular model selection criterion in Bayesian estimation because it resembles the Akaike Information Criterion (AIC), widely used in frequentist inference (Andres-Escayola et al., 2023). DIC is also an indicator that incorporates the fit and complexity of fitted Bayesian models to optimise the behaviour of the residual error term.

2.3. Prior selection and hyperparameters

Another important step in Bayesian VAR analysis is prior selection. Estimating in small sample Bayesian models is very responsive to the prior

distribution. For this reason, this study selects the common hyperparameters of the prior distributions to overcome the problems. Since there is no previous study analysing the economic outcomes of food price shocks in Turkey using the Bayesian method, there are no existing priors to be used in this study. Therefore, in the SBVAR model estimated in this study, multiple priors are selected according to the Minnesota, Normal-Normal-Wishart, and Independent Normal-Wishart methods. However, the results obtained do not show a significant difference.

The model is estimated by means of the BEAR (Bayesian Estimation, Analysis and Regression) tool in MATLAB, prepared by Dieppe et al. (2016), with a 2 lag. The default values for the hyperparameters in the BEAR Toolbox are the common values from the Turkish studies for the calculation of the mean and the variance of the prior distribution for the VAR coefficients (Çelik & Oğuş-Binatlı, 2022). The autoregressive coefficient (δ_i) is 0.8, overall tightness (λ_1) is 0.1, cross-variable weighting (λ_2) is 0.5, lag decay (λ_3) is 2, and exogenous variable tightness (λ_4) has the value 100. The total number of Gibbs sampling iterations is set to 10,000, with 5,000 discarded as burn-in iterations to obtain impulse response functions.

3. Empirical findings

3.1. Impulse response functions

This study seeks to identify the consequences of food price shocks on core inflation and inflation expectations through impulse response functions (IRFs) analysis. The study principally investigates how core inflation and inflation expectations respond to food price shocks. To this end, Figure 2 displays the impulse responses from the Bayesian SVAR estimation. The regular blue solid line demonstrates the median responses of the relevant variables to the shocking events in the model, and the corresponding shaded area shows the 68% credible interval of the response. The credibility intervals are only meant to summarize the distribution of impulse responses to a given shock (Büyükbaşaran et al., 2020). The horizontal axis shows the time or period after the first effect of the shocks, while the vertical axis demonstrates the size of the reaction to the explained shocks.

The IRFs in the sixth row of Figure 2 show the response of core inflation to the other variables in the model. There is a significant and long-lasting response of core inflation to a positive FAO food price shock. The impact of higher external food prices is transmitted to stronger inflation by means of the supply-side channel. Also, the rise in the prices of international commod-

ity goods such as food and oil prices contribute to the rise in core inflation by increasing inflation expectations. This is consistent with the findings of Khan and Ahmed (2014), Holtemöller and Mallick (2016), Köse and Ünal (2021), and Alp et al. (2023), who claimed that core inflations are mostly very sensitive to developments in commodity prices. These findings seem to be consistent for the Turkish economy, given the country's dependence on external commodities and derivative products used as an important component of manufacturing and service industries.

A shock in domestic food prices gives rise to a positive and statistically significant impact on core inflation, which lasts approximately five months. These findings indicate that external and domestic food price shocks confirm the existence of second-round effects on core inflation in Turkey. These findings are similar to those of Mija et al. (2013) for Moldova, Ruch and Du Plessis (2015) for South Africa, Bawa et al. (2020), Iliyasu and Sanusi (2024) for Nigeria, and Anderl and Caporale (2024) for most developed countries. To put it another way, food inflation plays an important role in the main inflationary pressures in the economy. This may occur when foods become inputs for producing other goods. In addition, many foods are intermediate inputs in the production of other goods whose prices are included in core inflation, such as starch used in biodegradable plastics or natural fibres

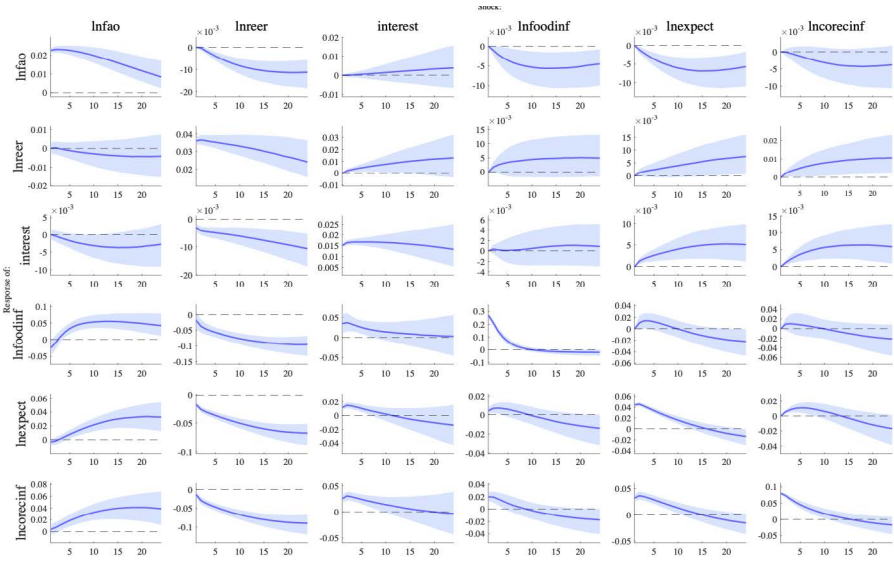

Figure 2. The impulse response functions of shocks to variables

Note: The *y*-axis represents the percentage change by cause of a one standard deviation shock in the variable, since the model variables are defined in terms of natural logs, except for interest rate. The BVAR is estimated with a normal-Wishart prior.

Source: own work.

used in textiles and construction; these lead to a rise in the overall production costs for companies, which are then reflected on to consumers prices (Anderl & Caporale, 2024).

A food inflation shock gives rise to a positive and statistically significant impact on inflation expectations. This shows that the second-round effect on the economy is realized through the expectations channel. Food prices exert a broad impact on the economy through their effect on intermediate input prices and inflation expectations. Food inflation, leading to higher inflation expectations, influences price-setting behaviour and second-round price effects. Second-round effects are observed in developing countries due to food constituting a large part of household expenditures, less stabilized expectations, and persistent supply shocks.

The IRFs also show that the of inflation expectation shock on core inflation is positive and lasts 10 months. According to Wong (2015), for the second-round effect to occur, it is not enough for an oil price shock to raise inflation expectations: this increase should also be reflected in inflation. The formation of high inflation expectations is reflected in core inflation through the realisation of price setting and wage bargaining in the presence of second-round effects. The consensus among economists is that inflation expectations create inflationary pressures as businesses and consumers incorporate them into their forward-looking pricing behaviour (United Nations, 2023). Such increases in inflation expectations could also lead to persistently higher inflation via second-round effects. Furthermore, the second-round effect pertains to the increase in inflation through labour force demands for higher wages to maintain the existing standards (Bhat et al., 2018). Because of the non-negligible division of food in consumption expenditures, food price inflation is the primary determinant of headline inflation. It forms the basis not only for prevailing inflation but also for future inflation and wage negotiations via expectations. This is confirmed by the following studies: Ferrucci et al. (2010), Walsh (2011), De Gregorio (2012), Mija et al. (2013), Rangasamy and Nel (2014), Misati and Munene (2015), Bhat et al. (2018), Patnaik (2019), Shahzad et al. (2022), Anderl and Caporale (2024), and Iliyasu and Salusi (2024).

Normally, the emergence of second-round effects is expected to follow a time lag. However, in economies with heightened inflation expectations and disrupted pricing behaviour, such as Turkey, these effects can manifest contemporaneously. In such high-inflation contexts, where inflation expectations and pricing mechanisms are severely distorted, core inflation may respond immediately to surges in food prices (Kara & Sarıkaya, 2024). This phenomenon can be explained by two primary channels. Firstly, the Expectations Channel: In a country where food prices constitute a significant portion of consumer expenditures (Turkey is a suitable country with approximately 25% food expenditure in the CPI), an increase in food prices can

swiftly impact inflation expectations. Businesses and consumers, sensitive to these expectations, often adjust non-food prices concurrently, eliminating the usual lag and generating a contemporaneous second-round effect. Secondly, the Cost Pass-Through Channel: The transmission of increased input costs to broader consumer prices can occur almost instantly, especially when supply chains are tightly interconnected, as observed in the post-COVID-19 period (Aktug & Akarsu, 2024; Algieri et al., 2024). These rapid adjustments collectively lead to a simultaneity in the responses of food and core inflation, suggesting that under these conditions, a contemporaneous second-round effect is plausible.

The influence of the real effective exchange rate on core inflation is positive and statistically significant in the long run. The stabilization or reduced depreciation of the national currency helps curb inflationary pressures in Turkey. On the contrary, the depreciation of the national currency causes inflation to spiral out of control. The findings present a strong exchange rate pass-through effect (EPRE) mechanism of domestic currency depreciation directly to the core inflation rate. This EPRE mechanism has been approved through many recent papers in the Turkish economy (Gayaker et al., 2021; Karaoğlu & Demirel, 2021; Tetik & Yıldırım, 2021; Ulug et al., 2023).

An increase in the policy rate causes all interest rates in the market to move upwards. Accordingly, in the short term this leads to an increase in the cost of borrowing and a rise in core inflation. Some of the recent studies on Turkey show that a rise in interest rates has an impact on inflation. Tayyar (2019), Sümer (2020), Şeker and Demirel (2022) and Akça (2023) show that a hike in nominal interest rates increases inflation. This result implies that long-term high interest rates in Turkey have inflationary effects by increasing inflation expectations.

3.2. Forecast error variance decomposition (FEVD)

The IRFs do not demonstrate the effect of these shocks in the variation of core inflation, although they do provide information on the effect of food price shocks on core inflation. In contrast, the FEVDs for the identified shocks in the model show how much variation is described by each shock. The FEVDs represent the importance of the intended shock on the variables. For the variance decomposition of the variables in the model, 1-, 6-, 12-, and 24-month forecast horizons are considered.

Table 1 reports the share of the variance for the core inflation shock (*lncorecinf*) explained by FAO food price shock (*lnfao*), real effective exchange rate shock (*lnreer*), interest rate shock (*interest*), food price inflation shock (*lnfoodinf*), inflation expectation shock (*lnexpect*) and its own shocks. Two impor-

tant shocks explain the variation in core inflation in the first month: inflation expectation (11.48%) and interest rate (7.57%). In the short 6-month period, shocks to the real exchange rate (20%), inflation expectations (13.23%) and interest rates (9.90%) are the source of variance in core inflation. The analysis findings demonstrate that looking at the one-year period, after the real exchange rate shock (40.99%), the global food price shock (9.36%), the inflation expectation shock (8.72%) and the interest rate shock (7.38%) explain the changes in core inflation. In the long run (24 months), real exchange rate and FAO food price shocks explain 57.39% and 13.32% of the variation in changes in core inflation, respectively. Then, 14.90% of changes in core inflation are explained by its own shocks.

Table 1. FEVD analysis of core inflation

Period	*lnfao*	*lnreer*	*interest*	*lnfoodinf*	*lnexpect*	*lncorecinf*
1	1.16	1.30	7.57	4.40	11.48	74.06
6	3.07	20.01	9.90	3.57	13.23	50.18
12	9.36	40.99	7.38	3.06	8.72	30.46
24	13.32	57.39	5.92	3.33	5.11	14.90

Source: own estimates.

In our empirical findings, it is crucial to differentiate between the roles of Forecast Error Variance Decomposition (FEVD) and Impulse Response Function (IRF) analyses, as both contribute unique insights to the relationship between food prices and core inflation. The FEVD analysis quantifies the extent to which variations in core inflation can be attributed to shocks in food prices over different time horizons. While the results show that food inflation explains only a modest share of the overall variation in core inflation, this reflects the multifaceted nature of core inflation, which is influenced by a variety of macroeconomic factors beyond food prices alone. Conversely, the IRF analysis is designed to illustrate the dynamic response of core inflation to an initial shock in food prices. This approach captures the immediate and potentially sustained impact of such shocks, emphasizing how they can create significant second-round effects through channels like inflation expectations and cost pass-through. Thus, while the FEVD provides an overview of the proportional influence of food price shocks, the IRF analysis reveals the mechanism and timing of their impact, highlighting the meaningful role food price fluctuations play in the formation of core inflation.

3.3. Historical decomposition

Figure 3 shows the historical decomposition of core inflation, indicating the relative contribution of other structural shocks over the estimation period from January 2013 to June 2024. From a different perspective, historical decomposition graphs can be used to examine which periods of food price shocks provide more explanation of the behaviour of core inflation. After the pandemic, core inflation increased by a higher rate than can be explained by the identified shocks, which confirms the abnormal nature of this episode. However, it can be inferred that historical decompositions of core inflation confirm the findings of the baseline model. As explained in the previous section, food price shocks and exchange rate shocks are also an important source of fluctuations in core inflation.

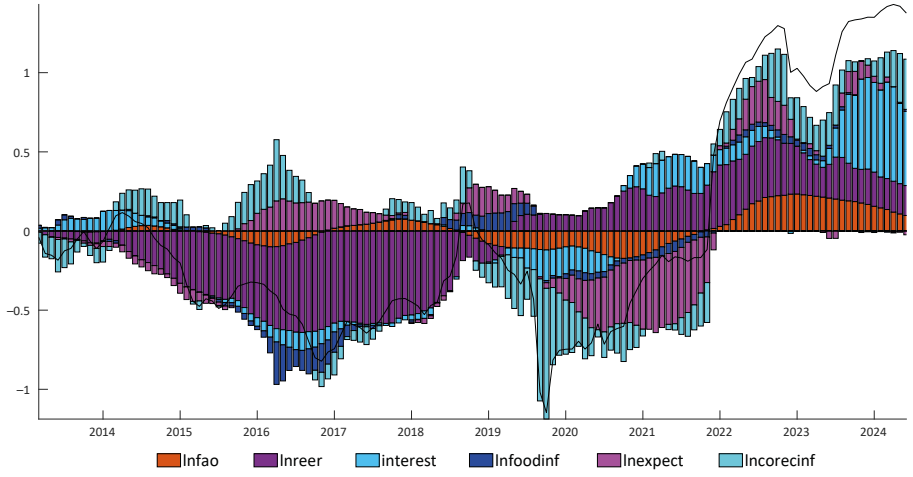

Figure 3. Historical decomposition of core inflation

Source: own work.

Furthermore, the impact of commodity price fluctuations, such as those of oil and food prices, on inflation is more pronounced when there is a lack of credibility in the monetary policy framework. It is therefore evident that if the central bank has established credibility in consistently achieving inflation targets, the size of the second-round effects from food prices will be more moderate (Baba & Lee, 2022; Behera & Ranjan, 2024). Central bank credibility fosters the formation of stable expectations among economic agents, thereby reducing the probability of excessive reactions to policy adjustments. A central bank with greater credibility will result in less sensitivity to shocks, as well as weaker second-round effects of commodity shocks on wages and inflation

(Bems et al., 2018). The credibility of the CBRT, which has been the subject of recent discussion, reinforces the direct (exchange rate pass-through, EPRT) and indirect effects of commodity prices on the overall economy (Gayaker et al., 2021).

3.4. Robustness checks

This section briefly provides robustness checks of the results by estimating the baseline model with the addition of various variables and with the use of different priors. Following Anderl and Caporale (2024) and Iliyasu and Sanusi (2024), the nominal FAO food prices, nominal exchange rates and real money supply are first replaced as new variables in the model. Secondly, the baseline model is estimated using different prior parameters, such as Independent Normal Wishart.

The IRF findings are reported in Figure A1 and A2, respectively, in the Appendix of the study. The results under different specifications, alternative variables and priors are consistent with the baseline results. No significant change in the results was observed after the robustness checks. According to the findings of robustness estimation, there is a second-round effect of food prices shocks on core inflation in Turkey

Conclusions and policy recommendation

This study explores the existence of the second-round effect of food prices on core inflation by using the SBVAR model for the Turkish economy throughout January 2013 and June 2024. The model is analysed using impulse responses, variance decompositions, and historical decomposition tools to reveal the presence of the second-round effect on core inflation.

Historically, food inflation has been a significant determinant of inflation expectations. This is due to its relatively lower volatility compared to energy inflation, as well as its substantial impact on household expenditures. Given that Turkey is among the countries with the highest inflation and food price inflation worldwide, an examination of the influence of food prices on core inflation via the inflation expectations channel represents a significant motivation for this study.

The results from the IRFs reveal that core inflation responds positively and strongly to domestic and external food price shocks. Furthermore, the impact of food price shocks on inflation expectations also appears to be signif-

icant and persistent. When these two effects are considered together, it can be seen that the second-round effect of food prices emerges and the inflationary pressure from the food price shock is transmitted to core inflation via the inflation expectations channel. Historical decomposition findings reveal that the effects of food price shocks on core inflation have been more persistent since the COVID-19 period. These findings indicate that food prices have become a much more important component of overall inflation over recent years through inflation expectation channel. The development of food prices has been an important factor in generating inflationary episodes in Turkey and in the rise in inflation expectations.

These findings have important implications for policymakers. The results of this paper show that it is essential to keep food price movements under control to maintain price stability in Turkey. Hence, monetary policy needs to follow food prices closely. Ignorance of food price movements may lead to a misleading picture of underlying inflationary pressures and an inappropriate monetary policy response. Second-round effects may become persistent through two potential channels: higher inflation expectations or price / wage increases by firms / labour. Both of these scenarios are crucial for central banks to ensure price stability. By establishing a robust anchor for inflation expectations, monetary policy can assist in preventing a wage-price spiral and mitigating the second-round effects of supply shocks. This would help to circumvent an unfavourable macroeconomic outlook of lower growth and higher inflation. This calls for a renewed and vital role for the Central Bank of the Republic of Turkey in anchoring households' inflation expectations through effective communication and transparency. Finally, in the management of a central bank such as the Central Bank of the Republic of Turkey, which has failed for years to achieve its inflation target and to manage expectations, the emergence of strong and persistent second-round effects in commodity prices may be an important universal lesson for failed monetary policy implementations.

Appendix

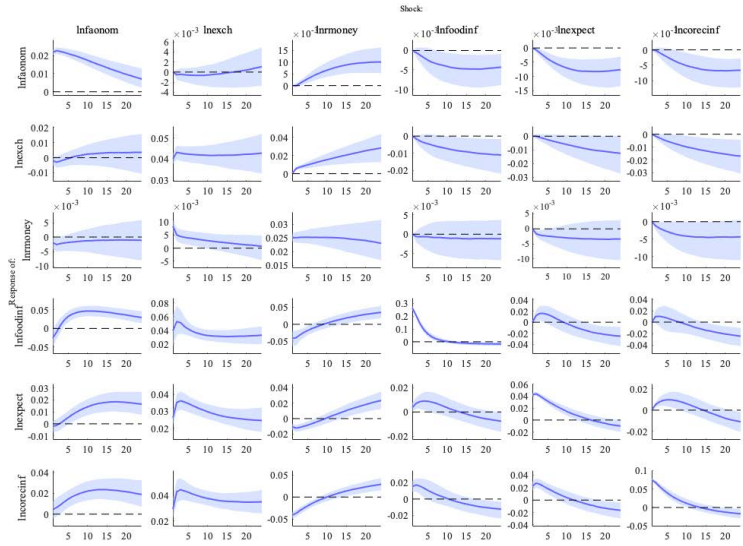

Figure A1. Robustness checks-1: IRFs to alternative VAR model

Source: own work.

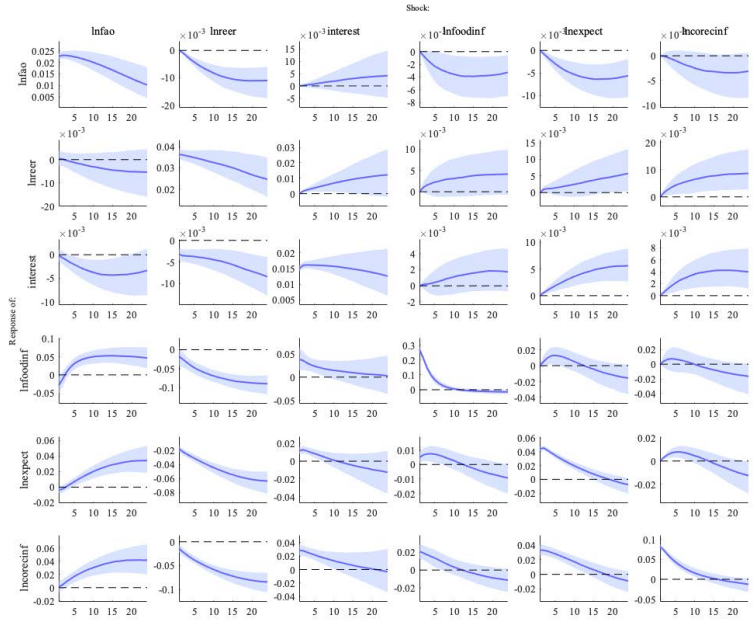

Figure A2. Robustness checks-2: IRFs to alternative prior (Independent Normal Wishart)

Source: own work.

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Analysis of the impact of financial inclusion and FinTech on youth labour force participation in the MENA region

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Abstract

This study examines the determinants of financial inclusion and FinTech, and then evaluates their effects on youth labour force participation in the MENA region. The World Bank's Global Findex 2021 database was used to perform probit estimations and propensity score matching. The results show that young people with higher education levels, higher incomes, mobile phones and Internet access are more likely to be included in the traditional and digital financial systems. In addition, barriers to financial inclusion encompass a lack of documentation, religious constraints and the costs associated with financial services. Furthermore, examining the effect of financial inclusion and FinTech reveals that having formal bank accounts and mobile money accounts, as well as savings, formal loans, and digital transactions, has a significant impact on young people's participation in the labour force.

Keywords

- financial inclusion
- FinTech
- labour force
- propensity score matching
- MENA

JEL codes: G50, J21, N2

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Introduction

Youth is a pivotal stage in an individual's life, where they begin shaping their future and establishing their role in society (Sykes et al., 2016). Particular attention must be given to young people, as they are the builders of tomorrow, an essential component of the global workforce, but also a natural resource that requires investment (Bessant & Cook, 1998). Youth participation in the labour market is not only critical for their personal growth but also for driving economic prosperity (Aslan, 2019). However, the persistent lack of decent job opportunities, exacerbated by rapid population growth in developing countries, creates an urgent need for sustainable economic solutions (ILO, 2024). This challenge is further intensified by the global nature of youth unemployment, which continues to be a widespread and entrenched crisis (Denny & Churchill, 2016). Addressing this issue is essential, as providing meaningful employment opportunities for young people is key to fostering both individual empowerment and broader economic development.

The GET for Youth 2024 report indicates that despite a decline in the youth unemployment rate to 13% in 2023, nearly 20.4% of young people worldwide are classified as NEET (neither in employment, education, nor training). Additionally, the report highlights that the Arab States and North Africa are among the most affected regions, with over one in three economically active young people being unemployed in 2023, illustrating the magnitude of the challenges, especially in low-income countries. This shows that despite efforts to promote a linear transition of young people into the labour market from school to work, the reality is that this transition is far from linear, due to challenges and barriers that make their trajectory less predictable and more complex than policies assume (Denny & Churchill, 2016).

Financial inclusion has attracted increasing attention from international organisations and policymakers in recent years. It has become a priority for achieving the Sustainable Development Goals (Shen et al., 2023) and a catalyst for inclusive growth and socioeconomic development, particularly in developing countries (Niaz, 2021). Several studies have highlighted financial inclusion as an effective mechanism for combating youth unemployment and vulnerability, primarily by fostering entrepreneurship and creating work opportunities for the young (Claessens & Perotti, 2007; Elouaourti & Ibourk, 2024a). Financial inclusion is thus seen as a critical tool for unlocking the potential of young people to drive sustainable transformation and inclusive development (Wilson, 2021).

In addition, the digitalisation of financial services has emerged as a powerful lever for extending access to financial services to hitherto underserved groups, such as women and youth (Elouaourti & Ibourk, 2024a). This digital shift facilitates the integration of the informal economy and contributes to

poverty reduction by creating new opportunities for economic empowerment (Elouaourti & Ibourk, 2024b; Xu et al., 2023).

The impact of financial inclusion and FinTech on youth participation in the labour market has, to our knowledge, not been sufficiently explored in the Middle East and North Africa (MENA)[3] region. This study aims to fill this gap by providing new empirical evidence on how access to financial services and digital financial technologies influences youth engagement in the labour market.

Interest in this subject arises from the fact that the MENA region, notably its lower-income countries, continues to experience high unemployment rates, with an overall rate of around 12% of the total labour force and 28% among those aged 15 to 24 (World Bank Database, 2021). This highlights the persistent barriers to youth participation in the labour market. Despite some progress in financial inclusion within the MENA region, marked by a 9% increase in formal account ownership, a 3% rise in formal savings, and a 15% growth in formal credit, alongside a 20% boost in digital transactions and a marginal 1% increase in mobile money accounts in 2021 compared to 2017 (World Bank Group, 2021), these levels remain relatively low compared to regions such as Latin America and the Caribbean, Emerging Asia, and Emerging Europe (Ndoye & Barajas, 2022). The situation for young people in the MENA region is particularly concerning, with only 33% of those aged 15–24 holding a bank account and just 7% owning a mobile money account (World Bank Group, 2021).

The contribution of this research lies in its focus on youth, a group largely underrepresented in previous studies on financial inclusion in the MENA region, and in its examination of the role of FinTech in facilitating economic participation. Thus, this study provides valuable insights that can inform policy interventions aimed at promoting youth employment and economic empowerment.

In this regard, to address our research question, Section 1 begins with a review of the literature. Section 2 then presents the data and methodology used in the study. Section 3 is devoted to the results, and the final section provides the conclusions.

1. Literature review

It is increasingly recognised that access to financial services can facilitate the transition to employment and greater economic security by facilitating entrepreneurship, savings, investment in education, training, and access to credit to

[3] Middle East and North Africa (MENA) include: Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malta, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, Palestine, and Yemen.

start a business (Banerjee et al., 2015) or to finance income-generating activities (Lyons & Contreras, 2017). Thus, this literature review aims to examine previous work analysing the determinants of access to, and use of, traditional and digital financial services and their effects on youth labour market participation.

1.1. Determinants of youth financial inclusion and access to FinTech

There is no universally agreed international definition of financial inclusion. However, it is generally accepted that financial inclusion is a multidimensional concept that encompasses access, use, availability and quality of financial products and services (Cámara & Tuesta, 2014). These services are essential for promoting economic development, reducing poverty, and improving resilience to financial shocks. Moreover, in light of technological evolution and innovation, the financial sector has responded to this dynamic by giving rise to digital financial services and Financial Technology (FinTech). Digital financial services encompass financial services, products and infrastructure accessed and delivered via digital platforms and mobile apps, and they are typically offered by FinTech companies and innovative financial service providers (Ozili, 2018).

Young people often encounter various barriers when seeking to access formal financial services. These obstacles include regulatory and policy constraints, such as age restrictions for opening accounts and stringent identification requirements, as well as minimum balance requirements imposed by banks (Babajić et al., 2018). Chowa et al. (2015) emphasise that a supportive regulatory environment is essential to ensure the widespread availability of youth products in formal financial institutions. Also, Ndungu and Moturi (2020) indicate that factors such organisational size, resource availability, and the regulatory environment significantly influence the adoption of mobile FinTech. Furthermore, high service costs deter young people from engaging with financial institutions (Iyambo, 2020). The geographical distance of financial institutions, particularly in rural areas where banking infrastructure is limited or non-existent, exacerbates this issue (Mossie, 2022). Addressing these barriers is crucial for promoting broader financial inclusion and FinTech access among young people, thereby enhancing their economic empowerment and resilience (Asuming et al., 2018).

On the demand side, several sociodemographic, psychological, cultural and religious factors influence young people's access to formal and digital financial system. According to Zins and Weill (2016), older men with higher levels of education and income are more likely to benefit from financial inclusion. Koloma (2021) finds that financial inclusion of youth in Mali is facilitated by factors such as stable employment, higher education level and high-income

levels. Other findings also indicate that being in the labour market and having a high level of education in Tanzania increases youth's chances of holding a current account or savings account with a formal financial institution (Kazungu & Njau, 2023). In addition, inequality in access to FinTech is also explained by sociodemographic factors such as gender, age, education and income (Elouardighi & Oubejja, 2023; Zins & Weill, 2016). Psychological factors, including trust in financial institutions and risk perception, also play a significant role. Some young people may choose not to engage with formal financial services because a family member already holds an account or due to insufficient funds (Babajić et al., 2018). Additionally, perceptions of hidden fees and a lack of transparency contribute to self-exclusion. Cultural and religious norms can also influence access to the formal financial system. For example, 18% of those excluded from the financial system in Jordan cite religious reasons for not having a bank account, highlighting the need for Islamic banking solutions (MED Confederation, 2021).

Financial literacy is a crucial determinant of financial inclusion. Williams and Oumlil (2015) indicate that students are often excluded from the formal financial sector due to a lack of financial knowledge, highlighting the need for improved educational initiatives. Sakanko et al. (2023) advocate for the integration of financial literacy into school curricula to encourage broader use of financial services, especially digital ones. Berguiga and Adair (2023) demonstrate that educating young people about financial products and services is critical for their engagement with FinTech. Fanta and Mutsonziwa (2021) confirm that financial literacy is a powerful driver of inclusion, enabling young people to understand and use FinTech services better.

The availability of technology and internet infrastructure is, in turn, essential for promoting financial inclusion and access to FinTech (Ndungu & Moturi, 2020). Bekele (2022) highlights that access to mobile phones and internet services plays a significant role in expanding financial inclusion in countries such as Kenya and Ethiopia. Furthermore, Vangvaidi (2024) points out that digital infrastructure remains one of the most important factors for fostering financial inclusion. The proliferation of mobile phones in Africa has made financial services more accessible, reducing geographical and economic barriers to traditional financial inclusion and also to digital financial inclusion for young people (Elouaourti & Ibourk, 2024a).

1.2. Financial inclusion, FinTech access and youth participation in the labour market

Young people are a valuable workforce for various occupational sectors, thanks to their mobility, mental agility and digital skills. However, the devel-

opment of this workforce depends not only on socio-demographic factors such as race, gender, place of residence and level of education, geographical characteristics, and infrastructural factors, but also on the financial system of a given territory. These factors influence youth decisions and labour market participation (Alikperova et al., 2019).

Financial inclusion allows young people to invest in their education, skills development, start businesses activities (Kazungu & Njau, 2023), and manage their finances effectively (OECD, 2020). As young people enter the labour market, their engagement with financial institutions can have a significant impact on their employment prospects (Sykes et al., 2016). They also help reduce the gender income gap (Kede Ndouna & Zogning, 2022) and strengthen the economic empowerment of individuals and businesses (Elouaourti & Ibourk, 2024a). Additionally, employees typically need a bank account to receive wages, as employers prefer direct deposit as a way of ensuring transaction security and traceability (Leyshon & Thrift, 1995). Therefore, addressing financial exclusion has become increasingly essential in promoting economic participation and security.

Furthermore, according to Lyons and Contreras (2017), financial inclusion helps young people create their own jobs when they cannot find work through traditional means. Cho and Honorati (2014) conducted a meta-regression on youth entrepreneurship programmes in developing countries, highlighting credit constraints as a significant barrier preventing young people from starting income-generating activities. Similarly, a randomised evaluation of a group-lending microcredit programme in Hyderabad, India found that while microcredit uptake increased by 8.4 percentage points, the impact on household outcomes varied. Investments and profits from existing small businesses rose, but overall household consumption did not show significant change (Banerjee et al., 2015). Alongside these findings, others have suggested that financial exclusion, particularly among young people, restricts opportunities for successful entrepreneurship (Markel & Panetta, 2014).

Several studies have suggested that access to financial services via digital platforms can promote economic participation, entrepreneurship and investment. Izzo et al. (2022) indicate that the FinTech sector has benefited most from the digital revolution and that, if managed properly, it can provide significant advantages in terms of employment, particularly for the youth population, and foster greater financial inclusion worldwide. Other authors have revealed that young Nigerians have benefited from virtual currencies (Bitcoin) to create jobs and generate wealth (Onyekwere et al., 2023). Koomson et al. (2022) find that mobile money significantly enhances entrepreneurship, particularly among young people. Alongside these findings, Sesabo and Mkuna (2024) suggest that improving the well-being of this group requires strengthening capabilities related to mobile financial services, as well as training, awareness-raising, and access to financial resources.

However, other authors have reported findings indicating a negative impact of financial inclusion on employment. For instance, Arcand et al. (2013) revealed that MEDA's Youth Invest initiative in Morocco, aimed at enhancing youth skills, financial literacy, and facilitating the opening of formal savings accounts, negatively impacted employment outcomes. Similarly, Grimm and Paffhausen (2015) found that microcredits were not an effective tool for job creation across 54 countries, primarily in Latin America, because most microfinance programmes focused more on stabilising incomes than on generating new employment opportunities.

Conversely, while financial inclusion influences youth participation in the labour market, it is important to acknowledge the potential for reverse causality (Lyons & Contreras, 2017). Indeed, while financial inclusion can promote youth labour market participation by providing the necessary resources for skills development, job search, or entrepreneurship, it is equally plausible that young individuals already active in the labour market may have better access to financial services due to their employment status (Berguiga & Adair, 2023). Young people in work are more likely to engage with formal financial systems. However, the analysis by Lyons and Contreras (2017) examining the relationship between entrepreneurship and financial inclusion among young people revealed that the direction of causality is more likely to flow from financial inclusion to entrepreneurial spirit, rather than the reverse. This bidirectional relationship underscores the importance of creating supportive financial ecosystems that enable youth to actively participate and facilitate their integration into the labour market. In the long term, this contributes to sustainable economic growth and poverty reduction (Demirgüç-Kunt & Singer, 2017).

Given these mixed results, this study aims to evaluate the impact of different dimensions of financial inclusion and FinTech access on youth labour force participation in the MENA region. The objective is to determine how these financial tools and services contribute to improving youth employability and economic integration within the region.

2. Data and methodology

2.1. Data and variables

This study aims to examine the determinants of youth inclusion in formal and digital financial systems and assess their causal effect on youth labour force participation in the MENA region. The youth category encompasses people aged between 15 and 35. The measurement of financial inclusion involves having a bank account, saving, and borrowing from a financial institu-

tion, while FinTech is measured by having a mobile account and receiving or making digital payments. Labour force participation is measured by the "workforce" denoting whether individuals are engaged in work-related activities.

The data used in this research is sourced from the World Bank's Findex survey database for 2021. We focused our study on MENA countries (excluding high-income countries). The analysed countries include Algeria, Egypt, Iran, Iraq, Jordan, Lebanon, Morocco, Tunisia, and the West Bank and Gaza. The total sample comprises 9,052 individuals, of which 4,655 are young people.

2.2. Methodology

To test empirically the effect of financial inclusion and FinTech on youth labour force participation, we classified these people into two groups: the first (experimental group) included youth with access to the formal and digital financial systems, while the second (control group) included youth excluded from the formal and digital financial systems. Given that the randomization condition is not respected in our dataset, the results of the study can be influenced by selection bias. Therefore, like Koloma (2021), we applied the propensity score matching (PSM) method developed by Rosenbaum and Rubin (1983). This approach controls selection bias and provides a more relevant estimate of the average treatment effect (ATT) on individuals studied (Lecocq et al., 2016). However, while PSM is effective in mitigating biases stemming from observable variables, it does not fully address concerns related to omitted variable bias and reverse causality. The absence of instrumental variables remains a limitation, but PSM still significantly reduces biases associated with the selection of observables.

To perform the analysis, we followed three steps. The first is to use a probit model to estimate conditional probability, i.e. the propensity score denoted $\mathrm{P}(x_i)$, so that each individual is exposed to the D_i treatment (in this case, holding a bank account, saving with a financial institution, borrowing from a financial institution, holding a mobile money account, and making or receiving digital payments). This estimation is based on the observable characteristics x_i of individuals, including age, age squared, gender, education level, income quintile, barriers to financial inclusion, and access to technology. Therefore:

$$\mathrm{P}(x_i) = \mathrm{P}(D_i = 1 \mid x_i)$$

$\mathrm{P}(x_i)$ – propensity score,
D_i – treatment status (1 – the youth is included in the formal and digital financial systems, 0 otherwise),
x_i – the vector of observable characteristics of youth i.

Secondly, this study applies a combination of propensity score matching techniques, including nearest neighbour matching, kernel matching and radius matching, to ensure that individuals in the treatment and control groups are appropriately paired based on similar propensity scores. Nearest neighbour matching assigns each treated observation to the closest control observation based on propensity scores, minimising bias. However, this approach can result in suboptimal matches if there are significant differences between covariates in the two groups (Abadie & Imbens, 2006). Kernel matching, on the other hand, assigns weights to control observations using a kernel function, improving data utilisation and reducing variance by considering all available control units (Heckman et al., 1998; Jann, 2017). Radius matching limits the selection of control units to those within a specific distance from treated observations, thereby avoiding overly distant matches, although the risk of improper matching remains if the radius is too wide or too narrow (Dehejia & Wahba, 2002).

The third step estimates the causal effect of financial inclusion and FinTech on youth participation in the labour force by calculating the average treatment effect on members of the experimental group. The treatment effect for individual i is $Y_{1i} - Y_{0i}$ and the average treatment effect is expressed as:

$$\tau \equiv E\left\{Y_{1i} - Y_{0i} \mid D_i = 1\right\} = E\left[E\left\{Y_{1i} - Y_{0i} \mid D_i = 1, P(x_i)\right\}\right] =$$
$$= E\left[E\left\{Y_{1i} \mid D_i = 1, P(x_i)\right\} - E\left\{Y_{0i} \mid D_i = 1, P(x_i)\right\} \mid D_i = 1\right]$$

3. Results and discussion

3.1. Descriptive analysis

Table 1 presents the main descriptive statistics for the MENA region data. The average age of the youth population was approximately 26 years, with an almost equal distribution between men (52%) and women (48%). In terms of education level and income level, 58% had attained a secondary level of education, while 24% reported having a high income. Additionally, there is a marked predominance of individuals residing in urban areas (93%), reflecting the global trend towards urbanisation. Access to technology is also noteworthy, with 94% owning a mobile phone and 87% having internet access.

Despite the presence in urban areas and their commitment to technology, young people in MENA still face challenges of financial inclusion. 38% of respondents reported having a formal bank account, while access to formal savings accounts was limited to 10%. Borrowing from financial institutions was

Table 1. Descriptive statistics

Variables	Observations	Minimum	Maximum	Mean	Standard deviation
Labour force participation					
Workforce	4,655	0	1	0.59	0.491
Socio-demographic characteristics					
Female	4,655	0	1	0.48	0.500
Male	4,655	0	1	0.52	0.500
Age	4,655	15	35	25.58	5.767
Urbanicity	4,655	0	1	0.93	0.250
Education _Primary	4,655	0	1	0.21	0.407
Education_Secondary	4,655	0	1	0.58	0.493
Education_Tertiary	4,655	0	1	0.21	0.407
Income quintile_Poor 20%	4,655	0	1	0.15	0.361
Income quintile_Second 20%	4,655	0	1	0.19	0.390
Income quintile_Middle 20%	4,655	0	1	0.20	0.401
Income quintile_Fourth 20%	4,655	0	1	0.22	0.411
Income quintile_Richest 20%	4,655	0	1	0.24	0.428
Financial inclusion					
Formal account	4,655	0	1	0.38	0.484
Formal savings	4,655	0	1	0.10	0.298
Formal credit	4,655	0	1	0.05	0.224
FinTech					
Mobile money account	4,655	0	1	0.07	0.250
Made or received a digital payment	4,655	0	1	0.31	0.462
Barriers to financial inclusion					
Too far	4,655	0	1	0.08	0.271
Too expensive	4,655	0	1	0.18	0.386
Lack documentation	4,655	0	1	0.10	0.296
Lack trust	4,655	0	1	0.16	0.365
Religious	4,655	0	1	0.09	0.283
Lack money	4,655	0	1	0.85	0.362
Family member	4,655	0	1	0.13	0.340
No need	4,655	0	1	0.27	0.445
Technology access					
Mobile owner	4,655	0	1	0.94	0.237
Internet access	4,655	0	1	0.87	0.341

Source: authors' calculations, based on Findex 2021 data.

even less common, with just 5% of young people utilising these services. A lack of money is cited by 85% of the financially excluded as the main reason for not having a bank account, highlighting tangible barriers to accessing to traditional financial services.

Almost 59% of participants were either employed or actively seeking employment, with a majority being men (69%). Among young people active in the labour market, 48% held a bank account, though access to formal savings remained low at only 13%. Nearly 40% were involved in digital financial transactions.

3.2. Determinants of financial inclusion and FinTech use

Given that we had five treatments (formal current account, formal savings, formal borrowing, mobile money account, and digital transactions), we estimated five probit models to obtain the propensity scores. The results (Table 2) show that all the estimated models are significant. Financial inclusion largely depends on sociodemographic variables, which is consistent with other researchers' findings (Ezzahid & Elouaourti, 2021). As young people grow older, they tend to hold current accounts, rely on formal credit, but are less likely to utilise formal savings. Moreover, the findings also reveal that younger individuals are more likely to access FinTech by owning mobile money accounts and using digital transactions.

Young people with higher education are more likely to access financial services (both traditional and digital) than their peers. This can be explained by the fact that educated individuals are capable of assessing the benefits and opportunity costs associated with the use of financial services (Stănescu & Gikay, 2020). Young people living in urban areas are more likely to have a bank and mobile money account, but are less likely to use formal savings services than those living in rural areas.

Young women were found to be less likely to be financially included and to access FinTech. These findings are consistent with other studies that have demonstrated significant gender gaps in financial inclusion in the MENA region (Özşuca, 2019). Similarly, other studies show that borrowing conditions vary by gender, which has consequently excluded women from accessing bank loans (Antonijević et al., 2022). Other authors explain the differences between men and women by pointing out that women are more likely to favour informal financial services (Hasler & Lusardi, 2017). Moreover, the findings related to FinTech access through holding a mobile money account and executing or receiving digital payments are consistent with previous studies showing that men are more likely to use digital banking services (Lee et al., 2022), but these are contrary to the conclusions of Ameme (2015), who as-

Table 2. Estimating propensity scores for financial inclusion and FinTech use among young people

Variables	Formal account	Formal savings	Formal credit	Mobile money account	Made or received a digital payment
Sociodemographic characteristics					
Female	–0.261*** (0.0445)	–0.193*** (0.056)	–0.150** (0.064)	–0.345*** (0.061)	–0.275*** (0.043)
Age	0.073** (0.0395)	–0.142*** (0.049)	0.034 (0.062)	–0.119** (0.048)	–0.024 (0.037)
Age squared	–0.001 (0.000)	0 .002*** (0.000)	0.000 (0.001)	0.002** (0.000)	0 .000 (0.000)
Urbanicity	–0.182** (0.103)	0.203* (0.111)	–0.121 (0.142)	–0.299** (0.144)	–0.147 (0.093)
Education_Secondary	0.221*** (0.062)	0.247*** (0.089)	0.067 (0.087)	0.095 (0.084)	0.235*** (0.061)
Education_Tertiary	0.693*** (0.073)	0.583*** (0.097)	0.327*** (0.098)	0.319*** (0.098)	0.673*** (0.071)
Income quintile_ Second 20%	0.023 (0.078)	0.054 (0.119)	–0.066 (0.110)	0.014 (0.114)	0.059 (0.077)
Income quintile_ Middle 20%	0.058 (0.077)	0.199* (0.111)	–0.039 (0.105)	–0.011 (0.113)	0.098 (0.075)
Income quintile_ Fourth 20%	0.143** (0.076)	0.126 (0.111)	–0.150 (0.109)	0.108 (0.108)	0.091 (0.075)
Income quintile_ Richest 20%	0.446*** (0.073)	0.634*** (0.105)	–0.071 (0.105)	0.321*** (0.105)	0.433*** (0.072)
Barriers to financial inclusion					
Too far	–0.343** (0.145)	–0.029 (0.162)	–0.069 (0.152)	0.166 (0.127)	–0.086 (0.112)
Too expensive	–1.313*** (0.093)	–0.879*** (0.125)	–0.205** (0.098)	–0.336 (0.104)	–0.884*** (0.078)
Lack documentation	–0.881*** (0.145)	–0.662*** (0.193)	–0.188 (0.144)	–0.092 (0.121)	–0.481*** (0.107)
Religious	–0.713*** (0.146)	–0.538*** (0.198)	–0.258* (0.156)	0.118 (0.115)	–0.270** (0.105)
Lack money	1.652*** (0.112)	0 .986*** (0.133)	0.643*** (0.142)	0.430*** (0.098)	1.140*** (0.085)
Technology access					
Mobile owner	0.275** (0.121)	–0.080 (0.166)	0.086 (0.181)	0.678** (0.271)	0.366*** (0.126)

Table 2 cont.

Variables	Formal account	Formal savings	Formal credit	Mobile money account	Made or received a digital payment
Internet access	0.447*** (0.080)	0.579*** (0.132)	–0.003 (0.106)	0.402*** (0.129)	0.451*** (0.081)
Constant	–3.802*** (0.524)	–1.280** (0.642)	–3.127*** (0.812)	–1.457** (0.644)	–2.401*** (0.485)
Number of observations	4,655	4,655	4,655	4,655	4,655
Wald chi^2	693.15	297.74	100.06	132.89	656.80
Prob > chi^2	0.000	0.000	0.000	0.000	0.0000
Pseudo R^2	0.304	0.166	0.071	0.072	0.1964

Note: Standard errors in parentheses, statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: authors' estimates, based on FINDEX data (2021).

serts that gender does not have a significant influence on the adoption of digital banking services.

In addition, belonging to the highest income bracket increases the likelihood of holding a traditional and digital bank account, as well as saving and conducting digital transactions, although this category is excluded from formal credit. This aligns with the findings of Triki and Faye (2013), who found that, on average, adults in the highest income quartile were nearly four times more likely to have a formal bank account than those in the lowest income quartile. Similarly, as Akileng et al. (2018) suggest, individuals without a stable and substantial income have little incentive to open a savings account and are unlikely to qualify for loans, making them the most vulnerable to financial exclusion. It is also demonstrated by Lyons and Kass-Hanna (2019) that young people, women, individuals with lower levels of education, and the poor continue to face significant barriers to financial inclusion in the MENA region.

Furthermore, the main determinants of financial exclusion among young people are lack of documentation, religious considerations, and the costs associated with financial services. However, the lack of money among young people is associated with a greater likelihood of holding a traditional and digital bank account. In addition, these individuals also tend to make greater use of formal savings and credit than their counterparts.

Access to technology plays a determining role in the likelihood of having a bank account and accessing technological financial services. This is consistent with the findings of Evans (2018), which indicate that the increase in internet and mobile phone usage is associated with greater financial inclusion.

Similarly, Lyons and Kass-Hanna (2019) show that people living in MENA countries with high levels of financial education and better financial and technological infrastructure are associated with better financial inclusion outcomes.

3.3. Bias reduction test

After obtaining the propensity scores using the probit model, we examined the overlap between the distributions of the propensity scores of the experimental and control groups. An adequate overlap is required to ensure that the matching method is applicable and that the two groups are comparable. In fact, the visualisation of the Figures 1 and 2 reveals slight differences (particularly in the treatment of formal savings). However, they generally confirm the achievement of a good balance. Therefore, to ensure that the matching reduces the biases initially observed and to examine the reliability of our analysis, we carried out a bias reduction test, using the kernel matching technique to match the young people included in the traditional and digital financial systems to the excluded who had the closest propensity score. This approach is equivalent to comparing the means (or percentages) between the experimental and control groups.

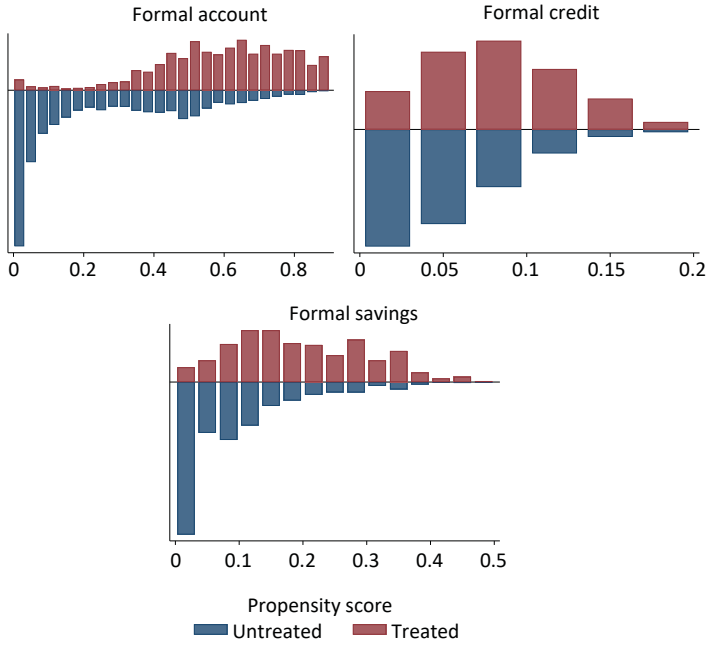

Figure 1. Propensity score distributions for the "financial inclusion" treatment

Source: authors' elaboration, based on Findex 2021 data.

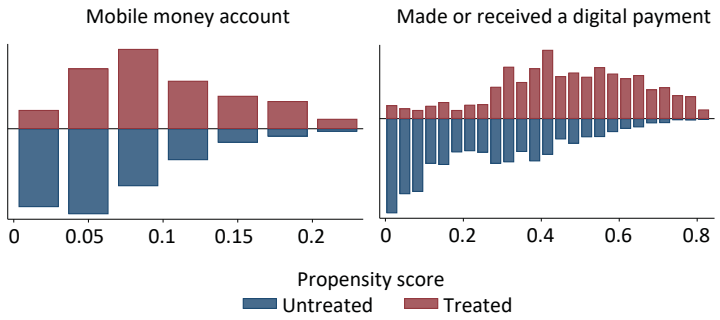

Figure 2. Propensity score distributions for the "FinTech" treatment

Source: authors' elaboration, based on Findex 2021 data.

The matching procedure has reduced bias in terms of propensity scores between young people studied who have a traditional bank account, who use formal savings, who use formal borrowing, who hold a mobile money account and who conduct digital transactions, and their counterparts (nearly 99%, 94%, 100%, 100% and 98% respectively), with a p-value greater than 5%[4] in the matched sample. However, we found that before matching, there were significant biases between groups. Nevertheless, after matching, the biases were reduced, but some variables, such as exclusion due to remoteness and religion in the first model, seemed to exhibit significant bias after matching. However, the majority of the variables reveal non-significant differences between groups. Therefore, we can accept the equilibrium of covariates, since no covariate has a bias value greater than 20 (Rosenbaum & Rubin, 1985).

3.4. Average treatment effects on the treated group

Table 3 shows the average effect of the treatment (access to traditional and digital financial systems) on members of the experimental group. We first applied the Stata command psmatch2 using kernel matching, nearest neighbour matching and radius matching. This command enabled us to perform both propensity score calculations and subsequent verification of balancing properties (Alam & Mamun, 2017) and to apply rbounds to estimate Rosenbaum (2002) bounds.

Then, to check the robustness of the ATT estimate, we tested the effect (ATT) by the nearest neighbour matching technique and by the propensity score matching technique. We applied these techniques because they are likely to provide more consistent estimates of the standard errors of the estimated

[4] The detailed results are available from the authors upon request.

Table 3. Average treatment effects on the treated group

	ATT estimation results (based on psmatch2 command)			ATT estimation results (based on teffects psmatch command)	
	Kernel matching	**Radius matching**	**Nearest neighbour matching**	**Propensity--score matching**	***k*-nearest neighbour matching**
Formal account	0.12** (0.02)	0.253** (0.012)	0.141** (0.034)	0.125*** (0.229)	0.0906*** (0.0189)
Formal savings	0.09** (0.022)	0.194** (0.028)	0.094** (0.041)	0.094*** (0.023)	0.0481** (0.0145)
Formal credit	0.10** (0.03)	0.216** (0.02)	0.020 (0.043)	0.0601** (0.025)	0.026 ** (0.01)
Mobile money account	0.12** (0.025)	0.213** (0.024)	0.096** (0.041)	0.088** (0.026)	0.0315** (0.0135)
Made or received a digital payment	0.098** (0.019)	0.247** (0.013)	0.105** (0.032)	0.099*** (0.0169)	0.098*** (0.0194)

Note: statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: authors' calculations.

effects (Abadie & Imbens, 2012). In addition, the latter adjusts for biases that arise when matching is based on more than one covariate.

The results obtained from these five techniques support the hypothesis that traditional and digital financial systems exert a significantly positive effect on youth labour force participation. Consequently, compared with the counterfactual group, the mean labour force participation is significantly greater for those included in the traditional and digital financial sectors who have access to a formal current account (ATT = 0.12), who use formal savings (ATT = 0.09), who borrow from a financial institution[5] (ATT = 0.10), who have a mobile money account (ATT = 0.12), and who conduct digital transactions (ATT = 0.098).

These effects could be explained by the fact that the "possession of a formal current account" facilitates commercial transactions and financial management for young people. "Formal savings" strengthen the ability of young people to plan financially and to stabilise their income. "Formal borrowing" is a crucial instrument for encouraging young people to invest in education, training or entrepreneurship, which could improve employment and entrepreneurship opportunities. These results confirm those obtained by other research (Kazungu & Njau, 2023; Koloma, 2021) indicating the positive effect of financial inclusion on the willingness to engage in entrepreneurial activities. According to Gangani and Raval (2021), access to formal financial services can

[5] Except for ATT nearest neighbour, access to credit has no significant effect.

serve as a catalyst for young people, contributing to their empowerment and enhancing their overall well-being.

Furthermore, the results of this study reveal that digital transformation within the financial system plays a crucial role in facilitating the integration of young people into the labour market. Owning a mobile money account and making or receiving digital payments enables young people to conduct financial transactions with ease and immediacy, such as salary payments and access to banking services. This can help reduce employment barriers and stimulate economic activity by fostering greater inclusion and participation in the labour force. These findings are consistent with previous research, which highlights that by facilitating access to essential financial services allows businesses and individuals to improve their economic opportunities, creating a fertile environment for entrepreneurship and labour market engagement, and thus improving regional competitiveness (Pearce, 2011). Capasso et al. (2023) also point to the positive influence of financial technology on entrepreneurship, demonstrating that knowledge, the availability and access to crowdfunding and blockchain technologies greatly improve entrepreneurial intentions. In addition, digital savings and access to digital credit are key channels through which FinTech adoption influences entrepreneurial activities.

3.5. Sensitivity of results to unobservable selection

We utilised Rosenbaum's bounds test to examine how the results would be affected in the presence of hidden bias stemming from an unobserved

Table 4. Sensitivity of the results to unobservable selection

	Formal account		Formal savings		Formal credit		Mobile money account		Made or received a digital payment	
Gamma	$p+$	$p-$	$p+$	$p-$	$p+$	$p-$	$p+$	$p-$	$p+$	$p-$
$\Gamma = 1$	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000
$\Gamma = 1.1$	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000
$\Gamma = 1.2$	0.000	0.000	0.002	0.000	0.036	0.000	0.003	0.000	0.000	0.000
$\Gamma = 1.3$	0.017	0.000	0.017	0.000	0.103	0.000	0.017	0.000	0.001	0.000
$\Gamma = 1.4$	0.208	0.000	0.074	0.000	0.221	0.000	0.057	0.000	0.033	0.000
$\Gamma = 1.5$	0.661	0.000	0.204	0.000	0.378	0.000	0.143	0.000	0.230	0.000

Γ – log odds of differential assignment due to unobserved factors. $p+$ denotes the upper bound significance level and $p-$ denotes the lower bound significance level.

Source: own elaboration.

confounding variable. Gamma (Γ) equal to 1 corresponds to the random assignment of treatments (no selection bias due to unobserved factors). In contrast, Gamma (Γ) equal to 1.1 measures the effect of a 10% change in the log-odds of selection into the treatment (Zupi & Cerulli, 2020). In our study, we set the gamma values from 1 to 1.5, representing up to a 50% change in the odds ratio between the propensity score with and without the presence of a potential unobserved confounder.

Table 4 reveals that our results are robust up to $\Gamma = 1.3$ in the case of formal current accounts, mobile money accounts, and formal savings. As for the case of the effect of engaging in digital transactions, its effect is robust up to $\Gamma = 1.4$. The effect of credit on youth labour force participation becomes sensitive to a difference in unobserved covariates beyond the threshold of $\Gamma = 1.2$.

Conclusions

The aim of this paper was to investigate the determinants of youth access to traditional and digital financial services, and then to examine their effects on labour force participation in the MENA region. The World Bank's Global Findex 2021 database was used to perform probit estimations and propensity score matching. The results highlight greater financial exclusion among young women. As also demonstrated by Demirgüç-Kunt et al. (2015), the MENA region has the largest gender and youth gaps in financial inclusion. On the other hand, young people with a higher level of education, high income, mobile phones and internet access are more likely to be included in the formal financial system. Barriers to inclusion include lack of documentation, religious constraints, and costs associated with financial services.

By analysing the effects of financial inclusion and financial technology, we deduce that ownership of a formal current account and mobile money account, savings, formal loans and digital payments have significant impacts on youth labour force participation. In particular, holding a formal current account and making or receiving digital payments have particularly strong effects. These findings underline the importance of socioeconomic and technological factors in developing policies and initiatives to encourage financial and digital inclusion, especially for young women. These factors must be taken into account by decision makers when implementing awareness and training programmes to minimise economic disparities and encourage the financial empowerment of young people, contributing to the region's inclusive and sustainable development.

This study has some limitations. While the propensity score matching (PSM) method helps to reduce selection bias by balancing the observed character-

istics between the groups studied, it remains sensitive to unobserved covariates. Furthermore, the potential for reverse causality between financial inclusion and youth labour participation is a significant concern. As a result, the estimation of causal effects may not be fully captured in this study. Future research could benefit from incorporating instrumental variable techniques to more effectively address an endogeneity issue and to provide a clearer understanding of the causal relationships at play (DiPrete & Gangl, 2004).

Nevertheless, this study makes a contribution to the literature on financial inclusion and youth labour market participation. The use of rigorous methodologies and robustness analyses strengthens the validity of our results. In addition, we included various dimensions of financial inclusion in our study to provide an in-depth understanding of their impacts. Despite methodological limitations, this research offers valuable policy insights for improving the economic and financial integration of young people. The results of this study suggest that it is essential to promote young women's access to the formal and digital financial systems and to improve access to education for young people, which could be achieved through the implementation of targeted educational programmes. Furthermore, investing in digital infrastructure is also necessary to ensure that all young people, especially those living in rural or disadvantaged areas, have access to technology, a determinant factor for financial inclusion and, consequently, their economic empowerment.

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Role of subjective norms in shaping entrepreneurial intentions among students

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Abstract

In view of the inconsistency in prior research, the main goal of this analysis is to determine the influence of subjective norms on entrepreneurial intentions among Polish students. The secondary goal is to examine how these subjective norms are affected by entrepreneurial experiences among individuals close to students, the students' self-employment history and work experiences, and their gender. Based on the framework of the theory of planned behaviour and data generated through surveys of students in a management programme (N = 255), structural equation modelling is applied. The results indicate that subjective norms indirectly influence students' entrepreneurial intentions (through attitude towards entrepreneurship and perceived behavioural control). Regarding the antecedents of subjective norms, students' prior entrepreneurial experience and work history are not significant, nor is gender. The entrepreneurial experience of individuals close to students has a significant and positive impact on subjective norms only when students are convinced of the successes of their close entrepreneurs.

Keywords

- entrepreneurial intention
- SEM
- subjective norms
- theory of planned behaviour
- Polish students

JEL codes: D91, L26, M13

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Introduction

In many countries, individual entrepreneurship benefits from institutional support because of its substantial contributions to employment, innovation, and economic growth. Therefore, understanding the processes of entrepreneurial activity at various stages is essential. The first of these stages is establishing one's business, usually preceded by a conscious and planned intention (Krueger & Carsrud, 1993; Lerner et al., 2018). This entrepreneurial intention is the best, albeit imperfect, predictor of actual entrepreneurial behaviour (Tsou et al., 2023). It is natural, therefore, that entrepreneurial intentions are the subject of intensive scientific inquiry (Batista-Canino et al., 2024).

The most commonly used theoretical framework for these studies is Ajzen's theory of planned behaviour (Ajzen, 1991), according to which one of the main factors influencing entrepreneurial intentions is subjective social norms. However, previous empirical research, both in Poland and abroad, has been inconsistent in determining the significance and form of this influence. In an international context, the direct impact is often found not significant, while the indirect impact sometimes is confirmed (González-Serrano et al., 2018). In the Polish context, studies usually considered only a direct impact, with mixed results (Kobylińska, 2022; Pawlak, 2016), and the only work exploring an indirect impact (Moriano et al., 2012) did not use the exact Ajzen's theory, which may be the reason why the impact was not significant. The geographical context in these investigations is important because local economic, social and cultural institutions shape social norms and their subjective interpretation (Moriano et al., 2012; Tomal & Szromnik, 2021).

The study aims to explore the above-mentioned research inconsistency in the Polish context and thus fill the research gap of exploring the direct and indirect role of subjective norms in shaping entrepreneurial intent in Poland, according to Aizen's theory of planned behaviour. The main goal of the analysis is to determine the influence of subjective norms on entrepreneurial intentions among Polish students. The secondary goal is to examine how the subjective norms are affected by entrepreneurial experiences among individuals close to students, the students' self-employment history and work experiences, and their gender. To achieve both goals, the analysis employs a struc-

tural equation modelling approach to the data gathered among students of master's programme in management at one of Poland's biggest universities.

The study results indicate that subjective norms indirectly influence students' entrepreneurial intentions. Moreover, they are not impacted by students' prior entrepreneurial experience and work history nor gender, whereas the entrepreneurial experience of individuals close to students has a significant and positive impact on subjective norms only when students are convinced of the successes of their close entrepreneurs.

The theoretical implications of our study concern scientific inquiries into entrepreneurial intentions based on the theory of planned behaviour (the need for more complex measures of subjective norms and entrepreneurial behaviour among individuals the subjects are close to), while the practical implications relate to confirming the value of actions that influence subjective norms by organisations developing entrepreneurial ecosystems. The Polish context reveals that in a cultural environment where entrepreneurship is often perceived as requiring unethical or illegal behaviours, but where individual entrepreneurial careers are generally valued (Glinka et al., 2023), subjective norms are shaped by the positive experiences of close individuals. Consequently, these norms indirectly influence entrepreneurial intentions through attitudes that reflect personal evaluations of entrepreneurship and the perception of it as an achievable endeavour.

The article is organised as follows: first, the theoretical background and hypothesis are presented, followed by an explanation of the methodology used in the study. Next, the results are presented and then discussed. Finally, the paper concludes with implications and suggestions for future research.

1. Theoretical background and hypotheses development

The theoretical framework for the study is the theory of planned behaviour (TPB), proposed by Ajzen (1991, 2012) as an extension of the theory of reasoned action (Fishbein & Ajzen, 1975). According to TPB, intention is the primary determinant of actual behaviour. The stronger the intention of behaviour, the greater the likelihood of its being enacted, provided there is access to the appropriate resources and opportunities. Intention, in turn, is shaped by the attitude towards the behaviour, subjective norms, and perceived behavioural control. All three behavioural determinants stem from personal beliefs regarding behaviour, norms, and control.

The attitude towards the behaviour is an individual assessment of the behaviour based on personal beliefs about its outcomes and the value attrib-

uted to these outcomes. Subjective norms refer to the perceived pressure from significant others, such as family, friends, or acquaintances, regarding the behaviour in question. They reflect an individual's perception of what others think the person should do. Perceived behavioural control is the personal belief in one's ability to perform the behaviour, encompassing the perceived ease / difficulty of performing the behaviour and facilitating or hindering factors. These three factors together (attitude, subjective norms, and perceived behavioural control), as well as the relationships between them, influence the intention to engage in the behaviour and, subsequently, the occurrence of the behaviour. Therefore, intention serves as a mediator between the cognitive evaluation of behaviour and its enactment. According to TPB, individuals consciously consider various factors and different options in pursuit of specific goals. This assumption is weaker than the requirement of full rationality based on maximising expected utility (Neumann & Morgenstern, 1944), requiring only conscious self-regulatory processes.

TPB serves as the primary theoretical framework in studies on entrepreneurial intentions (Batista-Canino et al., 2024; Hueso et al., 2021), including those related to student entrepreneurship (Tingting et al., 2022). On the one hand, some of these studies aimed to verify the impact of educational programmes on entrepreneurial intentions (Iglesias-Sánchez et al., 2016; Jones et al., 2008; Maresch et al., 2016; Solesvik, 2013; Wu & Wu, 2008). On the other hand, students constituted the research sample, through which attempts were made to expand TPB by incorporating elements that better explain the mechanisms stimulating these intentions. In this latter stream, the model included personality traits (Karimi et al., 2017; Mirjana et al., 2018; Zhang et al., 2015), motivations (Al-Jubari et al., 2019; Solesvik, 2013), and environmental conditions (Amofah et al., 2024; Iakovleva et al., 2011; Karimi et al., 2017), as well as respondents' demographic characteristics. According to the sufficiency assumption of TPB (Ajzen, 2020), these elements can either be determinants of the main predictors (attitude towards entrepreneurship, subjective norms, and perceived behavioural control) or moderate the latter's influence on entrepreneurial intentions.

Importantly, previous studies on student entrepreneurship based on TPB have led to the theory's positive empirical verification and the conclusion of a clear, positive impact of attitude towards entrepreneurship and perceived behavioural control on entrepreneurial intentions. The impact of subjective norms on student entrepreneurial intentions, however, remains ambiguous. The results of some authors' studies indicate the significance of this factor (Al-Jubari et al., 2019; Iakovleva et al., 2011; Karimi et al., 2017; Mirjana et al., 2018; Solesvik, 2013; Zhang et al., 2015), while the results of others provide contrasting findings (Che Nawi et al., 2022; Iglesias-Sánchez et al., 2016; Maresch et al., 2016; Wu & Wu, 2008). In the context of Polish students' entrepreneurial intentions, most previous studies suggest that subjective

norms play a significant role in the intention to start a business (Pawlak, 2016; Wach, 2015). However, divergent conclusions also emerge (Kobylińska, 2022; Moriano et al., 2012; Wach & Bilan, 2023).

One explanation for the inconsistency in research results may be the different operationalisation of subjective norms. Some studies measure this construct solely using questions about the belief in the likelihood that a given reference person will support the implementation of the respondent's entrepreneurial intentions. However, these beliefs should be adjusted for the motivation to comply with these norms and thus weighted by the importance attributed to the opinions of the reference individuals (Ajzen, 2020; Fishbein & Ajzen, 2011).

Another problematic aspect of the impact of subjective norms on entrepreneurial intentions is the pathway of influence. Initially, TPB assumed only direct influence. However, later works highlighted the possibility of mutual interaction between attitude towards entrepreneurship, subjective norms, and perceived behavioural control (Heuer & Liñán, 2013). In such an approach, subjective norms may not directly influence entrepreneurial intentions, but its impact may be indirect through the attitude towards entrepreneurship and perceived behavioural control (González-Serrano et al., 2018; Liñán & Chen, 2009). Subjective norms reflect perceived values in the individual's environment, which may partially determine the attitude towards entrepreneurship and perceived behavioural control (Liñán & Santos, 2007). Perceived values also depend on the environment's economic, social, and cultural conditions. Given this, the following research hypotheses can be formulated:

H1: Subjective norms directly influence students' entrepreneurial intentions.
H2: Subjective norms indirectly influence entrepreneurial intentions by affecting attitude towards entrepreneurship.
H3: Subjective norms indirectly influence entrepreneurial intentions by affecting perceived behavioural control.

Additionally, it is believed that the presence of entrepreneurs among close individuals impacts subjective norms and, consequently, reinforces students' entrepreneurial intentions (Gurel & Daniele, 2010; Lingappa et al., 2020; Wach, 2015). People may be inclined to take action endorsed by their family, friends, and other significant ones (Portyanko et al., 2023). Furthermore, it is not only the mere fact of entrepreneurs' presence among close individuals but also the perceived quality of their experiences that correlates with the potential intention to run one's own business (Engle et al., 2011; Krueger, 1993). Based on this, the following research hypotheses may be formulated:

H4a: Subjective norms are shaped by the presence of entrepreneurs among close individuals.
H4b: Subjective norms are shaped by the quality of entrepreneurial experience among close individuals.

Moreover, one's experience, both entrepreneurial and in other professional work, can also positively influence attitudes, subjective norms, and perceived behavioural control, stimulating entrepreneurial intentions (Iakovleva et al., 2011; Zapkau et al., 2017). Direct involvement in entrepreneurial activities helps individuals connect with other entrepreneurs, which can influence their perceptions of how society views entrepreneurship and can shape subjective norms. Similarly, professional experience, through exposure to various organisational cultures, can impact beliefs about socially accepted behaviours, including entrepreneurial activities. Thus, we can pose the following hypotheses:

H5: Subjective norms are shaped by one's own entrepreneurial experience.
H6: Subjective norms are shaped by one's own professional work experience.

Other variables often considered as potential determinants of all three main factors of entrepreneurial intention are gender, age, education (including entrepreneurship-related education), institutional, and cultural environment. Considering the study context and characteristics of the research sample (students of the same management programme at the same university, of similar age and nationality), only the first variable on this list may exhibit sufficient variability to potentially influence subjective norms (as well as attitude towards entrepreneurship and perceived behavioural control). The higher entrepreneurial intentions among men as opposed to women are often explored as a result of gender factors shaping attitudes, subjective norms, and perceived behavioural control, although the findings are mixed (Iakovleva et al., 2011; Zapkau et al., 2017). Hence:

H7: Subjective norms are differentiated by gender.

2. Material and methods

2.1. Measurements and research process

To assess the influence of TPB components on entrepreneurial intentions, the scale developed by Liñán and Chen (2009) was adopted. The scale consists of 19 statements, with 5 assessing the attitude towards entrepreneurship, three focusing on subjective norms, 5 measuring perceived behavioural control, and 6 evaluating entrepreneurial intentions. Additionally, to account for the motivation to comply with norms in the case of subjective norms, the scale was supplemented with three items measuring the importance that respondents attribute to the opinions of those they consider close individuals

(based on Kolvereid, 1996). All items were measured on a Likert scale, ranging from 1, indicating "strongly disagree," to 7, indicating "strongly agree." A detailed description of the items is provided in Table 2.

The questionnaire also included questions about gender, age, engagement in paid work amounting to at least 20% of full-time employment (Iakovleva et al., 2011), prior self-employment experience, and the presence of entrepreneurs among the close individuals. The latter was supplemented with an additional question, where respondents were asked to assess the entrepreneurial success of their close entrepreneurs on a five-point ordinal scale (ranging from "they experience many failures" to "they experience many successes"). This measurement approach facilitated structural equation modelling (SEM), whereby all previously derived research hypotheses were tested simultaneously, while also controlling for other relationships linking experiences and gender with TPB components (Figure 1).

The model's attitude towards entrepreneurship, perceived behavioural control, and entrepreneurial intentions constructs followed Liñán and Chen's (2009) framework. However, subjective norms underwent prior weighting, following the procedure advocated by Kolvereid (1996). Thus, each of the three items relating to subjective norms determined by family (SN_1), friends (SN_2), and other significant individuals (SN_3) was first recoded onto a bipolar scale (from 1 = –3 to 7 = 3). Subsequently, the obtained values were multiplied by the weights generated by the corresponding answers, determining the importance of these individuals' opinions. This process yielded weighted subjective norm items, reflecting the importance attributed to them by the respondent (SN_W1, SN_W2, SN_W3).

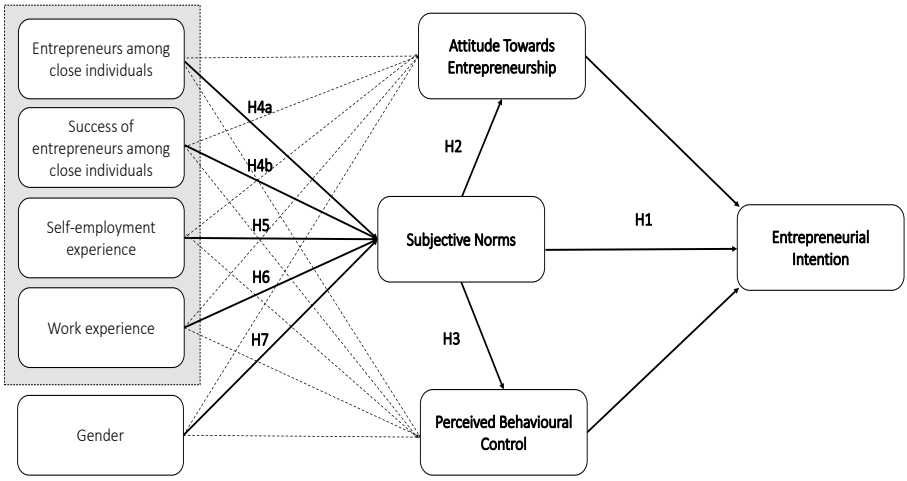

Figure 1. Research model

Source: own study.

The presence of entrepreneurs among the close individuals and their perceived successes, as well as students' own entrepreneurial experience and other work experience, were incorporated into the model as dichotomous variables, where a value of 1 indicated the phenomenon's presence. The variable describing gender, also dichotomous, was assigned a value of 1 for females. The entrepreneurial success of the close individuals was operationalised through interaction with the presence of entrepreneurs among them, implying that the influence of this factor was activated only for students for whom it could potentially occur.

The data analysis process comprised two stages, following the procedure recommended by Hair et al. (2010). In the first stage, scale validation was conducted using confirmatory factor analysis (CFA), while in the second stage, the structural model was estimated. The assessment of fit measures and interpretation of other validation criteria were based on guidelines formulated by Fornell and Larcker (1981), Hair et al. (2010), and Kline (2005).

2.2. Data collection and analysis

The data for analysis were collected using a survey method from October 2017 to March 2024. The questionnaires were distributed among full-time second-degree students majoring in Tourism and Sports Management at the Jagiellonian University in Kraków. They were completed during educational classes, excluding the pandemic period from 2020 to 2021. The questionnaires were administered either on paper or online, according to the organisational conditions of the classes. In all cases, respondents' anonymity was offered to all participants. A total of 310 surveys were collected across 6 cohorts with a combined cohort size of 499, corresponding to a sampling ratio of 62%. To ensure the homogeneity of the research sample in terms of age and cultural background, the study was restricted to surveys completed by Polish nationals aged 26 years or younger. After applying this criterion and removing incomplete surveys, the final sample consisted of 225 responses.

Most of the students surveyed were aged 23 or 24 (64%), with the age distribution of all respondents falling within the narrow range of 21–26 years (Table 1). In the sample, the majority were females (65%) without prior entrepreneurial experience (89%) but with some work experience (87%). It was common for them to have entrepreneurs among their close individuals (78%) and, if so, to perceive them as successful in this field (62%). Given the minimal number of negative assessments of entrepreneurial experiences among the close individuals (below 2%), responses of "many failures" and "failures" were combined into a neutral category, which became a reference point for positive assessments ("successes" and "many successes").

Table 1. Description of the research sample

Variable/ Response	*n*	%	Variable/ Response	*n*	%
Gender			Entrepreneurs among close individuals		
Male	78	35	no	50	22
Female	147	65	yes	175	78
Age			Entrepreneurial successes among close individuals[1]		
21	4	2	no	67	38
22	39	17	yes	108	62
23	76	34	Entrepreneurs among close individuals* Entrepreneurial successes among close individuals		
24	67	30	no	117	52
25	33	15	yes	108	48
26	6	3	Own entrepreneurial experience		
The year of the survey			no	205	91
2017	65	29		20	9
2018	63	28	Own work experience		
2022	32	14	no	29	13
2023	10	4	yes	196	87
2024	55	24			

* Refers to individuals having entrepreneurs among their close individuals.

Source: own study.

Concerning the main elements of TPB (Table 2), the high values describing the attitude towards entrepreneurship are worth noting (ATT_2, ATT _3, ATT _4 above 5.0), indicating a generally positive attitude towards developing this activity among students. A higher-than-average level of entrepreneurial intentions was also observed (mean values of items in the range of 4.0–5.0). Importantly, considering the data collection period disrupted by the COVID-19 coronavirus pandemic, the level of entrepreneurial intentions in the pre- and post-pandemic periods remained unchanged. This is evidenced by the results of Kolmogorov-Smirnov tests, which show that the response distributions for all items describing entrepreneurial intentions in the periods 2017–2018 and 2022–2024 did not exhibit significant differences: ($D_{INT\_1} = 0.041$ [$p = 1.00$]; $D_{INT\_2} = 0.114$ [$p = 0.474$]; $D_{INT\_3} = 0.103$ [$p = 0.602$]; . $D_{INT\_4} = 0.117$ [$p = 0.433$]; $D_{INT\_5} = 0.164$ [$p = 0.101$]; $D_{INT\_6} = 0.161$ [$p = 0.112$]).

3. Results

3.1. Confirmatory factor analysis

The modification of indices resulting from the combination of error paths of two pairs of constructs (INT_5 with INT_6 and PBC_4 with PBC_5) led to acceptable model fit indices [$\chi^2(df) = 277.387(144)$, $p < 0.001$, $\chi^2/df = 1.926$, $\mathrm{RMSEA} = 0.064$, $\mathrm{CFI} = 0.963$, $\mathrm{TLI} = 0.956$, $\mathrm{SRMR} = 0.049$]. The RMSEA value did not exceed 0.08, CFA and TLI exceeded the threshold of 0.90, and the SRMR was less than the required 0.10 (Hair et al., 2010). Although the chi-square tests showed undesirable statistical significance, the ratio of the test value to the degrees of freedom yielded a result of 1.92, significantly below the accepted criterion of 3.0 (Kline, 2005).

Based on the composite reliability (CR), we can conclude that the items forming the constructs are reliably associated with each other, thus adequately measuring them (see Table 2). The lowest CR value was observed for PBC ($= 0.844$), significantly exceeding the norm of 0.70 (Fornell & Larcker, 1981; Hair et al., 2010).

The model also meets the requirements of convergent validity concerning the degree of interrelatedness among measures forming the same construct. All items are statistically significant ($p < 0.001$) and load on the constructs to the expected extent, i.e. above the cutoff line of 0.5 (Hair et al., 2010). The highest values are observed in items related to entrepreneurial intentions, specifically INT_4 ($= 0.954$) and INT_5 ($= 0.916$), while the lowest is for PBC_1 ($= 0.593$). Moreover, the average extracted variance (AVE) in the constructs ranges from 0.722 for entrepreneurial intentions to 0.526 for perceived behavioural control, thus, in each case, exceeding the cutoff line set at 0.5 (Fornell & Larcker, 1981).

The AVE values were then utilised for discriminant validation, assuming that their square roots should exceed the correlations between constructs (Fornell & Larcker, 1981), while the correlations themselves should not exceed 0.85 (Kline, 2005). Consistent with the TPB assumptions, there are significant yet moderate interrelationships among attitude towards entrepreneurship, perceived behavioural control, and subjective norms (Table 3) – the highest being between attitude towards entrepreneurship and perceived behavioural control (0.539) and the lowest linking perceived behavioural control with subjective norms (0.295). Simultaneously, each of these correlations does not surpass the square roots of AVE, which range from 0.725 (for perceived behavioural control) to 0.839 (for subjective norms).

Table 2. Results of confirmatory factor analysis (CFA)

Domain / Item	AVE	CR	FL	C.R.	M	SD
Entrepreneurial Intentions (INT)	0.772	0.953				
INT_1: I am ready to do anything to be an entrepreneur			0.762	–	4.15	1.58
INT_2: My professional goal is to become an entrepreneur			0.843	13.86***	4.41	1.52
INT_3: I will make every effort to start and run my own firm			0.881	14.65***	4.34	1.61
INT_4: I am determined to create a firm in the future			0.954	16.06***	4.63	1.64
INT_5: I have very seriously thought of starting a firm			0.916	15.24***	4.80	1.66
INT_6: I have the firm intention to start a firm someday			0.903	14.96***	4.79	1.70
Attitude Towards Entrepreneurship (ATT)	0.673	0.911				
ATT_1: Being an entrepreneur implies more advantages than disadvantages to me			0.736	–	4.94	1.24
ATT_2: A career as an entrepreneur is attractive to me			0.871	13.33***	5.18	1.26
ATT_3: If I had the opportunity and resources, I would like to start a firm			0.817	12.29***	5.80	1.19
ATT_4: Being an entrepreneur would entail great satisfaction for me			0.851	12.82***	5.49	1.25
ATT_5: Among various options, I would rather be an entrepreneur			0.819	12.34***	4.65	1.48
Subjective Norms (SN)	0.704	0.877				
SN_W1: My close family would approve of my decision to become an entrepreneur * The opinions of my close family about my career choice are important to me.			0.786	–	8.84	6.95
SN_W2: My friends would approve of my decision to become an entrepreneur * The opinions of my friends about my career choice are important to me.			0.833	13.09***	7.82	5.54
SN_W3: People who are important to me would approve of my decision to become an entrepreneur * The opinions of people who are important to me about my career choice are important to me			0.893	13.48***	9.01	5.75
Perceived Behavioural Control (PBC)	0.526	0.844				
PBC _1: To start a firm and keep it working would be easy for me			0.593	–	3.61	1.25
PBC _2: If I tried to start a firm, I would have a high probability of succeeding			0.882	9.43***	3.79	1.39
PBC _3: I can control the creation process of a new firm			0.840	9.10***	3.95	1.32
PBC _4: I know the necessary practical details to start a firm			0.644	7.59***	3.95	1.40
PBC _5: I know how to develop an entrepreneurial project			0.617	7.36***	4.16	1.35

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

AVE – average variance extracted; *CR* – composite reliability; FL – Factor loadings; C.R. – critical ratio; *M* – mean; *SD* – standard deviation.

$\chi^2(df) = 277.387\ (144)$, $p < 0{,}001$; $\chi^2/df = 1.926$, RMSEA = 0.064, CFI = 0.963, TLI = 0.956, SRMR = 0.049.

Source: own study.

Table 3. Discriminant validation

Construct	INT	ATT	SN	PBC
Entrepreneurial Intentions (INT)	*0.879*			
Attitude Towards Entrepreneurship (ATT)	0.862***	*0.820*		
Subjective Norms (SN)	0.297***	0.352***	*0.839*	
Perceived Behavioural Control (PBC)	0.637***	0.539***	0.295***	*0.725*

Notes: ***$p < 0.001$. The table presents correlation coefficients between constructs, while the italicised values denote the square roots of AVE values for the given constructs.

Source: own study.

However, the correlation between the attitude towards entrepreneurship and entrepreneurial intentions, which stands at 0.862, is potentially problematic. Although this relationship is typical in the Polish context (as observed previously by, e.g., Amofah et al., 2024), from the perspective of the discriminant validation of the entire model, it leads to the recommended level of correlations between constructs being exceeded and surpassing the square root of AVE for attitude towards entrepreneurship (= 0.820). Nevertheless, considering that the criterion itself for the relationship between correlations and AVE is sometimes criticised as overly conservative (Rönkkö & Cho, 2022), in addition to the highly satisfactory results of the other validation actions regarding the scale, we accept the entirety of the CFA results as acceptable and the scale suitable for further estimations.

3.2. Structural equation modelling

The overall fit indices of the structural model demonstrate satisfactory fit to the empirical data [$\chi^2(225) = 293.986$ ($p < 0.001$); $\chi^2/df = 1.307$; RMSEA = 0.058, CFI = 0.954, TLI = 0.945, SRMR = 0.096]. Entrepreneurial intentions were explained to a high degree ($R^2 = 0.763$).

According to the results presented in Table 4, we did not find confirmation for H1, which assumed the direct influence of subjective norms on entrepreneurial intentions ($\beta = -0.052$ [n.s.]). However, hypotheses H2 and H3, regarding the occurrence of this influence indirectly through the attitude towards entrepreneurship and perceived behavioural control, were confirmed. Subjective norms moderately influences attitude toward entrepreneurship ($\beta = 0.342$ [$p < 0.001$]), which, in turn, is a powerful predictor of entrepreneurial intentions ($\beta = 0.787$ [$p < 0.001$]). The influence of subjective norms on perceived behavioural control is slightly weaker than on the attitude towards entrepreneurship ($\beta = 0.266$ [$p < 0.001$]), and the direct effect of per-

ceived behavioural control on entrepreneurial intentions is significantly weaker than through the attitude towards entrepreneurship ($\beta = 0.301$) but still statistically significant ($p < 0.001$). Therefore, we obtained explicit confirmation of the significance of subjective norms for entrepreneurial intentions, albeit the pathway of this influence passes through the other components of TPB.

Regarding the antecedents of subjective norms, we did not find confirmation of the influence of either one's own work experience (H5: $\beta = -0.020$ [n.s.]) or own entrepreneurial experience (H6: $\beta = 0.037$ [n.s.]). However, the influence of the entrepreneurial experience of close individuals is more complex. The mere fact of such experiences does not lead to changes in subjective norms (H4a: $\beta = 0.094$ [n.s.]). Only when their entrepreneurial activity is perceived as successful does it begin to stimulate subjective norms positively (H4b: $\beta = 0.200$ [$p < 0.05$]). Overall, subjective norms seem susceptible to the influence of favourable external patterns, but we have no basis for claiming that they can be self-shaped through one's own experiences.

While it has no impact on subjective norms, own entrepreneurial experience remains a significant indirect predictor of entrepreneurial intentions. This happens through favourable stimulation of both perceived behavioural control ($\beta = 0.292$ [$p < 0.001$]) and, to a lesser extent, the attitude towards entrepreneurship ($\beta = 0.198$ [$p < 0.01$]). It differs from own work experienc-

Table 4. Results of structural equation modelling—coefficients and standard errors (in parentheses)

Variable / Measure	Entrepreneurial Intentions		Subjective Norms (SN)		Attitude Towards Entrepreneurship (ATT)		Perceived Behavioural Control (PBC)	
SN	–0.052	(0.058)	–	–	0.342***	(0.067)	0.266***	(0.070)
ATT	0.787***	(0.039)	–	–	–	–	–	
PBC	0.301***	(0.052)	–	–	–	–	–	
Work experience	–	–	–0.020	(0.069)	0.084	(0.064)	0.051	(0.065)
Entrepreneurial experience:								
Own (yes = 1)	–	–	0.037	(0.070)	0.198**	(0.063)	0.292***	(0.062)
Among close individuals (yes = 1)	–	–	0.094	(0.081)	–0.007	(0.075)	0.084	(0.076)
Close individuals* Success (yes = 1)	–	–	0.200*	(0.080)	0.054	(0.076)	0.052	(0.078)
Gender (women = 1)			0.030	(0.069)	–0.073	(0.063)	–0.071	(0.065)
***R*-squared**	**0.763**		**0.070**		**0.190**		**0.209**	

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Source: own study.

es, for which no evidence was found regarding either the attitude towards entrepreneurship or perceived behavioural control. Similarly, the successes of close individuals, although stimulating subjective norms, do not affect any other TPB components.

H7 regarding the potential significance of gender for shaping subjective norms was also not confirmed ($\beta = 0.030$ [$p < 0.001$]). Furthermore, in the context examined here, gender remains without any influence on entrepreneurial intentions and does not affect the attitude towards entrepreneurship nor perceived behavioural control.

Additionally, we also tested a model that did not include the weighting of subjective norms. Its results remained consistent with the version we adopted and presented above (with the correction proposed by Kolvereid, 1996). This alternative model also meets the criteria of CFA. In structural modelling, it presents acceptable fit indices [$\chi^2(225) = 404.778$ ($p < 0.001$); $\chi^2/df = 1.799$; RMSEA = 0.06, CFI = 0.952, TLI = 0.943, SRMR = 0.090] and effectively describes the entrepreneurial intentions of students ($R^2 = 0.770$). Like the weighted model, subjective norms do not directly influence entrepreneurial intentions but act through the attitude towards entrepreneurship and perceived behavioural control. The only significant difference is the influence on subjective norms by the entrepreneurial experiences of close individuals (at the significance level of only $p < 0.1$), at the expense of conditioning this factor with successes. The significance of the other variables remains unchanged. Detailed results are available from the authors.

4. Discussion

The study's main goal was to determine the influence of subjective norms on entrepreneurial intentions among Polish students. The secondary goal was to examine how these subjective norms are influenced by entrepreneurial experiences among students' close individuals, their personal self-employment history and work experiences, and their gender.

The study's primary conclusion concerns the indirect (through the attitude towards entrepreneurship and perceived behavioural control) rather than the direct influence of subjective norms on students' entrepreneurial intentions. Although this confirms the results of some studies on international students (Barba-Sánchez et al., 2022; González-Serrano et al., 2018; Heuer & Liñán, 2013), it is the first conducted on Polish students. Previous studies on the latter, based on the TPB model and utilising SEM analysis, either did not consider the possibility of indirect influence (Kobylińska, 2022) or found no such influence (Moriano et al., 2012). Noting that, in the study

by Moriano and co-authors (2012), the concept of self-efficacy substituted perceived behavioural control. Importantly, in both of these studies the direct influence was insignificant. In our study, the indirect influence of subjective norms on intentions is more substantial through attitude than perceived behavioural control, which is similar to the results of Liñán and Chen (2009) and González-Serrano et al. (2018). Furthermore, the scale of this influence for Polish students in our study is similar to that of students from Spain and lower than that of students from Taiwan in Liñán and Chen's study (2009). This confirms the conclusion of the latter researchers about the lesser influence of subjective norms on research intentions in more individualistic cultures. Moreover, in both Polish and Spanish contexts, the perception of entrepreneurs is somewhat ambiguous, with students noting the darker sides of entrepreneurship. However, as indicated in the case of Poland, this perception becomes more positive when focusing on individual entrepreneurs rather than viewing them as collective economic actors (de la Cruz Sánchez-Escobedo et al., 2011; Glinka et al., 2023). This helps explain why subjective norms do not directly influence entrepreneurial intentions but instead exercise their effect through personal evaluations of entrepreneurship and the perception of it as an achievable endeavour.

Our study also reveals a significant and positive impact that entrepreneurial experience among students' close ones has on subjective norms, but only when the student is convinced of the success of these close entrepreneurs (mainly in contrast to the belief in mixed effects of this experience or a lack of information about its outcomes). This finding is further explained by the previously mentioned distinction between how entrepreneurs are perceived on an individual versus a collective level. However, in our sample, the number of students assessing the effects of entrepreneurship among their close ones predominately as failures was too low for inference. This is a potential direction for future research. In previous studies in the Polish context, the focus was mainly on the mere presence of entrepreneurial role models among close ones (primarily parents as entrepreneurs or family businesses). In these cases, positive correlations were found between the presence of such individuals and a higher level of all constructs of the theory of planned behaviour (Wach, 2015).

Prior work experience (measuring employment other than self-employment) in our study had no significant impact on any of the three main determinants of entrepreneurial intention. This contradicts the findings of Liñán and Chen (2009), who showed a positive influence of this experience on perceived behavioural control (though only for students from Taiwan, not from Spain). However, prior entrepreneurial experience matters in our study, albeit only for attitude towards entrepreneurship and perceived behavioural control, contrary to the study of Liñán and Chen, where this experience only influenced subjective norms.

In our study, gender does not significantly influence any of the determinants of entrepreneurial intention and, thus, entrepreneurial intentions. This result is consistent with the Global Entrepreneurship Monitor reports, which show that the ratio of women to men among early-stage entrepreneurs and business owners in Poland is one of the highest in European countries covered by the study (GEM, 2024). This may relate to the high level of masculinity in Polish society, which reduces gender-related stereotypes associated with entrepreneurship and makes Polish women confident and willing to take risks (Pawlak, 2016). This would confirm the study's findings by Rantanen et al. (2015), in which subjective norms in Poland were not influenced by gender but rather by the sense of individual responsibility.

Conclusions

The study helps understand the role of subjective social norms in shaping students' entrepreneurial intentions in the Polish socio-cultural context. The influence of norms on intentions is indirect, mediated by changes in attitude towards entrepreneurship and perceived behavioural control. This is a significant finding in the field of entrepreneurship research in Poland, which has previously struggled to identify such an influence (primarily directly on intentions). Equally important is the perceived quality of entrepreneurial experiences among close individuals influences subjective norms.

The theoretical implications of our study, also with the regard to international literature, concern scientific inquiries into entrepreneurial intention based on the theory of planned behaviour. There are three such implications. Firstly, from the perspective of conceptual consistency with this theory, it is advisable to consider complex measures of subjective norms (even if the statistical fit of the SEM model with simplified subjective norms measures is similar, as also seen in the work of Heuer & Liñán, 2013). Additionally, this approach allows for a more granular analysis of entrepreneurial experiences among close individuals. Secondly, the potential indirect influence of subjective norms should be considered in order to assess their impact on intentions correctly, especially in more individualistic countries and in countries with a discrepancy between perceptions of individual and collective entrepreneurship. Thirdly, as the antecedents of entrepreneurial intent and the relationships between them are shaped by cultural values, these values should be accounted for in cross-country research and entrepreneurship-related policymaking.

The practical implications relate to confirming the value of actions that influence subjective norms by organisations developing entrepreneurial ecosystems. This is particularly relevant in the education sector, where there is

an opportunity to indirectly influence individuals' attitudes towards entrepreneurship by shaping the beliefs of their close ones, such as friends, acquaintances, and teachers. Achieving this involves exposure to successful entrepreneurial role models or access to support infrastructure. In doing so, it is crucial to recognise the complementarity of subjective norms with attitude and perceived behavioural control (Nowiński & Haddoud, 2019).

The results and implications of our study must also be interpreted in light of its limitations. These primarily include the non-random sampling of the study from a specific management programme at a Polish university. A characteristic feature of the study is the homogeneity of the research sample in terms of age, education, university environment, and geographical location, which allowed for better control over the influence of variables addressed by the research hypotheses, at the expense of generalisability. Consequently, the results may not be fully transferable to the student population in Poland, and they may serve only as guidance for further studies on student populations in other countries.

In future research, the research sample could be diversified, including other groups besides students or high school students, who are overrepresented in studies of entrepreneurial intentions (Batista-Canino et al., 2024). A more heterogeneous sample could not only allow the inclusion of additional variables in the model but also deepen the conclusions about the impact of negative experiences in this area among close entrepreneurs on entrepreneurial intentions (which may not have only negative effects, Zapkau et al., 2017), as well as the quality of previous self-employment experience (which was not considered in this study). It would also be advisable to extend the analysis of the model's moderating effects (Barbera & Ajzen, 2020).

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Religious service attendance and consumer financial outcomes: Evidence from a longitudinal survey

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Abstract

Previous literature has pointed to strong links between religion and economic outcomes. However, little is known about how individual consumers' religiosity is related to their financial management outcomes. Using longitudinal data from a national representative survey of households in Poland (more than 90% of believers declaring Roman Catholic religious denomination), we examine the associations between religious service attendance (RSA) and three subsequent consumer financial outcomes: savings, debt, and financial satisfaction. Social contacts, general trust, and risk tolerance have been tested to mediate these associations. The results indicate that RSA is prospectively associated with all three consumer financial outcomes: savings (positive), debt (negative), and financial satisfaction (positive). Only one mediation effect was found: the association between RSA and savings is mediated by social contacts. This implies that religiosity, as measured by RSA,

Keywords

- religious service attendance
- savings
- debt
- financial satisfaction
- social contacts

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is prospectively associated with financial outcomes, and social contacts have some potential to mediate the process. The channels through which religion influences financial conditions require additional research.

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Introduction

Wealth and its distribution within the population is among the most important issues studied in the social sciences. The range of socioeconomic problems related to this issue is wide and includes such serious challenges as poverty and economic inequality. In this article, we empirically examine whether the key factors of wealth accumulation—savings (positively related to wealth) and debt (negatively related to wealth)—are prospectively associated with the religious trait that is one of the most important in common religions, religious service attendance (RSA). Given that accumulated wealth—through saving and borrowing—is an important factor in well-being measures (S. Brown & Gray, 2016; Hansen et al., 2008; Plagnol, 2011), we also examine whether RSA is linked to consumer-reported financial satisfaction.

For centuries, economic and religious thinking have been interdependent, sometimes chaotic, but always complex forces that have co-shaped civilisations (Friedman, 2011; Iyer, 2016). At present, about 85% of the world's population still declares membership of a religious denomination. This number is expected to increase by 2050 (Pew Research Center, 2022). Religious beliefs, and the related social norms and values (e.g., the Decalogue in Christianity), shape a person's sense of self (Akerlof & Kranton, 2000; Blaine et al., 1998). These norms and values define and crystallise a set of acceptable and unacceptable behaviours (Iannaccone, 1998). Adherence to these is often associated with a system of rewards and/or sanctions (Keister, 2007). Consequently, religions create incentives to undertake certain behaviours that may lead to particular outcomes. This also applies to the sphere of consumer finance.

As stated by Keister (2003, p. 178), "(…) people draw on the tools they learn from religion to develop consistent strategies (…) for making decisions such as savings, investment, and consumption".

Research using cross-country data confirms that religion has a significant impact on macro-scale economic and financial outcomes (Barro & McCleary, 2003; Guiso et al., 2003; Stulz & Williamson, 2003). There is also empirical literature available which scrutinises the role of religions in corporate financial choices (Chen et al., 2016; He & Hu, 2016; Hilary & Hui, 2009). However, as indicated by some authors (Kim et al., 2021; Renneboog & Spaenjers, 2012; Sarofim et al., 2020), limited evidence has been provided regarding the impact of religion on both consumer and household financial decisions, and, as a consequence, its impact on their financial outcomes.

Theoretical mechanisms through which religions affect economic and financial outcomes are indicated in the literature (Barro & McCleary, 2003; Guiso et al., 2003; Keister, 2003, 2008). Religion is part of culture, which—through the system of values and social norms derived from these values—shapes personal traits (integrity, willingness to commit and work hard, thrift, readiness to cooperate with others, etc.) and life choices (marriage, fertility, labour force participation) important for material outcomes (Keister, 2012; Stulz & Williamson, 2003). It is hypothesised that through a set of such individual characteristics considered to be conducive to economic growth and development religion influences consumer financial outcomes. However, the researchers have only begun to empirically verify these conceptual assumptions with regard to the mechanisms mediating between religion and financial outcomes, especially with respect to microeconomic data describing consumer finance. Our article aims to fill this research gap by examining the link between RSA and consumer financial outcomes as well as the likely process mechanisms between RSA and these outcomes.

The purpose of this article is to examine whether and how RSA—one of the most widely used measures of religiosity—is prospectively associated with consumers' financial outcomes. Our study relies on the conceptualization of the effects of religion on consumer financial outcomes proposed by Sarofim et al. (2020). To test this conceptual model empirically, we used longitudinal data from a national representative survey of the socioeconomic situation of households in Poland ('Social Diagnosis') and mediation analysis. Our aim is to present empirical evidence on how and through which process mechanisms RSA is associated with subsequent financial outcomes such as saving, borrowing, and financial satisfaction.

The contribution of our study is threefold. Firstly, this is the first study conducted in a *de facto* mono-religious tradition, Roman Catholicism (see the cross-country comparison in Arruñada (2010, Table 1, p. 896)). In Poland, Roman Catholics account for 98.38% of all religiously affiliated individuals (GUS, 2022). Most of the existing research concerning the relationship be-

tween religion and consumer financial outcomes originates from Western countries, where the religious affiliation is more dispersed among different denominations. In a mono-religious country, there is no need to control against the structure of the religion market (compare with Gruber, 2005). In addition, the effects of religion may be different in a mono-religious country compared to countries characterised by religious pluralism because of differences in the strong link between belonging to a particular religion and a sense of national identity (Pew Research Center, 2017).

Secondly, three potential mediators between RSA and consumer financial outcomes (identified based on prior, mostly theoretical, research) were empirically tested, including general trust, risk tolerance, and social contacts. Earlier work on the role of religion in shaping economic and financial outcomes, while theorising about the channels of influence, has rarely verified the accuracy of these theoretical predictions empirically (see notable exceptions in Benjamin et al. (2016) and Bryan et al. (2021), e.g.).

Moreover, most studies concerning the role of religion for financial outcomes are cross-sectional and thus are subject to the risk of reverse causality and provide little evidence referring to cause-and-effect relationships. Due to the longitudinal nature of our data, it was possible to reduce this risk and to make inferences about the associations between RSA and subsequent consumer financial outcomes.

1. Literature review

1.1. Religiosity and saving

Keister (2003) points out that thrifty living, which appeals to the religiously promoted virtues of moderation, foresight, and precaution, is almost universally valued by religions (positive effect hypothesis). On the one hand, empirical studies within the consumer consumption literature strand confirm that religion has a mitigating impact on consumerism and materialism (Minton et al., 2020), whereas, on the other, they show how religion contributes to high saving rates and favourable portfolio choices (Keister, 2007).

However, Barro and McCleary (2003) argue that religious service attendance may entail a transfer of resources from an individual to the community (the Church), which consequently limits the possibilities of accumulating private savings (negative effect hypothesis). This might be linked with the exhortation by many religions to solidarity, charity and the sharing of possessions with others (especially the poor) (Kose & Cinar, 2024). Hence, the relation-

ship between religion and the accumulation of savings does not necessarily have to be positive. Based on cross-country data, Guiso et al. (2003, p. 250) show that although overall "religiosity is associated with a higher emphasis on thrift", different measures of religiosity were correlated differently with this variable (religious upbringing—positively, while frequent attendance at religious services—negatively).

In this study, we have adopted the positive effect hypothesis. We hypothesize that individuals who report more frequent RSA report greater savings (H1). This hypothesis is based on two premises. Firstly, we measured savings in relation to income, which seems to be better suited to addressing the concept of thrift (precaution). It relates to the precautionary motive of saving (saving as a safety buffer). Secondly, since Poland is a country with weak social ties and low social capital (Ipsos, 2022), it may suffer from a limited willingness of individuals to make their resources available for the common good. This decreases the likelihood of a negative effect hypothesis. Although the teachings of the Catholic Church call for charity, empirical evidence from Poland shows that it is the non-believers who are more likely to both donate money to charity and work voluntarily for the benefit of others (Centrum Badania Opinii Publicznej, 2013).

1.2. Religiosity and borrowing

Chunping et al. (2016) elaborated on the theoretical link between religion, borrowing decisions, and the outcomes of consumers. In line with the arguments put forward by Keister (2003), they point to thrift as religiously sanctioned virtue, which can lead to greater restraint on consumption and, as a result, more limited willingness (and need) to borrow. They also argue that the affirmation of a particular asceticism in Christianity can inspire an entrepreneurial spirit and facilitate the accumulation of capital without a loan or credit.

Another reason why religion may reduce the propensity to borrow relates to the sanctioning of certain lending / borrowing behaviours as unacceptable. Islamic law (*shari'ah*), e.g., is characterised by the prohibition of interest (*riba*) and excessive leverage (Baele et al., 2014). Likewise, although the Catholic Church's stance on lending money at interest is adapting to the changing rules governing socio-economic life, the Catholic Church forbade the practice of lending money with interest for a very long time (Graeber, 2011). Consequently, this stigmatisation of lending / borrowing activity has left a lasting mark on the culture. Empirical studies show that some cultural traits—especially those related to religion—are extremely persistent and change slowly (Petkov et al., 2014). In some languages (e.g., in German), there is a semantic association between financial debt and moral guilt (or shame)

(Almenberg et al., 2021). In line with these theoretical predictions, prior empirical evidence indicates that consumers with a religious background borrowed less (Chunping et al., 2016).

Consequently, based on the literature indicated above, we tested the hypothesis that more frequent RSA is associated with reporting less debt (H2).

1.3. Religiosity and financial satisfaction

To the best of our knowledge, the currently available evidence concerning the effect of religion on consumer financial satisfaction is scarce. Although Sarofim et al. (2020) use the term financial well-being in their conceptual model showing the relationship between religion and consumer finance, they only apply a limited set of financial outcome variables (savings, debt, etc.). However, their approach is based on the reasonable and empirically supported assumption that better financial outcomes lead, *ceteris paribus*, to a greater sense of financial satisfaction (and well-being) reported by consumers (see, e.g., the structural models of Shim et al. (2009) as well as Xiao et al. (2009). In particular, Hansen et al. (2008), Plagnol (2011), in addition to S. Brown and Gray (2016), showed that the financial outcome variables that were used in our study—that is, assets (which are the product of saving) and financial liabilities (debt)—have a significant but opposing (positive for assets and negative for liabilities) relationship with financial satisfaction.

Similarly, Kose and Cinar (2024), who report the results of wide-ranging research using data from the World Values Survey, considered financial outcome variables to be a channel through which religion affects financial satisfaction. The results reveal the non-linear nature of the relationship between religiosity and financial satisfaction. This is particularly visible in the case of (faith-based) individual religiosity ('a person's level of devoutness and religion's importance in one's life' (Kose & Cinar, 2024, p. 2)). In this case, the study by Kose and Cinar (2024) revealed a U-shaped relationship (a negative relationship at low levels of religiosity and a positive at high levels). In the case of (communal-based) social religiosity (regular religious service attendance and active participation in religious communities), the relationship bears a closer resemblance to a J-shaped curve, but it is still negative at the lowest levels of religiosity.

Despite these findings, our third hypothesis (H3) is as follows: if more frequent RSA increases saving and reduces borrowing then more frequent RSA should also increase the financial satisfaction of consumers. In light of the results presented by Kose and Cinar (2024), this is to be expected, especially when the measure of religiosity used (i.e. RSA) refers to the social dimension of religion—a measure also employed in our study.

1.4. Risk tolerance as a mediator between religiosity and consumer financial outcomes

Attitudes towards risk and the willingness to take risks are among the relevant determinants of financial decisions and behaviour (Eeckhoudt et al., 2005). Research shows that risk aversion enhances precautionary savings (Bommier & Le Grand, 2018), limits borrowing (S. Brown et al., 2012), and positively affects financial satisfaction (Joo & Grable, 2004).

The link between religion and risk tolerance is also well documented. Most studies reveal that religiously affiliated individuals, in general, and those who are more religious, in particular, demonstrate a higher level of risk aversion (Chen et al., 2016; Hilary & Hui, 2009; León & Pfeifer, 2017; Noussair et al., 2013). However, the explanation for this relationship varies. For instance, Miller (2000) posits that being non-religious is in itself a form of risky behaviour—at least regarding those religions that claim exclusivity (e.g., Christianity and Islam, as opposed to Buddhism or Hinduism). Benjamin et al. (2016, p. 7) put it very plainly as a Pascal's wager: "irreligion is a risky strategy because one gains little if there is no God but potentially loses a great deal if there is a God". On the other hand, León and Pfeifer (2017) point to passages in both the Bible and the Quran, according to which it is clear that financial risk-averse behaviour is promoted by the norm and value systems of both Christianity and Islam. Finally, some studies have shown that the relationship between religion and risk aversion is sensitive to how broad the definition of risk is (such as generalised risk or financial risk) (León & Pfeifer, 2017).

Based on the evidence described above, we hypothesize that individuals whose RSA is more frequent will report less risk tolerance (H4). Additionally, risk tolerance will mediate the relationship between frequency of RSA and savings (H5) / debt (H6). Extending this argument, we also hypothesize that risk tolerance will mediate the relationship between RSA and financial satisfaction (H7).

1.5. General trust as a mediator between religiosity and consumer financial outcomes

The role of trust in finance—both generalised and to financial institutions—has already been well documented (Sapienza & Zingales, 2012). Trust correlates with various forms of financial inclusion worldwide (Xu, 2020). Specifically, it has been established that trust has a positive relationship with both savings (Baidoo & Akoto, 2019) and financial well-being (Barrafrem et al., 2021).

Berggren and Bjørnskov (2011) argue that religion can be both positively and negatively associated with general trust (i.e. trust in other people in

general or social trust as Berggren and Bjørnskov (2011) call it). On the one hand, religiosity can increase trust through the belief that religious people are guided by a code of ethics that prohibits indecent and dishonest behaviour. As a result, a religious person may be perceived as more trustworthy. Additionally, religions are associated with doing good for others, which in itself should go hand in hand with a greater openness to others and a willingness to trust them. On the other hand, religions can lead to divisions, distrust, and intolerance. Anyone who does not belong to a particular religion is in a sense different (alien): they do not adhere to the same values, they do not share the same norms and principles, and consequently, they cannot be trusted.

Despite the fact that empirical research is inconclusive concerning the relationship between religion and general trust (Berggren & Bjørnskov, 2011), in our study we hypothesized that it is a positive relationship. The worldwide results of Guiso et al. (2003, p. 228) support such a hypothesis showing that "Trust towards others is associated for the most part with religious participation" and that "Participation in religious services increases trust only among Christians"—an observation essential to us in studying Catholics and their religious service attendance.

As a consequence, we tested the hypothesis that individuals with more frequent RSA will demonstrate more trust (H8). Furthermore, we hypothesised that trust mediates the relationship between frequency of RSA and savings (H9) / debt (H10). Additionally, trust is expected to mediate the relationship between frequency of RSA and financial satisfaction (H11).

1.6. Social contacts as a mediator between religiosity and consumer financial outcomes

A separate channel through which religion can influence financial outcomes is that of social contacts (Keister, 2008). The church represents a community that provides access to the resources of others. Through this access, an individual may gain knowledge and skills, including those related to financial management. Specifically, Keister (2008, p. 1240) argues that "People learn how to save from their parents and others they encounter as children (…). Strategies for saving and for avoiding debt as well as work behaviours that facilitate saving are largely learned".

Empirical evidence supports these theoretical considerations. It has been shown that social networks influence individual financial decisions in two ways: through the peer effect and the conformity effect (Duflo & Saez, 2003; Hong et al., 2004). The former concerns information-sharing and learning from others, while the latter arises from the need to conform to the social group one that belongs to. J. R. Brown et al. (2008) confirmed that 'neighbours matter':

a 10-percentage point increase in community stock ownership translates into an approximately 4-percentage point increase in the likelihood of an individual to participate in the stock market. Georgarakos and Pasini (2011, p. 695) not only established that sociability has an effect on stock market participation that is distinct from the effect of trust (although both are positive), but also that sociability 'can partly balance the discouragement effect on stockholding that is induced by low trust'. In a meta-analysis Shariff et al. (2015) showed that religious priming has a robust effect on pro-social behaviour. Cwynar et al. (2020) found that individuals with access to greater resources embedded in their social networks are more likely to seek professional debt advice.

As a result, the following was hypothesised in our study: firstly, the respondents with a more frequent RSA will report more social contacts (H12); secondly, social contacts will mediate in the relationship between the frequency of RSA and savings (H13) / debt (H14); finally, social contacts will mediate in the relationship between the frequency of RSA and financial satisfaction (H15).

1.7. Conceptual model of religiosity and consumer financial outcomes

In the present study, we aim to investigate how RSA is related to the consumer financial outcomes. To this end, we use a conceptual model proposed by Sarofim et al. (2020). This model is based on an extensive literature review, as well as on qualitative research. Not only does it capture the relationships between religion (conceptualised as religious identity) and individual financial outcomes, but it also identifies the mechanisms through which religion impacts these outcomes. These mechanisms include the mediating roles of trust, affect, risk propensity, and perceived control.

We adapted this model as follows: firstly, we conceptualized religiosity as RSA; secondly, we examined the longitudinal associations between RSA and three consumer financial outcomes related to wealth accumulation; thirdly, with regard to process mechanisms (mediators), we included risk tolerance, general trust, and social contacts. Due to the lack of an adequate variable in our data set, the affect and perceived control were not included.

In their original analysis, Sarofim et al. (2020) distinguished the supply (financial institutions) and demand side (consumers) of the financial market. Due to the excessive complexity of these relationships and the fact that disentangling how these two are related can be quite challenging, in this study we focus solely on consumers. Furthermore, since we do not empirically test the resulting intervention recommendations from this model, we abandoned the study of this element of the model as well. Also, some of the variables present in the Sarofim et al. model (2020) are not reflected in our empirical

study. As for the variables that are outcomes of religiosity, these are: donation participation and purchase of religious vs. non-religious brands. These are issues that go far beyond the domain of consumer finance, and are the subject of intense study in psychology and sociology on the one hand, and marketing science on the other (see an overview in Sarofim et al., 2020).

Our adaptation of the conceptual model in Sarofim et al. (2020) that we examined empirically is presented in Figure 1.

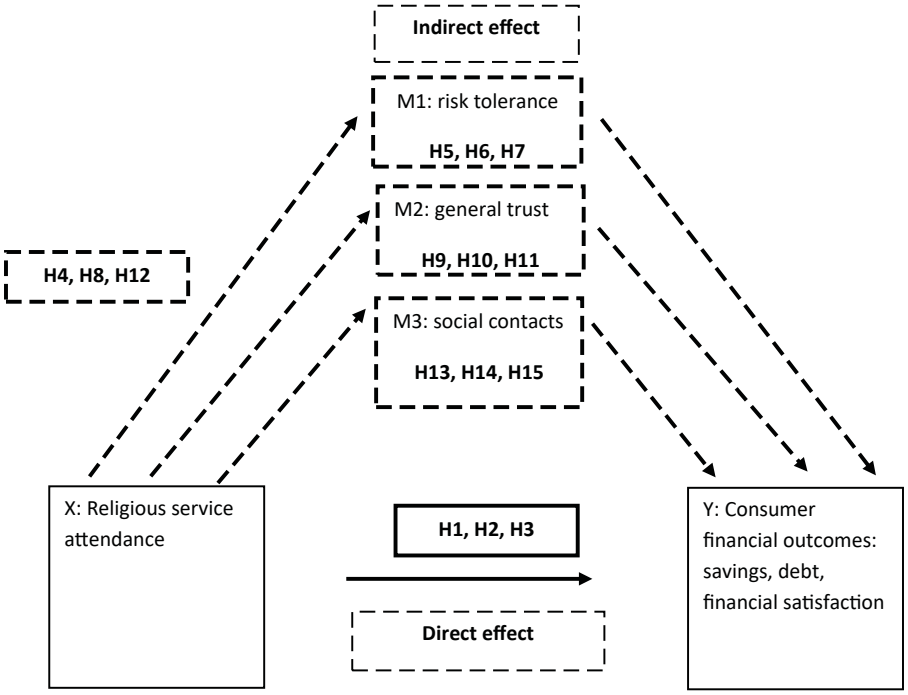

Figure 1. Analysed conceptual model adopted from Sarofim et al. (2020)

Note: Mediators were included in regression models one at a time.

Source: own elaboration.

We empirically verified the model in the Polish population. According to the European Values Survey (EVS, 2022), Poland appears to be one of the most religious country in Europe in terms of every measure used: the importance of God, church attendance, and the perception of oneself as a religious person. Poland is among the few European countries (next to Italy and Portugal) where the vast majority of respondents believe that there is a personal God (EVS, 2022). Despite the great importance of religion in Polish life, secularisation trends are also evident in Poland, particularly in younger age groups (EVS, 2022; Pew Research Center, 2017). As is the case with Western Europe,

Poland is experiencing the phenomenon of faith and belonging without practising: although almost all Poles declare themselves to be religious believers, the indicators of religious practice (such as daily prayers or RSA) are low (Pew Research Center, 2017). The characteristic feature of Poland, though, is its mono-religiousness, with 98.38% of those who belong to a religious denomination (89.88% of those who declared themselves as either belonging or not belonging to a religious denomination) indicating Roman Catholicism as their affiliation (GUS, 2022).

2. Methods

2.1. Data and study participants

The analysis builds on three waves (2011, 2013 and 2015) of the Polish household panel study 'Social Diagnosis' (Czapiński & Panek, 2015). It is a biennial panel survey designed to examine the living conditions and well-being of Polish households. Data are self-reported and representative of the Polish population aged over 15. The survey comprises questions concerning the household financial situation (income, debt, and savings), various aspects of well-being, lifestyle, and socio-economic characteristics. The relevant data and study documentation are freely available (in Polish and English) in the public domain (http://www.diagnoza.com/).

In *Wave 2011*, the study covered 36,655 individuals aged 16 and over. Of these, 25,717 individuals were surveyed in *Wave 2013*. By 2015, the number of individuals covered by all three rounds of the survey had declined to 19,492 respondents. All individuals with missing values for outcomes (i.e. financial conditions), control or exposure variables, i.e. RSA were excluded. This resulted in the analytical samples ranging between 11,453 and 15,512 individuals (depending on the estimate model).

2.2. Exposure—religious service attendance

RSA was used as an indicator of religiosity in this study. RSA was assessed by a single question: "On average, how often in a month do you take part in a church service or other religious meetings?" with the following answers to choose from: (1) never, (2) sometimes (1–3 times a month), (3) weekly (4 times a month), (4) very often (more than 4 times a month). This variable was recoded as a dichotomous one (1: at least once a week, 0: less than once a week)

following recommendations from previous studies, which indicated that this threshold served well as a means of differentiating between individuals in terms of their adherence to the moral code of the Catholic religion (Kirchmaier et al., 2018). Alternative specification was examined as a robustness analysis. The primary exposure measurement in the analyses was RSA in 2011.

2.3. Consumer financial outcomes

Three distinct consumer financial outcomes were examined. Savings and debt were both expressed in relation to monthly income ("What is the approximate total amount of your household savings?" / "What is the total amount of your household's debt?"). Five positive answers ranging from "Up to the equivalent of the household's monthly income" to "Above the equivalent of the household's yearly income" were allowed, plus a negative response indicating zero savings / debt. The third outcome was satisfaction with the financial situation. It was measured by the question: "Please assess to what extent you are satisfied with the financial situation of your family?" with six response categories from which respondents could choose the answer most appropriate to their circumstances, ranging from very not satisfied to very satisfied.

2.4. Mediators

A set of three mediating variables was tested. These were: (1) general trust ("Most people can be trusted"; yes, no); (2) risk tolerance (measured by the question "Do you smoke?"; yes, no), (3) social contacts as measured by the number of friends. These variables have already been established as important mediators of the relationship between religion and financial outcomes (Keister, 2008; León & Pfeifer, 2017; Renneboog & Spaenjers, 2012; Sarofim et al., 2020).

2.5. Control variables

A comprehensive set of control variables was used to examine the prospective association between RSA and consumer financial outcomes. These variables have already been established as important determinants of RSA and general financial conditions. Specifically, the analysis accounted for demographic

variables (gender, age, marital status, education, and the size of the place of residence), objective financial conditions such as equalised household disposable income (after log transformation) and labour market status (being unemployed vs. not). Moreover, civic engagement was also accommodated by controlling for voting in the last parliamentary elections (yes, no) and volunteering (yes, no). Additionally, controls related to baseline well-being and health were also included: (1) general health ("Please assess to what extent you are satisfied with your health condition?" with six possible answers from which respondents could choose, ranging from very not satisfied to very satisfied), and (2) feeling lonely ("Do you feel lonely, though you would prefer not to?" with two answers to choose from: yes, no).

On top of that, each regression controls for the respective outcome and respective mediator in 2011 to reduce the risk of reverse causation. Baseline descriptive statistics for all control variables are presented in Table 1 and the descriptive statistics of mediating and outcome variables are presented in Table 2.

2.6. Statistical analysis

The longitudinal dataset was used and a mediation analysis as proposed by Valeri and VanderWeele (2013) was applied to examine the direct effect (i.e. the association between independent and dependent variables), indirect effects (the association between independent variables and the dependent variable through the mediator), and total effects of RSA on consumer financial outcomes.

In this mediation analysis three waves of data were used with an exposure measured in waves for 2011, mediators in 2013, and outcomes in 2015, controlling for a set of control variables (in 2011) and prior mediators and outcomes (i.e. measured in 2011). This specification includes lagged covariates, as suggested by VanderWeele et al. (2020). In this analysis, the outcome is measured in the last period, while attempting to evaluate factors that change over time and might influence this outcome. This design necessitates multiple waves of data. For example, each potentially changeable determinant of the outcome is examined through a regression model fitting the outcome in wave 3 against the mediator of interest in wave 2 and controlling for (1) potentially confounding covariates in wave 1, (2) the prior level of the moderator in wave 1, and (3) the baseline outcome level in wave 1. The coefficient for the wave 2 mediator is then interpreted as an estimate of its effect on the outcome in wave 3, assuming that wave 1 mediator, baseline outcome, and the set of covariates sufficiently account for the confounding. This design controls (albeit not entirely, as it is feasible only in randomized control trials and

Table 1. Distribution of participant characteristics at study baseline (*N* = 11,453 – 15,512). Polish household panel study 'Social Diagnosis'

Participant characteristic	%	Mean (SD)
Religious service attendance		
Never	29.2	
1–3 times a month	25.4	
4 times a month	34.1	
More than 4 times a month	11.3	
Control variables		
Gender (male)	47.5	
Age group (years)		
18–24	11.9	
25–34	16.0	
35–44	12.9	
45–54	13.9	
55–64	15.2	
65+	30.1	
Marital status		
Unmarried	27.1	
Married	58.4	
Widowed	10.3	
Divorced	3.6	
Legally separated	0.2	
Practically separated	0.5	
Education attainment		
Post-secondary or higher education	23.8	
Upper secondary or vocational education	57.6	
Primary or lower secondary	18.6	
Size of place of residence		
Rural areas	42.2	
City with up to 100,000 residents	32.0	
City with 100,000–500,000 residents	16.9	
City with 500,000 residents	8.9	
Unemployment (% of yes)	2.2	
Equivalised monthly income (PLN)		1,481.3 (1121.3)
Voting in the last elections (% of yes)	69.6	
Volunteering (% of yes)	18.9	
General health		
Very satisfied	8.3	
Satisfied	32.4	
Satisfied a little bit	30.5	
Dissatisfied a little bit	12.5	
Dissatisfied	11.0	
Very dissatisfied	5.3	
Feeling lonely (% of yes)	20.5	

Source: based on data from 'Social Diagnosis'.

Table 2. Descriptive statistics of mediating and outcome variables at study baseline (*N* = 11,453 – 15,512). Polish household panel study 'Social Diagnosis'

Participant characteristic	%	Mean (SD)
Outcome		
Financial satisfaction		
1. Very not satisfied	8.0	
2. Not satisfied	14.6	
3. Rather not dissatisfied	15.6	
4. Rather satisfied	33.0	
5. Satisfied	24.6	
6. Very satisfied	4.2	
Savings		
None	65.7	
Up to one-month household income	8.5	
From 1-month up to 3-month household income	12.0	
From 3-month up to 6-month household income	7.7	
From 6-month up to 12-month household income	3.9	
Above 12-month income	2.1	
Debt		
None	59.5	
Up to one-month household income	8.5	
From 1-month up to 3-month household income	9.4	
From 3-month up to 6-month household income	7.4	
From 6-month up to 12-month household income	5.7	
Above 12-month income	7.9	
Difficult to say	1.9	
Mediators		
General trust ("Most people can be trusted"; % of yes)	13.2	
Risk tolerance / aversion ("Do you smoke?"; % of yes)	26.3	
Social contacts (number of friends)		6.9 (7.4)

Source: based on data from 'Social Diagnosis'

not with observational data we use) for potential confounding and reverse causation by accounting for baseline outcome, baseline mediator and the set of covariates measured at the beginning of the study period. Although this design cannot examine distant exposures from an individual's distant past, it addresses more actionable exposures that are potentially modifiable in the present, addressing pertinent research questions using available data.

A series of nine models was run—for each of the three outcome variables separately and for each of the three mediators separately. In these models, the same set of control variables were used. In this sense, an outcome-wide approach was applied (VanderWeele et al., 2020), which allows for the effect of a single exposure on multiple outcomes to be compared.

The significance of examined associations and effects was tested using the bootstrapping method as suggested by Aguinis et al. (2017). 1,000 replications were used to construct the bootstrapped errors. In order to determine whether the mediation exists, a strategy suggested by Aguinis et al. (2017, p. 676) was adopted. They suggested that to claim the existence of a mediation it should be sufficient that the indirect effect is significant, regardless of the presence or absence of a direct effect. The procedure *paramed* implemented in Stata and applying bootstrapped standard errors to the obtained parameters was used (Liu et al., 2016; Valente et al., 2020).

In the supplementary analyses, two additional specifications of RSA were tested to examine the robustness of results against different frequencies of RSA. Firstly, the original models were recomputed with RSA coded as 1: more than 4 times a month vs. others (Supplementary Material, Table S1). Secondly, RSA was recoded as follows: 1: sometimes (1–3 times a month) or weekly (4 times a month) vs. others (Supplementary Material, Table S2).

Analyses were performed using Stata 17.

3. Results

Our analyses indicated that there was a positive association between RSA and subsequent savings. This association was also found to be mediated by social contacts, although the indirect effect was rather minor (Table 3). It was also found that RSA was negatively associated with both a subsequent increase in borrowing and a subsequent increase in financial satisfaction. No mediation effects were found for these two associations.

Regarding the associations between RSA and subsequent mediating variables, it was found that RSA was associated with subsequent increased social contacts and risk tolerance. As for the mediations (process mechanisms—as Sarofim et al. (2020) call them), our empirical results only support the hy-

Table 3. Effects of religious service attendance on financial outcome measures as mediated by risk tolerance, general trust, and social contacts (*N* = 11,453 – 15,512, depending on the model estimated)

Path (RSA → mediator → outcome)	Effect of RSA on the mediator	Effect of the mediator on the outcome	Indirect effect of RSA on the outcome	Direct effect of RSA on the outcome while controlling for the mediator
	β (95%CI) *p*-value	*β* (95%CI) *p*-value	*β*[a] (95%CI) *p*-value	*β*[a] (95%CI) *p*-value
Religious service attendance and financial satisfaction				
RSA → GT → SF	0.001 (–0.009; 0.012) 0.803	0.030 (–0.039; 0.098) 0.395	0.000 (–0.000; 0.001) 0.811	0.082 (0.037; 0.132) <0.001
RSA → RT → SF	–0.026 (–0.036; –0.017) <0.001	–0.022 (–0.100; 0.056) 0.579	0.001 (–0.001; 0.003) 0.581	0.074 (0.001; 0.003) 0.002
RSA → SC → SF	0.448 (0.254; 0.642) <0.001	0.002 (–0.002; 0.006) 0.394	0.001 (–0.001; 0.003) 0.402	0.069 (0.027; 0.122) 0.004
Religious service attendance and savings				
RSA → GT → Savings	0.000 (–0.010; 0.011) 0.956	0.046 (–0.049; 0.141) 0.95	0.000 (–0.001; 0.001) 0.956	0.078 (0.011; 0.143) 0.018
RSA → RT → Savings	–0.028 (–0.037; –0.018) <0.001	–0.064 (–0171; 0.043) 0.246	0.002 (–0.001; 0.005) 0.256	0.057 (–0.010; 0.125) 0.086
RSA → SC → Savings	0.478 (0.285; 0.670) <0.001	0.008 (0.003; 0.014) 0.002	0.004 (0.002; 0.008) 0.010	0.079 (0.015; 0.149) 0.018
Religious service attendance and debt				
RSA → GT → Debt	0.000 (–0.011; 0.011) 0.990	0.056 (–0.075; –0.188) 0.401	0.000 (–0.002; 0.001) 0.990	–0.276 (–0.363; –0.189) <0.001
RSA → RT → Debt	–0.027 (–0.036; –0.017) <0.001	0.037 (–0.114; 0.187) 0.634	–0.001 (–0.006;0.002) 0.635	–0.272 (–0.364; –0.187) <0.001
RSA → SC → Debt	0.456 (0.262; 0.650) <0.001	–0.002 (–0.010; 0.005) 0.591	0.000 (–0.005 0.001) 0.593	–0.276 (–0.368; 0.191) <0.001

Notes: RSA: religious service attendance; SF: financial satisfaction; GT: general trust; RT: risk tolerance; SC: social contacts; CI: confidence interval.

[a] bootstrapped confidence intervals (1000 replications).

Source: based on data from 'Social Diagnosis'.

pothesis formulated for social contacts and only with regard to the effect of RSA on savings. The rest of the mediators turned out to be insignificant (in all models estimated). In short, although RSA was associated to a significant extent with future social contacts and risk tolerance—and the direction of temporal influence was as expected—these constructs did not act as mediators to convey the impact of RSA on consumer financial outcomes. There was, however, one exception to this conclusion: social contacts were found to mediate the relationship between RSA and savings.

For the secondary mediation analyses with differently defined RSA (Table S1 and S2 in the Supplementary Material), the directionality of most associations was preserved but the effect sizes were somewhat attenuated, and with wider confidence intervals. However, differences were found for the associations between very frequent RSA (more than once a week) and savings mediated with social contacts. In these models, significant estimates for direct and indirect effects were found.

4. Discussion, implications, and future research

The purpose of this study was to examine whether (and if so, how) religiosity correlates with subsequent consumer financial outcomes as measured by the level of savings and debt to income, as well as the level of financial satisfaction. Given the measure of religiosity used (RSA) and the applied outcome measures related to consumer finances, our study fits into the still limited stream of literature concerning the link between religiosity and consumer financial outcomes.

Our results confirmed all the formulated hypotheses regarding the direct effects of RSA on the applied financial outcome variables (H1, H2, H3). We provide empirical evidence that RSA is prospectively associated with the following: the total stock of savings relative to income (positively), the total amount of debt relative to income (negatively), and the level of financial satisfaction (positively). Consequently, our study reinforces the existing empirical evidence that wealth accumulation factors are significantly linked to religion (Keister, 2003, 2008). By using a longitudinal study design with the appropriate temporal sequence of exposure, mediator and outcome, our results provided stronger evidence regarding the causal links between RSA and financial outcomes (from RSA to financial outcomes) than purely cross-sectional evidence. Such a temporal design was often difficult to achieve in earlier studies and the causality was determined for the most part using instrumental variables (Chunping et al., 2016; He & Hu, 2016; Kim et al., 2021; Renneboog & Spaenjers, 2012).

We also provide empirical evidence that RSA is associated with two (of the three studied) variables considered in the literature as the individual characteristics conducive to economic growth and material outcomes: risk tolerance (negatively) and social contacts (positively). Such results confirm hypotheses H4 and H12 and are consistent with the results of previous studies (Chen et al., 2016; Hilary & Hui, 2009; Keister, 2008; León & Pfeifer, 2017; Noussair et al., 2013). In contrast, our results do not support hypothesis H8 that RSA and general trust are positively related. The coefficient for this relationship was found to be insignificant.

With regard to mediating mechanisms, our results do not confirm that RSA is linked to savings, debt, and financial satisfaction either through risk tolerance or through the general trust (rejection of hypotheses H5, H6, H7, H9, H10, H11). Of the mediators tested, only social contacts significantly mediated between RSA and savings (confirmation of hypothesis H13)—but not between RSA and debt, nor between RSA and financial satisfaction (rejection of hypotheses H14 and H15). Consequently, our results provide only partial empirical support for the conceptual model proposed by Sarofim et al. (2020), which assumes that religiosity influences consumer finances through a set of process mechanisms. Our results show that most interactions between RSA and consumer finance occur through the direct channel. Testing other mediators is an important and interesting direction for future researchers, as despite many theoretical and conceptual proposals, little is still known about what variables actually mediate between religion and consumer financial outcomes.

Given that a household's net worth is determined by both its savings and its debts, our results obtained among Poles (almost exclusively Roman Catholics) confirm what Keister (2003) observed in the United States: that religious service attendance is significantly positively related to consumer wealth. In our study, we showed that this relationship can occur through social contacts, which Keister (2003, 2008) refers to as direct channel of influence. What was proposed by Keister at the conceptual level (that is, that religion can influence wealth through social contacts) received empirical support in our study. Thanks to this, our proposal to extend the model presented by Sarofim et al. (2020) to include additional process mechanism mediating between religion and consumer financial outcomes—social contacts—has gained empirical justification.

We believe that the fact that only social contacts proved to be a significant mediator between RSA and savings in our study has a rationale. On the one hand, RSA represents precisely the social (and less theological) dimension of religion (Kirchmaier et al., 2018). RSA is more a measure of belonging than a measure of believing (Noussair et al., 2013) and in this sense it is a variable representing the same domain as social contacts. On the other hand, Keister's work convincingly suggests that social contacts (the accumulated knowledge

and experiences of others) are important particularly for learning the best strategies for saving and investing: "Knowledge about the importance of saving, the avenues available for saving, and saving strategies is at least partly gained through exposure to the savings behaviour of others. Wealth accumulation depends on having information about a number of financial instruments and their features" (Keister, 2003, p. 176). Research shows that learning outcomes are generally weaker for borrowing, as it is most often episodic (Kaiser & Menkhoff, 2017).

Both Keister's results and ours have practical implications. In light of these results, churches and other venues where group religious practices take place can be viewed as spaces that enable financial socialisation. They not only allow people to benefit from the knowledge and experience resources of other believers; as Keister (2003, p. 199) indicates, being "exposed to religious ceremonies, rituals, and values, people develop a set of competencies and habits that they draw on in making decisions about consumption, saving, and investment".

The results of the recent randomised control trial by Bryan, Choi and Karlan (2021) show that churches and other places of religious services can be goal-oriented training sites, where financial goals do not have to be achieved by means of strictly financial training. Bryan et al. (2021) showed that a several-month training programme run by a Protestant pastor and aimed at increasing religiosity led to an increase in the income of its participants (through increasing grit). A meta-analysis by DeHaven et al. (2004) shows that health improvement programmes conducted in religious organisation can improve health outcomes. There is no reason to believe that financial health programmes will not work in a similar way.

Our results also allow for some general reflections relating in some sense to the practical implications of the relationships we noted. If the frequency of attendance in religious services is indeed associated with more savings and less debt (i.e. with greater chances of financial prosperity and well-being), then ongoing secularisation in the Western world may entail the atrophy of an important driver of wealth, namely religiosity—at least among Roman Catholics. Therefore, perhaps the agenda indicating actions to be taken in order to improve the financial literacy, behaviour, and outcomes of consumers should include support for religious groups (e.g., for the Catholic Church in Poland) aimed at preventing the rapid erosion of its role in social and, as it transpires, in the everyday economic life of consumers.

Perhaps the reason for the lack of statistical significance of the mediating effects tested in our study are the specificities of the country in which it was conducted. We speculate that, for some reason, in Poland trust, risk tolerance, and, to a lesser extent, social contacts are not significantly correlated with consumer financial outcomes. This finding certainly requires further research (see Cwynar et al., 2017) into some of the preliminary results regard-

ing the credit and loans market and Pawlikowski et al. (2019) with regard to the results linking religiosity and well-being).

Poland is a country with very low social capital, including very low trust. According to a recent Ipsos global survey (covering 30 countries), in Poland trust in others ranks among the lowest in the world (Ipsos, 2022). Moreover, empirical evidence from Poland shows that believers have significantly lower levels of trust in other people compared to non-believers (Centrum Badania Opinii Publicznej, 2013). Given these findings, the lack of a significant relationship between RSA and general trust is much easier to explain. It seems that in Poland, despite the high degree of attachment to religious tradition and exceptionally high indicators of religiosity, even the sense of community that faith can bring about is not capable of breaking through the barrier of distrust. A symptom of this phenomenon is that more frequent participation in religious services, although positively related to the number of social contacts, does not translate into a greater degree of trust in other people.

Another explanation for the lack of statistical significance of indirect (mediation) effects in our study is that the measurement instruments that were used are responsible for such results. This may be especially true for risk tolerance. Although previous studies imply that smoking may be used as a proxy for risk tolerance (Ida & Goto, 2009; Khwaja et al., 2006; Rindfleisch & Crockett, 1999), we are aware of how imperfect a measure of the phenomenon under study this instrument actually is. However, in the survey we used, there were no other measures of risk tolerance (risk aversion) that could be applied in a longitudinal scheme.

Limitations

When interpreting our results, it is important to keep in mind that they involve only one measure of religiosity—the RSA. RSA represents the social dimension of religiosity and may therefore show different relationships with financial variables than measures of religiosity representing the theological dimension (various measures of religious beliefs). Previous research shows that using different measures of religiosity can generate different effects in the economic and financial domain (Guiso et al., 2003). In the survey we used, however, RSA was the only measure of religiosity available.

In our study, we used dummy variables as proxies for risk tolerance and general trust, which may be questionable, especially with regard to risk tolerance, which we measured by asking respondents whether they smoke cigarettes. Smoking is a nuanced behaviour (one may smoke compulsively, but also occasionally; one may not currently smoke, but at the same time have had years of smoking experience in the past, etc.). Binary coding of

this variable (smoker / non-smoker) ignores these nuances. Previous studies on which we based our assumption that smoking behaviour may be used as a proxy for risk tolerance have captured the gradient of this behaviour instead of treating it in a binary way. For example, Ida and Goto (2009) first divided their sample into current smokers and non-smokers. They then divided non-smokers into never-before and ex-smokers. Finally, using a battery of six questions, they divided current smokers into heavy, moderate, and light smokers. Similarly, generalised trust is an intrinsically complex phenomenon (Robbins, 2022). The use of binary measures—such as the one we used ("Most people can be trusted / can't be trusted")—gives a general picture of this phenomenon, but certainly does not allow for an analysis of its nuances.

Our results are also limited to the Roman Catholic religion, which prevails in Poland. It is known from previous studies that the effects of participation in religious services vary across religious denominations (Guiso et al., 2003; Keister, 2003). Poland is a unique country on the religious map of the world. The point is not only that the level of declared religious affiliation is very high, but above all that it is almost exclusively Roman Catholic. Cross-country data (Arruñada, 2010) shows that no other country can compare with Poland in this regard. Strong attachment to the Catholic Church played an important role in Poland's political transformation (the transition from communism to capitalism) and was intertwined with many social processes. All this may make country-specific factors strong in the effects we have noted. In future research, it would be worthwhile to verify whether RSA shows the same relationship with consumer financial outcomes in countries with a similar structure of its religious market, dominated by Roman Catholics (Ireland, Portugal, Italy—if one considers Europe alone).

Although the approach we used enabled us to link RSA with future financial outcomes in a time-sequential way that allows the risk of reversed causality to be minimised, our results do not allow an unambiguous inference about the direction of the cause-and-effect relationship, which is basically only possible in experimental studies such as those conducted by Bryan et al. (2021) and Benjamin et al. (2016).

Finally, the data we used were collected almost a decade ago (the last wave of the 'Social Diagnosis' took place in 2015; the survey has not been continued since then). During these several years, Polish society has experienced progressive secularisation (including a decline in the number and percentage of participants in group religious services). However, given the nature of the key variable (RSA), which refers to the social aspect of religiosity, we believe that our conclusions are still valid and up to date: those who attend religious services more often report better financial outcomes, which is likely to be due to social contacts and associated financial socialisation in the group.

Conclusions

Using data from the longitudinal 'Social Diagnosis' study of the socio-economic situation of households in Poland, we demonstrate that religious service attendance is sequentially linked to key consumer financial outcomes essential for wealth accumulation. Specifically, we find that it is positively associated with the level of savings relative to income (positively) and negatively associated with the level of debt relative to income. Additionally, religious service attendance is positively correlated with financial satisfaction.

Of the three mediators examined, only social contacts significantly explain the relationship between religious service attendance and savings. However, we found no evidence that risk tolerance or general trust mediate the relationship between religious service attendance and consumer financial outcomes, which we attribute to limitations in the available measures of these variables in the dataset.

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The effects of technology and innovation adoption on firm performance among small and medium enterprises: Evidence from Vietnam's logistics sector

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Abstract

In Industry 4.0, technology and innovation constitute a driver for enhancing firms' performance, particularly for small and medium-sized enterprises (SMEs). Our study aims to examine whether that statement is correct for SMEs in a developing country. We developed a generic model and employed multiple regression techniques, including ordinary least-squares, robust standard errors and weighted least

Keywords

- firm performance
- innovation
- logistics
- supply chain
- technology

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squares, to test this hypothesis and address heteroskedasticity. Using a micro-level dataset including 11,630 SMEs in Vietnam's logistics sector, an emerging logistics market in a developing country, our results reveals that the effects of technology on firm performance may differ depending on particular metrics of this performance. Furthermore, not all forms of innovation significantly affect SME performance. Control variables such as "firm's age", "firm's size", "state ownership", "education of the manager" and "foreign activities" also play a significant role in SME performance, underscoring the importance of both internal capabilities and external technological elements.

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Introduction

Today, the 4.0 technology revolution has permeated all economic sectors; therefore, adopting technology and innovation activities for businesses is an important and urgent requirement to improve the competitiveness of enterprises and maintain their position in the market. Thus, in recent years, there have been numerous studies on the rapid technological development as well as the use of information technology (IT) in corporate organisations (Gërguri-Rashiti et al., 2017). For small enterprises, adopting new production and management technologies is crucial to stay competitive; unfortunately, the majority of these firms tend to view these requirements in negative ways (Sevinç et al., 2018) due to significant barriers such as insufficient skills and human capital (Erjavec et al., 2023). Although SMEs are usually a dynamic force in the economy, the implementation of technology application and innovation presents many difficulties, meaning there are many challenges in improving their efficiency. Given these challenges, we raise the research question: Does the adoption of technology and innovation always positively affect SMEs' firm performance?

In an increasingly competitive environment, business efficiency is always a top concern to SMEs because it determines their existence in the market. Moreover, in the ever-changing environment, SMEs are under tremendous pressure to enhance efficiency, speed, and cost-effectiveness; as a result, they must not only deal with growing challenges, but also strengthen their adaptation capabilities (Taouab & Issor, 2019). Therefore, firm performance is an imperative target of all enterprises. Additionally, Nguyen et al. (2021) affirmed that business operations and supply chain risk resilience are also well-founded in company performance. Hence, the role of technology application and innovation is even more important to SMEs. According to the World Bank (2015) and Gyamera et al. (2023), the integration of information and communication technology (ICT) in organisations has influenced the economic performance of firms in developing countries. Innovation contributes to adding value to products by means of packaging or labelling, adding new features to existing products, or creating new products, for example (Chege et al., 2020). As innovation has been usually linked to the latest knowledge, abilities, or technologies, traditional research has mostly focused on the case of developed countries, not on developing countries (Na & Kang, 2019).

As an emerging logistics market with SMEs constituting approximately 98% of logistics service providers (LSPs), Vietnam was selected for an empirical case study to investigate the effects of technology and innovation on firm performance in a developing country context. The logistics industry has never received such great attention from researchers, business managers, and policymakers as it does today. In Vietnam, although logistics activities have existed for a long time, the concept of logistics was first mentioned in the Commercial Law 2005. The Governmental Decree No. 163/2017/ND-CP, issued on December 30, 2017, concerning the provision of logistics services, categorised 17 logistics services, reflecting the industry's still-immature stage. Our study examines the effects of technology and innovation activities on the firm performance of SMEs in Vietnam's logistics sector. The findings of this study provide practical evidence to help researchers, business managers and policymakers suggest policy implications for enhancing the performance of SMEs, as well as boosting Vietnam's overall logistics capacity. So far, this is one of few studies that specifically focus on SMEs in the logistics sector.

Our study marks an initial move towards bridging the research gap and making a valuable contribution to the literature as well as being useful for decision-makers in that it highlights the impact of technology and innovation on SMEs' performance. Our study demonstrates that technology and innovation do not always have significant effects on firm performance. Among the four technology categories—"internet access", "owning a website", "using software", and "automation"—only the first three significantly enhance both return on assets (ROA) and return on equity (ROE), while "automation" improves only ROA. Of the four innovation categories: "R&D", "product in-

novation", "organisational innovation", and "process innovation" only "organisational innovation" consistently boosts firm performance. This study adds valuable insights to the traditional literature on information systems and IT management practices in logistics, particularly in developing countries like Vietnam.

The rest of this paper is organised as follows: the conceptual model framework and hypotheses development are presented in Section 1. Section 2 covers econometrics models and the testing methodology. Section 3 is dedicated to a case study of Vietnam's logistics sector. The last Section provides conclusions, acknowledges limitations, and suggests research prospects.

1. Model framework and hypotheses development

1.1. Theoretical background

Firstly, the concept of firm performance is generic and has changed over the decades. In theory, firm performance is grounded in two perspectives: the economic perspective, which revolves around maximising profit for the organisation, and the stakeholder approach, which focuses on meeting the needs of individuals or groups who are affected by the organisation's activities (Aifuwa, 2020). The concept of firm performance has become commonly used as a dependent variable in the field of strategic management research (Taouab & Issor, 2019).

The adoption of technology is widely recognized as a key driver of firm performance, particularly for SMEs. The term "technology" used in this study is involved in both ICT and automation. ICT refers to tools and technologies that are used to exchange, distribute and gather information, as well as facilitate communication with each other, either individually or in groups, by using computers and networks that are connected. Furthermore, ICT are media that serve as platforms for the use of both telecommunications and computer technologies in the transmission of information. As highlighted by Lee (2000), ICT facilitates interorganisational linkages, which directly affects the innovation process within an organisational context. Hidalgo and López (2009) also confirmed that innovation can result from new ICT deployment. For automation technology, we need to use a broad definition of automation that encompasses programs that streamline and improve operations through automating even the most basic aspects of tasks, including automatically entering data from manually extracted sources into database fields, as discussed by Tsafnat et al. (2014). Generally, automation in logistics

can be understood as the use of computer software or automated machines to improve the efficiency of logistics companies. The resource-based view (RBV) posits that enterprises can utilise digital technologies to build and implement unique capabilities, such as data analytics, artificial intelligence and digital platforms to achieve their sustainable competitive advantage and improve their overall performance (Wade & Hulland, 2004). For SMEs, internet access, owning a website, using software such as enterprise resource planning (ERP), etc. tools and automation are fundamental digital technologies, which may influence firm performance through organisational capabilities (Wang & Prajogo, 2024), while additionally supporting the optimisation of supply chains by enhancing visibility, communication, and operational efficiency (Wang et al., 2020).

Beyond technology, innovation is widely acknowledged as a core component in enhancing firm performance (Sudrajat et al., 2017). From a RBV perspective, innovation can be regarded as an organisational capability that leverages resources proactively to generate value through new ideas (Wang, 2016). Innovation, according to West and Farr (1990), is the deliberate introduction and use of novel concepts, procedures, products or processes within a role, group or establishment. Such innovation activities are new to the pertinent adoption unit and are intended to offer significant benefits to individuals, communities, groups and organisations. Ramadani et al. (2019) categorised innovation into three primary kinds: (1) "product innovation", which entails launching new or improving existing goods or services; (2) "process innovation", which entails creating new methods of organising and integrating resources into the business production process; and (3) "organisational innovation", which involves the introduction of new or improved operating organisational structure for managing resources of firm. According to the European Commission (2020), research and development (R&D) is a type of innovation activity that involves inventive and methodical efforts to expand the repository of knowledge and develop new applications of existing knowledge. Koellinger (2008) re-affirmed the relationship between technology and innovation, in which innovation follows the adoption of novel technologies.

1.2. Proposed conceptual model framework

The primary purpose of this study is to evaluate how technology and innovation activities affect SMEs' firm performance. Therefore, the target variable is firm performance, whilst technology and innovation are feature variables in addition to control variables. The conceptual model with hypotheses is evolved as follows:

1.2.1. Technology and firm performance

Hidalgo and López (2009) examined factors that lead to and result from ICT adoption in the transportation and logistics service to investigate the performance influence of technology in logistics companies. A sample of data was collected in 2007 from 1,097 businesses involved in logistics-related activities from Germany, France, Poland, Italy, Sweden, Spain, the UK and the US. These businesses are involved in land/road and rail transportation, warehousing and storage, and freight handling, as well as other transportation support activities. Based on actual data from regression models, the authors found empirical evidence corresponding to theoretical predictions, suggesting the positive impact of ICT usage and innovation on company performance. For a particular technology, Ince et al. (2013) assumed that supply chain management practices and ERP systems are crucial for enhancing the performance of companies in Turkey. The authors surveyed 138 managers of Turkish companies and their findings indicated that ERP systems improve firm performance and competitive advantage. Considering transition economies, Gërguri-Rashiti et al. (2017) investigated ICT, innovation, and company performance by using primary data at the firm level. The results demonstrated that by engaging in innovation activities, the performance of the companies is improved. Concerning automation technology, Kromann and Sørensen (2019) confirmed the significant association between automation and profitability and productivity. In addition, Nyaoke and Muturi (2018), improving product quality, employee safety, lead time reduction, labour productivity, and operational performance are the main drivers of logistics automation. Relating to technology, Bellakhal and Mouelhi (2023) surveyed the case of 466 SMEs in Tunisia to shed light on how performance and digitalisation are related. The authors concluded that digitalisation has a positive impact on firm performance, even though the degree of digitalisation among Tunisian SMEs is low due to the lack of necessary resources and skills. In contrast, Guo et al. (2023) used data on Chinese companies during 2013–2020 to examine the impact of digital transformation on total factor productivity and company performance; they discovered the opposite result, due to the increase in management expenses, operation cost rates, and total asset turnover. Hence, to understand better the effect of technology on SMEs' performance, the following set of hypotheses (H_1) is postulated:

H_{1a}: Internet access positively affects firm performance.
H_{1b}: Own website positively affects firm performance.
H_{1c}: Software usage positively affects firm performance.
H_{1d}: Automation positively affects firm performance.

1.2.2. Innovation and firm performance

Most empirical studies corroborate how it is essential for companies to enhance their innovation capabilities for maintaining their competitive advantage. By studying the link between firm performance of international distribution centre operators in Taiwan and their logistics service capabilities, Lu and Yang (2010) found that innovation capability focused on enterprises obtained the greatest performance. Eris and Ozmen (2012) also showed evidence to conclude that innovativeness significantly improves the performance of logistics companies in Turkey. Ul Hassan et al. (2013) investigated how organisational-, product-, process- and marketing innovation all impact on several performance metrics in manufacturing firms in Pakistan. They collected data through survey questionnaires from 150 respondents across the manufacturing, R&D and marketing departments. Their results demonstrated that all innovation categories had positive impacts on firm performance. A typical study focusing on the effect of green innovation was conducted by Chu et al. (2018), who studied 165 third-party logistics providers in China and found a positive effect of green innovation on the financial performance of logistics companies. Another study, by Chege et al. (2020), focused on 240 SMEs in Kenya and the authors used structural equation modelling to analyse the effect of ICT innovation on performance. Their findings indicated that the performance of an enterprise is strongly associated with technical innovation; therefore, it is critical for entrepreneurs to create creative business strategies. Recently, Le et al. (2023) conducted a study on non-state SMEs in Vietnam's manufacturing sector. The results revealed that enterprises implementing innovation activities tend to exhibit better performance than those without, highlighting the crucial role of innovation in improving SMEs' performance. Moreover, in the context of global competitiveness, R&D is essential for enterprises in their business strategies to maintain their competitive position in the sector. Boiko (2022) established that R&D is now increasingly linked to a firm's growth and profitability. Indeed, the positive effect of R&D activity on company performance has been confirmed by many previous researchers (Ramos-Hidalgo et al., 2022). Therefore, to ascertain the effects of innovation activities on SMEs' performance, the following set of hypotheses (H_2) is postulated:

H_{2a}: R&D positively affects firm performance.
H_{2b}: Product innovation positively affects firm performance.
H_{2c}: Organisational innovation positively affects firm performance.
H_{2d}: Process innovation positively affects firm performance.

1.2.3. Firm characteristics and firm performance

To assess the effects of technology and/or innovation on firm performance, researchers have developed research models in different ways. In these models, besides using technology and innovation factors, other factors belonging to characteristics of firms, such as the firm's age, sise, ownership status, manager's education and firm's activities, are used in the models as control variables. The model framework of this study is established by referring to existing studies. According to Admassie and Matambalya (2002), the age of a company has a positive effect on production efficiency; basing on the theory of "learning by doing", authors argued that the older firm tends to produce more efficiently because it has more experience. The authors also agreed that most studies showed the positive effect of a firm's size on its performance. However, Mai et al. (2023) found an inverse relationship between them. Prior to that, when studying the technical efficiency of small-scale industry, Nikaido (2004) also confirmed the negative effect, while Susanti et al. (2022) measured firm size by using the total assets of the firm and found that its size did not affect a firm's performance. As a control variable, ownership is also an important element that affects firm performance, and this was included in the study models by Mai et al., (2023), Ramadani et al. (2019). Regarding human capital, Amran et al. (2014) argued that a more highly educated manager is also a more valuable asset for the firm, since he or she has greater cognitive ability, better decision-making capacity, elevated tolerance for unpredictability, and disposition towards innovation, which together provides them with effective solutions to solve complicated decision-making tasks (Bantel & Jackson, 1989). Additionally, Amran et al. (2014) confirmed that a company performs better when its chief executive officer has a higher education. Furthermore, De Loecker (2013) assumed that firms entering export markets improve their performance by learning through export mechanisms. They explained that businesses operating in global marketplaces can benefit from economies of scale and acquire knowledge by being exposed to more best practices.

In a summary, technology is incorporated in our model framework based on Hidalgo and López (2009), Gërguri-Rashiti et al. (2017), Kromann and Sørensen (2019), Bellakhal and Mouelhi (2023), Guo et al. (2023); meanwhile, innovation is incorporated in the framework based on Alegre et al. (2006), Lu and Yang (2010), Eris and Ozmen (2012), Ul Hassan et al. (2013), and Ramos-Hidalgo et al. (2022). Accordingly, technology encompasses "internet access", "owning a website", "software usage" and "automation", while innovation is measured by "R&D", "product innovation", "organisational innovation" and "process innovation". Factors that are enterprise characteristics constitute as control variables in the model framework. These variables are firm's age, firm's size, ownership status, education of the manager and

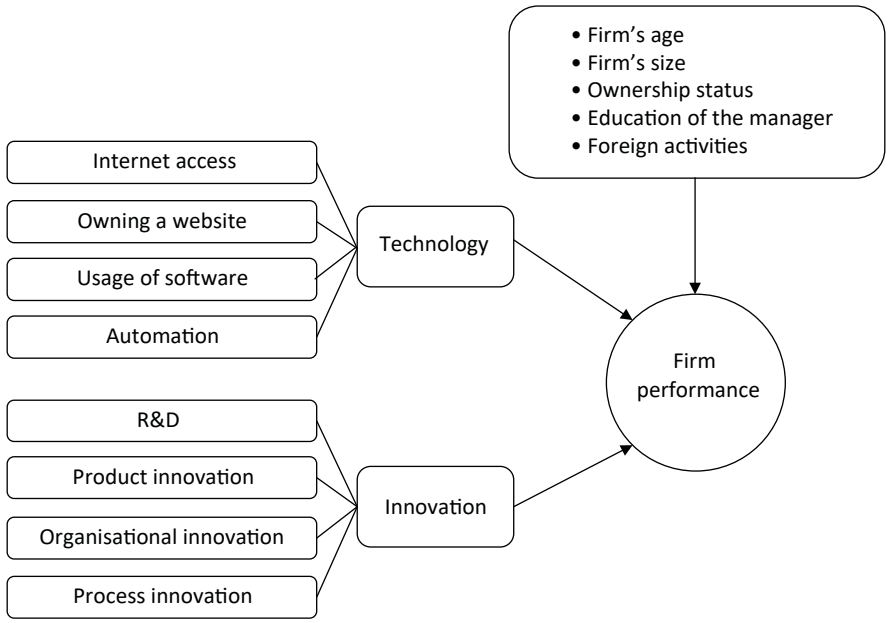

Figure 1. Framework of the study

Source: own elaboration.

foreign activities. Therefore, the generic model framework proposed for this study is presented in Figure 1.

2. Methodology and data

2.1. Econometrics model and methodology

From the framework outlined above, testing models were developed to examine how technology and innovation affect SMEs' firm performance. The two models were created with the same control variables, as follows:

$$FP_i = \alpha_0 + \alpha_1 Firmage_i + \alpha_1 Firmsize_i + \alpha_3 SOEshare_i + \alpha_4 FDIshare_i + \\ + \alpha_5 EM_i + \alpha_6 MX_i + \partial_k Tech_i + \varepsilon_i \quad (1)$$

$$FP_i = \alpha_0 + \alpha_1 Firmage_i + \alpha_1 Firmsize_i + \alpha_3 SOEshare_i + \alpha_4 FDIshare_i + \\ + \alpha_5 EM_i + \alpha_6 MX_i + \tau_k In_i + \vartheta_i \quad (2)$$

In general, the equation 1 and 2 can be rewritten in a short form as the following:

$$FP_i = \alpha_0 + \sum_{i=1}^{k} \beta_i x_i + u_i \quad (3)$$

All variables x_i are clarified in Table A1 in the Appendix, FP_i denotes financial performance (ROA or ROE), while ε_i, ϑ_i and u_i are white noises.

To estimate these models, ordinary least-squares (OLS) is initially used. A key presumption in the OLS method is homoskedasticity, which means that residuals for a regression model do have a constant variance: $Var(u_i) = E(u_i^2) = \sigma^2 \; \forall i = 1, n$. In the event that the homoskedasticity presumption is not met, it leads to biased and inconsistent estimators of the covariance matrix of the parameter estimations, which can result in a variable being found to be significant when in reality it is not (Hayes & Cai, 2007). Thus, White's test for the null hypothesis H_0: homoskedasticity is employed. If there is strong evidence to reject H_0, it indicates that there is a presence of the diagnosis of heteroskedasticity in the model, which means $E(u_i^2) = \sigma_i^2$. In such cases, the OLS estimator no longer meets the criteria for being the best linear unbiased estimator (BLUE) and may not be an effective tool (Romano & Wolf, 2017). To address heteroscedasticity, the robust standard errors technique (hereafter: Robust) can be applied for model regression to adjust the standard errors of the coefficients. Specifically, HC1—one of the heteroscedasticity-consistent (HC) estimators—is used, as recommended by Long and Ervin (2000) for its effectiveness. While Robust can provide more reliable standard errors, this method has limitations, such as not changing the estimated coefficients, which make it still less efficient than those obtained from methods specifically designed to handle heteroskedasticity, such as weighted least squares (WLS).

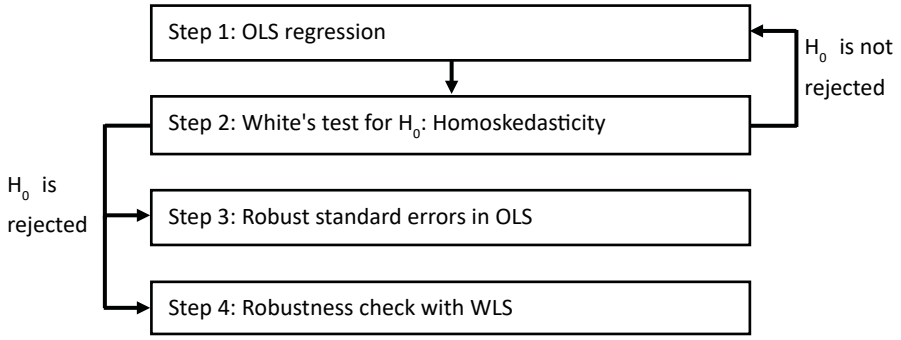

Figure 2. Flowchart for model estimation

Source: own elaboration.

WLS is more efficient than using Robust in OLS because it directly accounts for heteroskedasticity by weighting observations based on their variance. Under heteroskedasticity, WLS approach yields effective and consistent results in comparison to the OLS method (Safa, 2005) and can provide significant improvement over the OLS estimator (Harris et al., 2020). Therefore, the entire process for estimating models in this study is designed as shown in Figure 2. If the general model (model 3) suffers from heteroscedasticity, the WLS method is applied as a robustness check to ensure that the resulting estimators are BLUE. Obviously, assuming that σ_i^2 were determined, to fix heteroskedasticity in the model 3 we divide both sides of the equation 3 with σ_i^2, then the model regression can be written as:

$$\frac{FP_i}{\sigma_i} = \alpha_0 \left(\frac{1}{\sigma_i}\right) + \sum_{i=1}^{k} \beta_i \left(\frac{x_i}{\sigma_i}\right) + \frac{u_i}{\sigma_i} \tag{4}$$

With this new model:

$$Var(u_i^*) = Var\left(\frac{u_i}{\sigma_i}\right) = E\left(\frac{u_i}{\sigma_i}\right)^2 = \frac{1}{\sigma_i^2} E(u_i^2) = 1 \tag{5}$$

since $E(u_i^2) = \sigma_i^2$.

2.2. Measurement

All variables with measurement, expected sign and reference sources used in this study were displayed in Table A1 in the Appendix. Numerous metrics have been proposed to assess firm performance, such as ROA (Ali et al., 2022), ROE (Zhang et al., 2018), Tobin-Q (Akhtar, 2022), etc. A literature review on corporate performance measurements conducted by Al-Matari et al. (2014) showed that ROA is a unique metric, which is most frequently employed—with 46% use, followed by 27% for ROE, and profit margin with 8%. Hagel et al. (2010) pointed out that ROA is a better measure for assessing the financial performance of companies than income statement profitability measures such as return on sales, and it can provide a more thorough viewpoint on the fundamentals of the business, including efficient use of assets. Our study concentrates on the profitability metrics of financial performance indicators, thus both ROA and ROE are preferred to use as proxies for SMEs' firm performance.

3. The case of Vietnam's logistics sector

3.1. Data collection

Following Koellinger (2008) and Na and Kang (2019), this study employs cross-sectional data for analysing the effects of technology and innovation adoption on SMEs' firm performance. Vietnam, an emerging logistics market, was chosen as an ideal case study for a developing country. The dataset encompasses SMEs in the logistics sector of the country from an enterprise survey conducted by the General Statistics Office of Vietnam (GSO) in 2021, taking in 63 provinces and cities. This study emphasises financially healthy, profitable SMEs in the expectation of providing more actionable insights for enterprises that are already performing well. Unlike most of studies, which usually classify the size of enterprises solely based on quantities of labour or capital, the criteria applied for identifying SMEs in this study were based on Article 5 of the Decree No. 80/2021/ND-CP, issued on August 26, 2021 by Vietnam's government, concerning "Elaboration of some articles of the law on provision of assistance for SMEs". Accordingly, SMEs in the field of logistics are enterprises that have an average annual number of employees of no more than 100 employees and total capital recorded in the same year not exceeding 100 billion VND.

3.2. Data processing

The raw dataset required extensive cleaning, including removing duplicates and handling outliers to ensure accuracy and reliability, and also creating new variables for regression modelling. The final dataset includes 11,630 SMEs in Vietnam's logistics sector. Since cross-sectional data usually suffers from heteroskedasticity, following Masood et al. (2009) and Skvarciany et al. (2019), ROA and ROE were log-transformed in order to reduce heteroskedasticity and make highly skewed variables more symmetric and follow normal distribution more closely. Then, the process for model estimation as shown in the flowchart of Figure 2 is performed. The significance level is set to 0.05 ($\alpha = 5\%$) for all the statistical tests, meaning there is a 95% confidence level at least. All stages of data analysis are supported by the software tool STATA version 17.

3.3. Descriptive statistics

The collected data includes a total of 11,630 operating SMEs in Vietnam's logistics sector in 2021. The dataset encompasses a wide range of logistics

services, ranging from very small to medium-sized enterprises, and from newly established businesses to those with a long-standing operational history of up to 29 years (Table 1). The dataset comprises state-owned enterprises (SEOs), which constitute 0.55%, and foreign direct investment (FDI) enterprises, making up 2.24%. On average, the government holds 55.26% ownership in 64 SOEs, whereas 260 FDI enterprises have an average foreign ownership of 82%. The high level of foreign ownership in FDI enterprises reflects Vietnam's strategic openness to multinational corporations and underscores the country's successful attraction of FDI in the logistics sector. Figure 3 illustrates that a significant proportion of enterprises fall under the categories of logistics, with 49.14% engaged in "Freight transport by other motor vehicles (except special-purpose motor vehicles)", followed by "Freight transport by specialised vehicles" at 13.36% and "Other transportation support activities not elsewhere classified (activities of air cargo agents; activities of customs agents" at 11.07%. Additionally, "Inland freight water transport by motor vehicles" accounts for 3.72%; "Shipping agency/freight forwarding services" for 3.45% and "Logistics, including: planning, designing and supporting operations of transportation, warehousing and distribution" for 3.44% (for more information on the categories of logistics services, see Table A2 in the Appendix).

Table 1 shows the standard deviation of ROE (14.1518) is larger than that of ROA (7.7274), indicating that ROA is relatively more stable than ROE. The

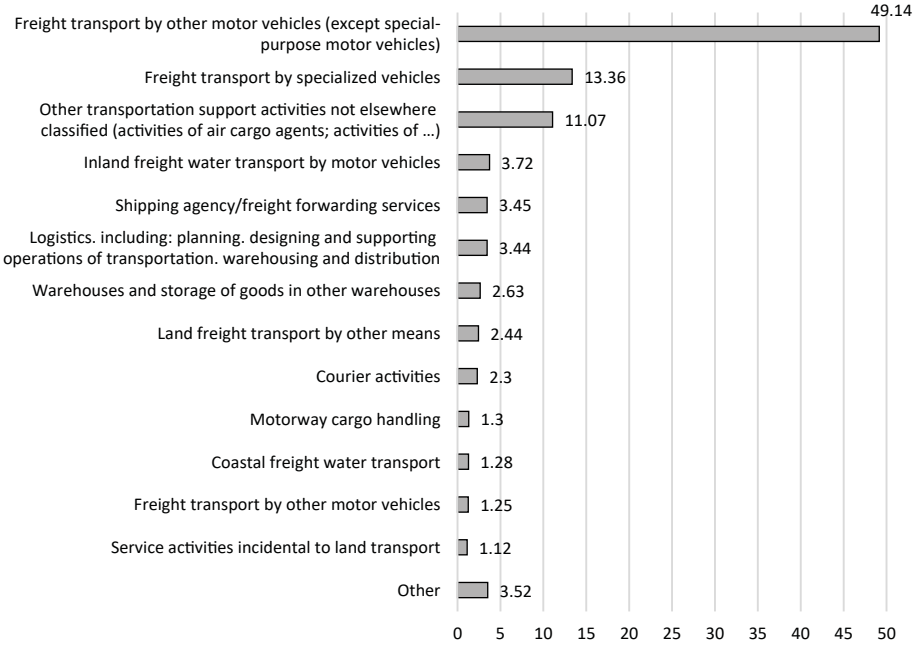

Figure 3. Percentage of LSPs by categories of logistics services

Source: own elaboration.

table also shows that 54.02% of managers have a university degree or higher. Among these SMEs, 7.73% of enterprises engage in import and export activities. Regarding technology adoption, a significant majority of enterprises, specifically 75.07%, utilise Internet connections for their business operations. In contrast, 39.65% of enterprises use management software or platforms. However, owning a website is relatively low at 7.23%, and only 1.23% of enterprises use automation technology systems. With respect to innovation initiatives, a minimal percentage of enterprises, only 0.86%, engage in R&D. Product innovation is implemented by 4.46% of enterprises, while innovation in the organisational model is adopted by 7.96%. Additionally, 6.34% of enterprises innovate in their production and business processes.

Table 1. Descriptive statistics of all raw variables used in models

Variable	Unit	Observations	Mean	Standard deviation	Min	Max
ROA	%	11,630	3.6375	7.7274	4.68E-05	95.96
ROE	%	11,630	7.5898	14.1518	0.0001	99.9378
Firm's age	number of years	11,630	7.5474	5.1040	1	29
Firm's size	million dong	11,630	20,972.89	82,035.18	6.8	3,013,255
SOEshare	%	11,630	0.3041	4.5766	0	100
FDIshare	%	11,630	1.8333	12.5966	0	100
EM	dummy	11,630	0.5402	0.4984	0	1
MX	dummy	11,630	0.0773	0.2671	0	1
Tech_Net	dummy	11,630	0.7507	0.4326	0	1
Tech_Web	dummy	8,731	0.0723	0.2590	0	1
Tech_Us	dummy	11,630	0.3965	0.4892	0	1
Tech_Auto	dummy	11,630	0.0123	0.1102	0	1
In_RD	dummy	11,630	0.0086	0.0923	0	1
In_Product	dummy	11,630	0.0446	0.2065	0	1
In_Organiz	dummy	11,630	0.0796	0.2707	0	1
In_Process	dummy	11,630	0.0634	0.2436	0	1

Note: Definitions of variables are presented in Table A1 in the Appendix.

Source: own elaboration.

The distribution of logistics SMEs across 63 provinces / cities of Vietnam reveals a notable concentration in key economic centres. Ho Chi Minh City, the primary economic and commercial centre, hosts the largest share at 31.56% of enterprises; Hanoi, the capital, follows with 10.03%; Hai Phong, a crucial port city, has 8.02%; Binh Duong and Dong Nai adjacent to Ho Chi Minh City, account for 5.17% and 5.05%, respectively; Da Nang and Binh Dinh in the central coastal area, have 2.83% and 2.55%, respectively, while Ba Ria-Vung Tau has 2.15%. All other provinces and cities have less than 2% of total enterprises.

3.4. Results and discussion

As the first step, OLS regression was performed for both models 1 & 2, utilising two metrics of firm performance: ROA and ROE. Then, White's test for the null hypothesis H_0: Homoskedasticity was implemented. The results indicate that all OLS regression models are statistically significant at the 0.01 level, with Prob > *F* values of 0.0000. However, these models show signs of heteroskedasticity, as evidenced by White's test, which reveals a Prob > chi^2 value of 0.0000. So, the null hypothesis H_0: Homoskedasticity was rejected at the 0.01 level. Since heteroskedasticity is present, the standard errors of the OLS estimates are not reliable. As a common method, the Robust technique can be applied to produce more accurate standard errors. Tables 2 & 3 present the regression results conducted by Robust in OLS on the effects of technology and innovation on firm performance. Basically, Robust is designed to adjust for heteroskedasticity without changing the OLS regression coefficients. As the last step shown in Figure 2, we performed a robustness check to examine the effects of technology and innovation on firm performance using WLS. The full WLS analysis results are presented in Tables 4 & 5.

3.4.1. The effect of technology on firm performance

The results from regressing the effects of technology categories on firm performance using Robust in OLS, as shown in Table 2, indicate that all models are statistically significant at the 0.01 level, with Prob > *F* values of 0.0000. Specifically, "Internet access", "owning a website" and "using software" significantly affect both ROA and ROE at the 0.01 level, indicating a strong positive relationship between these technology categories and firm performance. This suggests that enterprises adopting these technologies register better performance compared to those that do not. These findings are supported by previous studies such as Ince et al. (2013), Gërguri-Rashiti et al. (2017), Bellakhal and Mouelhi (2023), and Guo et al. (2023). In contrast, we did not

find any evidence to support the significant effect of automation on SMEs' performance at the 0.05 level. Thus, "automation" does not significantly affect ROA or ROE at this threshold, suggesting that it does not contribute to firm performance within the context of this study. Our finding differs from the results of Kromann and Sørensen (2019), who reported a significant association between "automation" and profitability and productivity. The *p*-values for "automation" in relation to ROA and ROE when using Robust in OLS regression are above the 0.05 level, recorded at 0.058 and 0.666, respectively. These findings are in line with the proposed hypotheses: H_{1a}, H_{1b} and H_{1c}, while it is not consistent with the hypothesis H_{1d}, which reports a positive effect of "automation" with firm performance. This difference suggests that the effect of "automation" may vary across different contexts or may require specific conditions to manifest.

Additionally, the study found that firm's age positively affects firm performance in all models at the 0.05 level, suggesting that older enterprises tend to perform better. This conclusion is supported by Admassie & Matambalya (2002) through the theory of "learning by doing". In contrast, our study found the significant negative effect of firm's size measured by the total assets of enterprises. This finding is different to most studies, which usually support the positive relationship between the size and the performance of firms. However, this negative effect aligns with the conclusion of Nikaido (2004), who found that firm's size had a significant negative effect on technical efficiency. The study suggests that SMEs receiving supportive policies might have prevented potential capacity. Mai et al. (2023) also noted that many studies have identified the adverse relationship between the size of enterprises and their performance.

Furthermore, this paper verifies the significant positive effect of both foreign ownership and state ownership on firm performance. However, our findings on state ownership differ from Mai et al. (2023), who found a negative impact in the Vietnamese shipping sector, reflecting ongoing debate about the influence of government ownership (Sun et al., 2002). The positive effect of foreign ownership on firm performance can be attributed to technological, managerial, innovation and skills transfers through FDI inflows (Nyeadi, 2023). Notably, our study found that state ownership has a stronger effect on ROA, while foreign ownership has a greater effect on ROE. Specifically, the coefficients for "SOEshare" are consistently higher than "FDIshare" for ROA, whereas for ROE, "FDIshare" coefficients exceed those of "SOEshare". This may be explained that SOEs enhance ROA by promoting stable and efficient asset utilisation, while FDI enterprises boost ROE through profit-maximising strategies and better access to resources and expertise.

Our study also demonstrates that the education of the manager is a critical factor affecting SMEs' firm performance, which is consistent with the findings of Amran et al. (2014). Mai et al. (2023) highlight that a manager's capacity

Table 2. Effects of technology categories on firm performance: Robust in OLS

	ROA				ROE			
Model	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**
LFirmage	0.0867*** (0.0222)	0.0513** (0.0256)	0.0808*** (0.0222)	0.0886*** (0.0222)	0.2015*** (0.0231)	0.1543*** (0.0268)	0.1965*** (0.0231)	0.2035*** (0.0231)
LFirmsize	–0.3467*** (0.0137)	–0.3255*** (0.0155)	–0.3561*** (0.0137)	–0.3450*** (0.0136)	–0.1519*** (0.0138)	–0.1332*** (0.0156)	–0.1601*** (0.0139)	–0.1492*** (0.0137)
SOEshare	0.0303*** (0.0029)	0.0253*** (0.0030)	0.0297*** (0.0029)	0.0304*** (0.0029)	0.0184*** (0.0027)	0.0148*** (0.0027)	0.0179*** (0.0026)	0.0185*** (0.0026)
FDIshare	0.0230*** (0.0016)	0.0210*** (0.0016)	0.0227*** (0.0016)	0.0231*** (0.0016)	0.0217*** (0.0015)	0.0201*** (0.0016)	0.0214*** (0.0015)	0.0217*** (0.0015)
EM	0.2878*** (0.0325)	0.3197*** (0.0378)	0.2848*** (0.0325)	0.2914*** (0.0325)	0.2695*** (0.0340)	0.2910*** (0.0395)	0.2672*** (0.0340)	0.2734*** (0.0340)
MX	0.7216*** (0.0636)	0.6167*** (0.0680)	0.6892*** (0.0635)	0.7374*** (0.0632)	0.7147*** (0.0637)	0.6383*** (0.0675)	0.6876*** (0.0637)	0.7331*** (0.0634)
Tech_Net	0.1171*** (0.0374)				0.1208*** (0.0392)			
Tech_Web		0.5019*** (0.0773)				0.3280*** (0.0760)		

	ROA				ROE			
Model	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**
Tech_US			0.2044*** (0.0336)				0.1853*** (0.0350)	
Tech_Auto				0.2601 (0.1375)				0.0614 (0.1421)
_cons	2.4662*** (0.1154)	2.4208*** (0.1316)	2.5712*** (0.1144)	2.5293*** (0.1148)	1.3455*** (0.1156)	1.3601*** (0.1326)	1.4477*** (0.1152)	1.4042*** (0.1153)
Observations	11,630	8,731	11,630	11,630	11,630	8,731	11,630	11,630
F test	*F*(7, 11622) = 147.35	*F*(7, 8723) = 121.58	*F*(7, 11622) = 153.88	*F*(7, 11622) = 147.44	*F*(7, 11622) = 103.81	*F*(7, 8723) = 87.55	*F*(7, 11622) = 107.29	*F*(7, 11622) = 103.34
Prob > *F*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.1026	0.1061	0.1046	0.1021	0.0608	0.0647	0.0622	0.0600

Note: Robust standard errors are enclosed in parentheses; ** *p*-value < 0.05; *** *p*-value < 0.01.

Source: own elaboration.

to manage and utilise capital is crucial for firm performance. In addition, our results align with De Loecker's (2013), indicating that SMEs engaged in import and export activities tend to exhibit higher firm performance. This confirms Singh et al. (2022), who argue that the process of internationalisation eventually helps to enhance SMEs' economic performance.

3.4.2. The effect of innovation on firm performance

The results from regressing the effects of innovation categories on firm performance using Robust in OLS, as shown in Table 3, indicate that all models are statistically significant at the 0.01 level, with Prob > *F* values of 0.0000. We found that "organisational innovation" consistently demonstrates a positive and significant effect on firm performance measured by both ROA and ROE at the 0.05 level across all models. This implies that if enterprises conduct "organisational innovation" or introduce a new or improved operating organisational structure for managing resources of firm, they tend to have higher performance than those without. In contrast, our analysis did not find any significant effects of "R&D", "product innovation", or "process innovation" on ROA or ROE at the 0.05 level. The regression analysis of the effect of innovation on ROA using Robust in OLS indicates high p-values for "R&D" (0.115), "product innovation" (0.356), and "process innovation" (0.401), suggesting no significant impact. Similarly, the regression of innovation's effect on ROE using Robust in OLS also shows high *p*-values for "R&D" (0.232), "product innovation" (0.327), and "process innovation" (0.396). Therefore, the results of our study suggest that "organisational innovation" is more effective in enhancing firm performance than other types of innovation. This finding is consistent with our hypothesis H_{2c}, which indicates that "organisational innovation" positively affects firm performance, although it is not consistent with the hypotheses H_{2a}, H_{2b} and H_{2d}. Concerning the effect of innovation, Table 3 indicates the limited effect of innovation on SMEs' performance in Vietnam's logistics sector. Tuan et al. (2016) studied the effects of different innovation categories on the performance of enterprises in the supporting industries in Hanoi, Vietnam. They concluded that organisational and process innovation had a positive effect on firm performance, but product innovation did not show a significant effect. On the contrary, Ramadani et al. (2019) studied transition economies and found the positive impact of product innovation on firm performance. Similarly, Na & Kang (2019) focused on enterprises in the manufacturing sector in Vietnam, Indonesia and Malaysia. These authors found that introducing new business production processes or significantly improving existing ones has a negative effect on firm performance. With R&D, Boiko (2022) used data from journals from 1980–2020 and showed the contradictory relationship between R&D and performance. We can therefore

Table 3. Effects of innovation categories on firm performance: Robust in OLS

	ROA				ROE			
Model	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**
LFirmage	0.0890*** (0.0222)	0.0886*** (0.0222)	0.0884*** (0.0222)	0.0885*** (0.0222)	0.2037*** (0.0231)	0.2034*** (0.0231)	0.2034*** (0.0231)	0.2034*** (0.0231)
LFirmsize	–0.3446*** (0.0136)	–0.3443*** (0.0136)	–0.3466*** (0.0136)	–0.3447*** (0.0136)	–0.1496*** (0.0137)	–0.1495*** (0.0137)	-0.1511*** (0.0138)	-0.1499*** (0.0138)
SOEshare	0.0304*** (0.0029)	0.0304*** (0.0029)	0.0304*** (0.0029)	0.0304*** (0.0029)	0.0185*** (0.0027)	0.0185*** (0.0026)	0.0185*** (0.0026)	0.0185*** (0.0026)
FDIshare	0.0231*** (0.0016)	0.0231*** (0.0016)	0.0231*** (0.0016)	0.0231*** (06.001)	0.0218*** (0.0015)	0.0217*** (0.0015)	0.0217*** (0.0015)	0.0217*** (0.0015)
EM	0.2901*** (0.0325)	0.2908*** (0.0325)	0.2898*** (0.0325)	0.2909*** (0.0325)	0.2723*** (0.0340)	0.2725*** (0.0340)	0.2721*** (0.0340)	0.2727*** (0.0340)
MX	0.7329*** (0.0634)	0.7364*** (0.0634)	0.7214*** (0.0637)	0.7356*** (0.0637)	0.7283*** (0.0636)	0.7296*** (0.0636)	0.7194*** (0.0639)	0.7292*** (0.0638)
In_RD	0.2670 (0.1694)				0.2026 (0.1693)			
In_Product		0.0708 (0.0767)				0.0785 (0.0801)		

	ROA				ROE			
Model	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**
In_Organiz			0.1563*** (0.0582)				0.1199** (0.0606)	
In_Process				0.0563 (0.0671)				0.0580 (0.068)
_cons	2.5274*** (0.1149)	2.523611 *** (0.1147)	2.5362*** (0.1146)	2.5268*** (0.1147)	1.4070*** (0.1153)	1.4050*** (0.1151)	1.4138*** (0.1152)	1.4081*** (0.1154)
Observations	11,630	11,630	11,630	11,630	11,630	11,630	11,630	11,630
F test	*F*(7, 11622) = 147.21	*F*(7, 11622) = 147.14	*F*(7, 11622) = 148.67	*F*(7, 11622) = 147.50	*F*(7, 11622) = 103.39	*F*(7, 11622) = 103.41	*F*(7, 11622) = 104.03	*F*(7, 11622) = 103.46
Prob > *F*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.1020	0.1019	0.1024	0.1019	0.0601	0.0601	0.0603	0.0600

Note: Robust standard errors are enclosed in parentheses; ** *p*-value < 0.05; *** *p*-value < 0.01.

Source: own elaboration.

see that there are some clear conflicts regarding the effect of innovation on firm performance.

In line with earlier findings, the Robust analysis confirms that all the control variables significantly affect firm performance at the 0.01 level. Specifically, firm's age positively affects firm performance across all models, suggesting that older firms perform better. It also reaffirms the negative effect of firm's size on firm performance. Both state ownership and foreign ownership continue to exhibit positive effects on firm performance. Furthermore, state ownership has a stronger effect on ROA, while foreign ownership has a greater effect on ROE. Additionally, the Robust results confirm that the education of the manager significantly affects SME performance and that international trade activities such as import and/or export contribute positively to firm performance, aligning with the conclusions before.

3.5. Robustness check

3.5.1. The effect of technology on firm performance

Table 4 presents the effects of technology categories on firm performance using WLS regression. The results strongly confirm the consistent effects of "internet access", "owning a website" and "using software" on firm performance at the 0.01 level. This finding aligns with the hypotheses proposed H_{1a}, H_{1b} and H_{1c}. In particular, the coefficient for "internet access" is 0.1078, indicating that, on average, a logistics enterprise with "internet access" tends to have a 10.78% higher ROA than those without "internet access" (*ceteris paribus*). Similarly, the differences in ROA of enterprises with "owning a website" and "using software" compared to enterprises without using them are 48.15% and 19.99%, respectively (*ceteris paribus*). Additionally, the results indicate that "internet access", "owning a website" and "using software" are associated with increases in ROE of 11.05%, 31.90%, and 18.31%, respectively (*ceteris paribus*). These findings are consistent with Bellakhal & Mouelhi (2023), who used a firm-level dataset of 466 SMEs and found that digitalisation is positively in line with firms' performance. Similarly, Wilson et al. (2015) indicated that the use of IT and information integration systems contributed to the firm performance of logistics companies.

Unlike robust regressions (Table 2), the WLS regression in Table 4 shows a positive significant effect of "automation" on ROA at the 0.05 level, but no significant effect on ROE, with a p-value of 0.595. Therefore, this finding provides partial support for our hypothesis H_{1d} that automation positively affects firm performance. This difference may be attributed to the essence of ROA and ROE. "Automation" can enhance the efficiency of operations by stream-

Table 4. Effects of technology categories on firm performance: WLS regression

	ROA				ROE			
Model	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**
LFirmage	0.0849*** (0.0210)	0.0511** (0.0243)	0.0787*** (0.0210)	0.0867*** (0.0201)	0.1915*** (0.0220)	0.1484*** (0.0254)	0.1848*** (0.0220)	0.1938*** (0.0220)
LFirmsize	–0.3433*** (0.0121)	–0.3221*** (0.0139)	–0.3523*** (0.0122)	–0.3422*** (0.0121)	–0.1424*** (0.0125)	–0.1257*** (0.0144)	–0.1496*** (0.0127)	–0.1403*** (0.0125)
SOEshare	0.0284*** (0.0030)	0.0244*** (0.0033)	0.0278*** (0.0030)	0.0285*** (0.0030)	0.0169*** (0.0031)	0.0139*** (0.0033)	0.0163*** (0.0030)	0.0171*** (0.0030)
FDIshare	0.0215*** (0.0011)	0.0202*** (0.0013)	0.0212*** (0.0011)	0.0216*** (0.0011)	0.0202*** (0.0011)	0.0192*** (0.0012)	0.0199*** (0.0010)	0.0203*** (0.0010)
EM	0.2744*** (0.0328)	0.3103*** (0.0381)	0.2719*** (0.0328)	0.2773*** (0.0328)	0.2693*** (0.0342)	0.2906*** (0.0397)	0.2677*** (0.0342)	0.2727*** (0.0342)
MX	0.7134*** (0.0600)	0.61997*** (0.0653)	0.6804*** (0.0602)	0.7276*** (0.0596)	0.6981*** (0.0599)	0.6331*** (0.0655)	0.6668*** (0.0598)	0.7144*** (0.0595)
Tech_Net	0.1078*** (0.0375)				0.1105*** (0.0393)			
Tech_Web		0.4815*** (0.0734)				0.3190*** (0.0742)		

	ROA				ROE			
Model	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**	**Tech_Net**	**Tech_Web**	**Tech_US**	**Tech_Auto**
Tech_US			0.1999*** (0.0339)				0.1831*** (0.0352)	
Tech_Auto				0.2902** (0.1428)				0.0781 (0.1471)
_cons	2.4581*** (0.1041)	2.3995*** (0.1196)	2.5546*** (0.1027)	2.5197*** (0.1026)	1.2922*** (0.1083)	1.3090*** (0.1239)	1.3822*** (0.1067)	1.3485*** (0.1067)
Observations	11,630	8,731	11,630	11,630	11,630	8,731	11,630	11,630
F test	*F*(7, 11622) = 203.25	*F*(7, 8723) = 153.54	*F*(7, 11622) = 207.86	*F*(7, 11622) = 203.24	*F*(7, 11622) = 140.25	*F*(7, 8723) = 106.13	*F*(7, 11622) = 146.30	*F*(7, 11622) = 140.01
Prob > *F*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.1091	0.1097	0.1113	0.1091	0.0779	0.0785	0.0810	0.0778

Note: Robust standard errors are enclosed in parentheses; ** *p*-value < 0.05; *** *p*-value < 0.01.

Source: own elaboration.

lining processes, reducing errors, and then increasing productivity, which can directly improve the utilisation of assets, leading to better ROA. In contrast, ROE simply measures profitability relative to shareholders' equity, and "automation" might not have an immediate effect on ROE. Despite the important role of automation technology regarding firm profitability and productivity, as highlighted by Kromann and Sørensen (2019), our empirical analysis reveals that only 1.23% of SMEs in the data sample use automation technology systems in their logistics activities (Table 1).

One more time, the WLS results in Table 4 confirms all the control variables significantly affect firm performance at the 0.05 level. Moreover, the study reveals that state ownership has consistently larger effects on ROA compared to foreign ownership, whereas foreign ownership has a greater effect on ROE than state ownership.

3.5.2. The effect of innovation on firm performance

Table 5 presents the effects of innovation categories on firm performance using WLS regression. The regression results show a consistent significant effect of "organisational innovation" on firm performance at the 0.05 level, similar to the findings from Robust regressions. This supports our hypothesis H_{2c}. The coefficients for the variable "In_Organiz" are 0.1558 for ROA and 0.1179 for ROE, indicating that logistics enterprises with "organisational innovation" tend to have a 15.58% higher ROA and an 11.79% higher ROE than those without (*ceteris paribus*). However, we did not find a significant effect of other categories of innovation—"R&D", "product innovation", or "process innovation"—at the 0.05 level, which does not support the hypotheses H_{2a}, H_{2b}, H_{2d}. This is consistent with Koellinger (2008), who found that engaging in innovative activities does not always result in higher profitability. As was the case with Robust regressions, all control variables were proved to consistently affect SMEs' firm performance at the 0.01 level.

Conclusions

The goal of this study was to investigate how the adoption of technology and innovation affects SMEs' firm performance. Focusing on 11,630 financially stable and profitable SMEs in Vietnam's logistics sector, we aimed to provide robust, interpretable, and actionable insights for firms already performing well. This research is among the few studies targeting SMEs in the logistics sector. We developed a model framework where "technology" was

Table 5. Effects of innovation categories on firm performance: WLS regression

	ROA				ROE			
Model	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**
LFirmage	0.0872*** (0.0210)	0.08678*** (0.0210)	0.0865*** (0.0210)	0.0867*** (0.0210)	0.1942*** (0.0220)	0.1938*** (0.0220)	0.1937*** (0.0220)	0.1937*** (0.0220)
LFirmsize	–0.3418*** (0.0121)	–0.3413*** (0.0121)	–0.3436*** (0.0121)	–0.3415*** (0.0121)	–0.1407*** (0.0125)	–0.1406*** (0.0125)	–0.1424*** (0.0126)	–0.1408*** (0.0126)
SOEshare	0.0285*** (0.0030)	0.0285*** (0.0030)	0.0285*** (0.0030)	0.0285*** (0.0030)	0.0170*** (0.0030)	0.0171*** (0.0030)	0.0171*** (0.0030)	0.0170*** (0.0030)
FDIshare	0.0217*** (0.0011)	0.0216*** (0.0011)	0.0216*** (0.0011)	0.0216*** (0.0011)	0.0203*** (0.0010)	0.0203*** (0.0011)	0.0203*** (0.0011)	0.0203*** (0.0011)
EM	0.2760*** (0.0328)	0.2767*** (0.0328)	0.2755*** (0.0328)	0.2769*** (0.0328)	0.2714*** (0.0342)	0.2718*** (0.0342)	0.2713*** (0.0342)	0.2720*** (0.0342)
MX	0.7234*** (0.0598)	0.7271*** (0.0598)	0.7121*** (0.0600)	0.7268*** (0.0599)	0.7106*** (0.0597)	0.7116*** (0.0597)	0.7018*** (0.0600)	0.7113*** (0.0597)
In_RD	0.2692 (0.1695)				0.1939 (0.1716)			
In_Product		0.0651 (0.0770)				0.0734 (0.0788)		

	ROA				ROE			
Model	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**	**In_RD**	**In_Process**	**In_Organiz**	**In_Process**
In_Organiz			0.1558*** (0.0590)				0.1179** (0.0604)	
In_Process				0.0464 (0.0659)				0.0519 (0.0674)
_cons	2.517*** (0.1026)	2.5129*** (0.1026)	2.5257*** (0.1026)	2.5149*** (0.1028)	1.3512*** (0.1067)	1.3493*** (0.1067)	1.3606*** (0.1068)	1.3512 *** (0.1068)
Observations	11,630	11,630	11,630	11,630	11,630	11,630	11,630	11,630
F test	*F*(7, 11622) = 202.65	*F*(7, 11622) = 202.41	*F*(7, 11622) = 203.63	*F*(7, 11622) = 202.37	*F*(7, 11622) = 139.98	*F*(7, 11622) = 139.79	*F*(7, 11622) = 140.13	*F*(7, 11622) = 139.91
Prob > *F*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R-squared	0.1088	0.1087	0.1092	0.1086	0.0778	0.0777	0.0778	0.0777

Note: Robust standard errors are enclosed in parentheses; ** *p*-value < 0.05; *** *p*-value < 0.01.

Source: own elaboration.

measured by "internet access", "owning a website", "using software" and "automation", whilst innovation activities included "R&D", "product innovation", "organisational innovation" and "process innovation". The control variables in the models included firm's age, firm's size, status of ownership, education of the manager and foreign activities.

Initially, OLS regression was performed, followed by White's test, which showed the existence of heteroskedasticity in all models. The Robust technique was then applied to produce more accurate standard errors in OLS regressions. Finally, we performed a robustness check to examine the effects of technology and innovation on firm performance using weighted least squares. The empirical results highlighted the insight that the effects of technology on firm performance may differ according to different metrics of firm performance. In particular, we found robust relationships of "Internet access", "owning a website" and "using software" on firm performance at the 0.01 level across Robust and WLS regressions, while "automation" only affects ROA significantly. The finding also revealed a consistent, positive and significant effect of "organisational innovation" on firm performance at the 0.05 level in all regression models, indicating that not all forms of innovation significantly affect SMEs' firm performance. Additionally, the study confirmed the positive significant of firm's age, state ownership, education of the manager, and foreign activities on firm performance, and also the negative significant effect of firm's size measured by total assets. Notably, state ownership appeared to have a stronger effect on ROA, while foreign ownership had a greater effect on ROE, indicating a potential effect of different capital structures on SMEs' profitability.

Understanding the extent to which technology adoption and innovation is essential for SMEs, as well as their effects on firm performance, offers valuable insights for practitioners and policymakers. Despite the challenges associated with building data on the level of technology and innovation application for SMEs, addressing this gap presents an important avenue for future research. Moreover, future studies may consider additional financial performance metrics, such as return on sales, to fully understand the effects.

Appendix

Table A1. List of all variables used in the study

Variables	Explanation	Expected sign	Study
FP – Financial performance measures			
1 ROA	Return on assets = Net income/Total assets		Salim & Susilowati (2020), Ali et al. (2022)
2 ROE	Return on equity = Net income/Total equity		Zhang et al. (2018), Guo et al. (2023)
Control variables			
1 Firmage	Duration since the company established till 2021 (in the natural logarithm)	+	Ramadani et al. (2019), Jang & Ahn (2021)
2 Firmsize	Natural logarithm of total assets	+/–	Huang et al. (2022), Mai et al. (2023)
3 SOEshare	Ownership, as percentage of state ownership of the enterprise	+/–	Sun et al. (2002), Mai et al. (2023)
4 FDIshare	Ownership, as percentage foreign ownership of the enterprise	+	Ramadani et al. (2019), Nyeadi (2023)
5 EM	= 1 if the manager's education is from university and above; = 0 otherwise	+	Amran et al. (2014), Ali et al. (2022)
6 MX	= 1 if the enterprise is covering import and (or) export activities; = 0 otherwise	+	De Loecker (2013), Mai et al. (2023)
Feature variables regarding technology			
1 Tech_Net	= 1 if the enterprise uses internet access in production and business activities; = 0 otherwise	+	Gërguri-Rashiti et al. (2017), Zhong et al. (2020)
2 Tech_Web	= 1 if the enterprise has its own website; = 0 otherwise	+	Gërguri-Rashiti et al. (2017)
3 Tech_US	= 1 if the enterprise uses software in production and business activities; = 0 otherwise	+	Hidalgo & López (2009), Gërguri-Rashiti et al. (2017)
4 Tech_Auto	= 1 if the enterprise uses automation technology in production and business activities; = 0 otherwise	+	Nyaoke & Muturi (2018), Kromann & Sørensen (2019)
Feature variables regarding innovation			
1 In_RD	= 1 if the enterprise has R&D activity; = 0 otherwise	+	Ramos-Hidalgo et al. (2022), Boiko (2022)

Variables	Explanation	Expected sign	Study
2 In_Product	= 1 if the enterprise has product innovation; = 0 otherwise	+	Ramadani et al. (2019), Le et al. (2023)
3 In_Organiz	= 1 if the enterprise has innovation/ improvement to the operating organisation model; = 0 otherwise	+	Ul Hassan et al. (2013), Tuan et al. (2016)
4 In_ Process	= 1 if the enterprise has innovation/ improvement to production and business processes; = 0 otherwise	+	Ul Hassan et al (2013), Ramadani et al. (2019)

Source: own elaboration.

Table A2. List of all categories of logistics activities in the data sample

Scode 5	Categories of logistics activities	Frequency	Percent
49332	Freight transport by other motor vehicles (except special-purpose motor vehicles)	5,715	49.14
49331	Freight transport by specialised vehicles	1,554	13.36
52299	Other transportation support activities not elsewhere classified (activities of air cargo agents; activities of customs agents…)	1,287	11.07
50221	Inland freight water transport by motor vehicles	433	3.72
52291	Shipping agency/freight forwarding services	401	3.45
52292	Logistics, including: planning, designing and supporting operations of transportation, warehousing and distribution	400	3.44
52109	Warehouses and storage of goods in other warehouses	306	2.63
49339	Land freight transport by other means	284	2.44
53200	Courier activities	267	2.3
52242	Motorway cargo handling	151	1.3
50121	Coastal freight water transport	149	1.28
49333	Freight transport by other motor vehicles	145	1.25
52259	Service activities incidental to land transport	130	1.12
52222	Service activities incidental to sea and coastal transportation	60	0.52
52101	Warehouses and storage of goods in bonded warehouses	57	0.49
53100	Postal activities	48	0.41
52244	Inland water cargo handling	44	0.38

Scode 5	Categories of logistics activities	Frequency	Percent
50122	Sea freight water transport	35	0.3
52102	Warehouses and storage of goods in refrigerated warehouses (except bonded warehouse)	34	0.29
52243	Seaway cargo handling	31	0.27
52224	Service activities incidental to inland water transport	29	0.25
52239	Service activities incidental to air transportation	15	0.13
52210	Service activities incidental to rail transportation	12	0.1
49120	Freight rail transport	10	0.09
52221	Operation of harbors	11	0.09
50222	Inland freight water transport by non-motorised vehicles	9	0.08
52223	Operation of inland ports	3	0.03
52241	Railway cargo handling	4	0.03
49400	Transport via pipeline	2	0.02
51209	Other freight air transport	2	0.02
49334	Freight transport by non-motorised vehicles	1	0.01
52245	Air cargo handling	1	0.01
Total		11,630	100

Note: The 5-digit codes is pursuant to the Decision No. 27/2018/QD-TTg, issued on July 06, 2018, by the Prime Minister, concerning "Promulgating Vietnam standard industrial classification".

Source: own elaboration.

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Relationship between corporate sustainability performance and corporate financial performance: The case of companies from the WIG-ESG Index

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Abstract

The aim of this paper is to identify the effect of corporate sustainability performance (CSP) on corporate financial performance (CFP) among Polish companies in all dimensions of sustainability. The main research hypothesis states that the relationship between CSP and corporate sales performance is positive. The empirical verification of this hypothesis was conducted among 21 companies from the WIG-ESG Index in two periods: 2012–2021 and 2016–2021. The main finding is that sales revenues are positively affected by environmental sustainability performance (years 2012–2021), while governance sustainability performance has a positive impact on the return on sales (years 2016–2021).

Keywords

- sustainable development
- corporate sustainability
- ESG scores
- productivity effect

JEL codes: D24, F23, M14

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Introduction

Corporate sustainability (CS), understood as meeting the needs of all of a firm's current stakeholders without compromising the needs of its future stakeholders (Dyllick & Hockerts, 2002), requires the inclusion of global sustainable development goals (SDGs) (SDSN, 2013) into the business strategy of a company (Giovannoni & Fabietti, 2013). To achieve these SDGs, which express the global concept of balance between economic growth, environmental integrity, and social welfare recognising established institutional framework (Mensah, 2019; UN, 2012; WCED, 1987), the company should consider the environmental and social costs of its business activity and do so in the decision-making process at the strategic level (Aluchna, 2015; Gray, 2010; Knežević & Škrobot, 2021). This implies that the company should build financial, natural, and human capital in compliance with the rules of law (Burchard-Dziubińska, 2014; Gond et al., 2012) to mitigate the negative effects of its business activity and to create long-term value for all stakeholders (Oželienė, 2017; Witkowska, 2016).

In terms of these issues, CS is a trend aimed at the business success in terms of economic, environmental, social, and governance performance of a company (Sanders & Wood, 2015). However, previous empirical studies on the relationship between corporate sustainability performance (CSP) and corporate financial performance (CFP) tended to focus on sustainability in environmental, social, and governance dimensions, overlooking the economic dimension. Additionally, these studies did not typically consider sales performance as CFP. The purpose of this paper is to identify the effect of CSP on CFP as represented by sales performance among Polish companies, including all dimensions of sustainability. The general research hypothesis states that the relationship between CSP and corporate sales performance is positive. Empirical verification of this hypothesis was conducted among 21 Polish companies from the WIG-ESG Index in the periods 2012–2021 and 2016–2021. The main research method was panel regression estimation. The empirical data was retrieved from the Refinitiv (Thomson Reuters) Eikon database and the Emerging Market Information Service (EMIS). The estimation results indicate that sales revenues (SR) are positively affected by environmental sustainability performance in the long run, while in the short run, governance sustainability performance has a positive impact on the return on sales (ROS).

The paper is structured as follows: Section 1 provides a literature review; Section 2 describes the research hypotheses, data and methodology; Section 3 reveals the estimation results and discusses the research findings. The final Section presents the conclusions.

1. Literature review

According to the Triple Bottom Line (TBL) Approach (Elkington, 1997, pp. 70–92), CS encompasses three main dimensions: economic, environmental, and social, which should be fully and authentically integrated, as they are interdependent. This interdependence cannot be ignored because companies can address issues arising in "shear zones" only when sustainability dimensions are not treated in isolation from one another. Therefore, companies must revise their growth strategies to incorporate all sustainability dimensions and find a balance between them. Such changes in corporate strategies seem crucial to meet the expectations of various stakeholder groups simultaneously.

The TBL Approach is a fundamental concept of CS, which has been modified by other authors (Oželienė, 2017), who have added new dimensions of sustainable development, creating various multiple bottom-line models (Brockett & Rezaee, 2012). However, the most commonly used approach today is the Quadruple Bottom Line (QBL) model (Budsaratragoon & Jitmaneeroj, 2019), which includes governance as a fourth sustainability dimension alongside the economic, environmental, and social ones. This model aligns with the sustainable development policy of the United Nations (Mensah, 2019), where the implementation of good governance practices is a prerequisite for sustainability in the other dimensions (SDSN, 2013).

The research that focuses on explaining the relationship between corporate sustainability performance (CSP) and corporate financial performance (CFP) is interdisciplinary and multidirectional. Theoretical studies aim to create the integrated business model describing the mechanisms by which CS efforts in particular dimensions can enhance stakeholder satisfaction and improve a company's profitability and market value (Kantabutra & Ketprapakorn, 2020; Perrini et al., 2011). At the same time, as shown in detail in Table 1, empirical studies apply quantitative research methods:

- to verify the CSP-CFP relationship in non-financial corporations and financial institutions;
- to test the bidirectional and non-linear relationship between CSP and CFP;
- to determine how the sustainability of a country or an industry affects the CSP-CFP relationship;
- to compare the effect of CSP on CFP across different countries and industries.

The empirical studies on the relationship between CSP and CFP are very extensive (Li et al., 2024), but they do not provide clear conclusions. Lu and Taylor (2016), who analysed 198 previous studies on the CSP-CFP relationship, claim that the main reason for this is variation in the adopted research methodology. The CSP-CFP link is found to be positive, especially when re-

Table 1. The main empirical findings on the CSP-CFP link

Authors	Sample/Period/Data/Empirical model	Main results
Wagner (2010)	The U.S. companies listed on the S&P 500 Index/ 1992–2003/ KLD database/ Panel regression model	The effect of joint sustainability performance on Tobin's *Q* is positive and moderated by the intensity of advertising. The impact of environmental performance on Tobin's *Q* is positive and direct. The impact of social performance on Tobin's *Q* is positive and indirect.
Nollet et al. (2016)	Companies listed on the S&P 500 Index/ 2007–2011/ Bloomberg database/ Panel regression model	The U-shaped relationship between CSP and CFP exists only in the case of CFP expressed as the return on assets (ROA) and the return on capital (ROC) and CSP measured by the overall ESG score and the governance score.
Zhao and Murrell (2016)	Companies listed on the S&P 500 Index/ 1991–2013/ KLD database/ Panel regression model	The original study (Waddock & Graves, 1997) reports a positive bidirectional relationship between CSP and CFP, measured by three profitability ratios—return on assets (ROA), return on equity (ROE), and return on sales (ROS). The replication results of Zhao and Murrell are: the accounting financial performance (ROA, ROE, and ROS) has a positive impact on CSP, but it is smaller than in the original research; the financial market performance, measured as Tobin's *Q*, market-to-book value (MTB) and market value added (MVA), could have a positive impact on CSP (the reported effect is very small); the impact of CSP on accounting financial performance is positive but statistically insignificant for ROE and ROS—the significant effect on ROA is smaller than in the original research; the impact of CSP on market financial performance is positive but statistically insignificant for all measures.
Agnese et al. (2024)	The Canadian companies listed on the S&P/TSX Composite Index/ 2014–2021/ LSEG Workspace and Bloomberg Termina Database/ Dynamic panel regression model	ESG engagement significantly affects profitability, measured as the return on assets (ROA) and the EBITDA margin (earnings before interest, taxes and depreciation as a percent of total revenues). The environmental dimension improves profitability—its effect increases with the social dimension and decreases with the governance dimension.

Authors	Sample/Period/Data/Empirical model	Main results
Jha & Rangarajan (2020)	The Indian companies listed on the S&P BSE 500 Index/ 2008–2018/ Bloomberg database/ Panel regression model	The return on assets (ROA) is negatively affected by the aggregate ESG score and the environmental score. Tobin's *Q* is negatively affected by the aggregate ESG score and the environmental score, as well as the governance score. The CSP-CFP link is bidirectional.
Behl et al. (2022)	The Indian energy companies listed on Nifty 500 Index/ 2016–2019/ Bloomberg database/ Cross-lagged panel model	The overall ESG score and its particular components have significant impact on Tobin's *Q*—this impact is negative in the short run (the first two lags) and positive in the long run (the last lag). The relationship between ESG scores and Tobin's *Q* is not bidirectional.
Tuppura et al. (2016)	Different industries in the U.S./ 1991–2009/ MSCI ESG Research database/ Panel regression model	Bidirectional causality between CSP and CFP exists in the clothing, energy and forest industries, but not in the food industry. The bidirectional causality between CSP and CFP in the clothing and energy sectors is evident both in the case of the return on assets (ROA) and market capitalisation. The bidirectional causality between CSP and CFP in the forest sector is evident only in the case of ROA.
Soana (2011)	International and the Italian banks/ 2005/ Three agencies: Ethibel, Axia and AEI/ Correlation analysis	Correlations between CSP, measured by global ethical ratings, and CFP are not significant in both international and Italian banks. Correlations between CSP, measured by analytical ethical ratings, and CFP are significant only in international banks—the significant correlations in international banks, which are negative, exist between the internal social rating and CFP, expressed as return on assets (ROA), the price-to-book ratio (P/B), and the price-to-earnings ratio (P/E).
Nizam et al. (2019)	Banks from different countries/ 2013–2015/ MSCI ESG Research database/ Cross-sectional regression model	The banks' return on equity (ROE) is positively influenced by social performance (access to finance) and environmental performance (environmental financing). The impact of access to finance on the banks' ROE is shaped by the management quality and the growth of loans. The impact of environmental financing on the banks' ROE is shaped only by the loan growth.

Authors	Sample/Period/Data/Empirical model	Main results
Xiao et al. (2018)	Different countries/ 2013/ United Nations and Yale University Panel regression model	The effect of country-level sustainability performance (CLSP) on the positive relationship between CSP and CFP is negative—the positive CSP-CFP link is insignificant when the CLSP is high, and significant when it is low.
Tran and Pham (2022)	Global companies from the ranking of Fortune World's Most Admired Firms/ 2005–2011/ Bloomberg database/ Panel regression model	The ESG score has a positive influence on sales performance, measured as sales revenues. The effect of a firm's social disclosure on sales revenues is significantly positive, while there is no significant effect of the environmental and governance disclosures. Research results do not change when only non-financial companies are investigated, or when the analysis is conducted separately in crisis and non-crisis years.
Yilmaz (2021)	Non-financial companies from BRICS/ 2014–2018/ Sustainalytics database/ Panel regression model	The total ESG score has a significantly positive effect on return on assets (ROA) and return on equity (ROE)—the effect on operating profit margin (OPM) and net profit margin (NPM) is not significant. Individual ESG scores reveal mostly insignificant effects—the social score has a significantly positive effect on ROE and OPM, while the governance score has a significantly positive effect only on ROE.
A. Ziegler et al. (2007)	The European companies/ 1996–2001/ Swiss bank Sarasin & Cie in Basle/ Cross-sectional regression model	The relative sustainability performance of the company within a given industry—neither environmental nor social performance—has no significant effect on the average monthly stock return. The average environmental performance of the industry has a significantly positive impact on the average monthly stock return. The average social performance of the industry has a significantly negative impact on the average monthly stock return.

Authors	Sample/Period/Data/Empirical model	Main results
W. Przychodzeń (2013)	The largest companies from the U.S. (S&P 500), U.K. (FTSE 350), Polish (WIG) and Hungarian (BUX) markets/ 2006–2010/ Non-financial reports available on the corporate websites/ Descriptive statistics and testing the significance of differences Cross-sectional regression model	The average annual rate of return on the market portfolio is lower than this rate on the portfolio of companies regarded as sustainable—the average stability of valuation for the market index is lower than for sustainable companies. The rate of return on the portfolio of sustainable companies does not reveal the countercyclicality to this rate on the market portfolio—there are some significant differences between the countries analysed. The average annual rate of revenues growth for non-sustainable companies is higher than this rate for sustainable companies—sales revenues in non-sustainable companies are less stable than in sustainable companies. The investment in sustainable companies generates benefits for shareholders—the scale of these benefits depends on the level of market development.
M. Mikołajek-Gocejna (2024)	Companies listed on the Polish capital market in WIG-ESG/ 2019–2022 Refinitiv database/ Cross-sectional regression model	ESG ratings (both overall ESGR and partial ratings) have a negative impact on a company's value, measured by Tobin's *Q* (market value to book value), but this impact is not statistically significant.
Bumin and Ertuğrul (2024)	Companies listed on the BIST Sustainability Index/ 2022/ Refinitiv database/ Cross-sectional regression model	The association with sales profitability, measured as the net profit margin (NPM), is positive for the environmental score and negative for the social score—both effects are statistically significant. The earning per share is positively affected only by the social score.

Source: own elaboration.

searchers use simple methods of analysis and when studies are conducted in the long period before 2,000 among non-U.S. companies operating in various industries. What is more, the positive effect of CSP on CFP occurs, especially when CSP refers to the environmental dimension and CFP is expressed in accounting measures. However, it is important to mention that differences in research results may stem from both the selected CFP measures and the rating agency providing the CSP measures (Berg et al., 2022).

Summarising, the results of empirical studies on the CSP-CFP relationship can differ due to methodological reasons (Bruna & Lahouel, 2022). It should also be emphasised that previous research has not considered all dimensions of CS outlined in the QBL Approach. Thus far, researchers have focused on CSP in the environmental, social, and governance (ESG) dimensions, overlooking the economic one. Additionally, most studies are based on CFP measures such as Tobin's *Q*, ROE, and ROA, frequently neglecting the impact of CSP on sales performance (Tran & Pham, 2022). Given that an improvement in sales revenues is one of the first signs of the positive impact of a company's increasing involvement in sustainable initiatives (Agnese et al., 2024; Kantabutra & Ketprapakorn, 2020; Perrini et al., 2011; Waddock & Graves, 1997; Witkowska, 2016), the relationship between CSP and sales performance should also be investigated.

Furthermore, an analysis of previous research highlights that the CSP-CFP relationship has not been sufficiently examined on the Polish market. Przychodzeń (2013) found that sustainable companies have lower but more stable sales growth than unsustainable companies, without assessing the impact of CSP on the growth rate of revenues. Sikacz and Wołczek (2018) used ESG data to evaluate the sustainability level in companies on the Respect Index, but they did not investigate the CSP-CFP relationship at all. Daszyńska-Żygadło (2019) revealed that the inclusion in the Respect Index improves ROA. Mikołajek-Gocejna (2024) analysed companies on the WIG-ESG Index, identifying no impact of ESG scores on Tobin's *Q*. Overall, these studies did not examine the effect of CSP on sales performance or incorporate economic sustainability performance.

2. Research hypotheses, data and methodology

The identification of the research gap has become a motivation to conduct own empirical studies on the CSP-CFP link. This study incorporates economic performance as the possible fourth determinant of CFP, alongside environmental, social, and governance ones to examine the impact of all sustainability dimensions on sales revenues and profitability in Polish companies. The

main research hypothesis states that the effect of CSP on the CFP, as represented by sales performance, is positive. To specify this hypothesis, the following five sub-hypotheses have been formulated:

H1: The impact of joint environmental, social, and governance performance on sales performance is positive.
H2: The impact of environmental performance on sales performance is positive.
H3: The impact of social performance on sales performance is positive.
H4: The impact of governance performance on sales performance is positive.
H5: The impact of economic performance on sales performance is positive.

The relationship between CSP and sales performance appears to be positive, as suggested by stakeholder theory, which is the most widely used framework to explain the effects of ESG disclosures on CFP (Li et al., 2024). Stakeholder theory asserts that a company should take action to protect the natural environment, maintain social relations, and provide adequate disclosures about its activities to meet the expectations of all stakeholder groups, without whose support its functioning and development would be impossible (Freeman & McVea, 2001). A company's involvement in sustainable initiatives enhances its brand image and reputation, as well as the trust and loyalty of various stakeholders, ultimately leading to cost savings, revenue growth, and higher profitability (Agnese et al., 2024; Waddock & Graves, 1997).

The research hypotheses are verified empirically using companies from the WIG-ESG Index (GPW Benchmark, 2022a), which has been calculated since September 3, 2019, and includes 60 companies from the WIG20 and mWIG40 indices, taking into account share prices, dividend income, ESG ratings from Sustainalytics, and compliance with the Warsaw Stock Exchange's 2002 Best Practice principles. Unfortunately, the final research sample consists of 21 companies, not 60 (GPW Benchmark, 2022b), due to the lack of data on CSP for all companies from the WIG-ESG Index in at least a ten-year period. What is more, the ten-year period had to be shortened when CSP in the economic dimension is analysed because the data on economic sustainability performance is available only for six years. To summarise, the empirical investigation is conducted in two periods:

- in the years 2012–2021 (the ten-year period) when just environmental, social, and governance sustainability performance is analysed (210 firm-year observations: panel A);
- in the years of 2016–2021 (the six-year period) when economic sustainability performance is incorporated in the analysis (126 firm-year observations: panel B).

According to the sector classification of EMIS, the companies examined operate across various sectors, with the majority involved in finance and insurance (eight companies), as well as energy and utilities (eight companies).

Additionally, three companies are active in telecommunications, media and technology, while one company is engaged in food and beverage production and another in wholesale. Considering financial and insurance companies in the study was important because they play a dual role in achieving SDGs. They not only adopt sustainable practices within their own operations, but also offer preferential services to customers who implement sustainable projects. To ensure the comparability of sustainability pillar scores between companies, weighted scores were used in the study. The weights assigned to particular ESG pillar scores reflect their importance in a company's business activities and vary depending on the sector in which the company primarily operates.

The financial data was retrieved from EMIS, while the sustainability data, including the weights for particular ESG pillar scores, was sourced from the Refinitiv Eikon database (data access: 27.06.2022). The CSP in the economic dimension was collected from the Sustainable Leadership Monitor (SLM), which is the specialised application of the Refinitiv Eikon database. To the best of the author's knowledge, this database is the only one that provides assessments of CSP (Galbreath, 2013) across all four dimensions of sustainable development: environmental, social, governance, and economic. Economic sustainability performance is represented by the long-term returns pillar score.

The empirical verification of five sub-hypotheses is based on the extended Cobb-Douglas (1928) production function, which in a logarithmic form, after denoting companies by i, the time period in years by t ($t = 1, 2, \ldots$), and the residual by μ, is as follows (Jones, 1993):

$$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta \mathbf{X}_{i,t-1} + \mu_{i,t} \tag{1}$$

where:

- V (output): CFP measured by the real value of sales revenues (*SR*) in thousands of PLN ($CPI_{2010=100}$);
- K (capital input): the average real value of tangible fixed assets (*ATFA*) in thousands of PLN ($CPI_{2010=100}$) calculated as the arithmetic mean of TFA_t and TFA_{t-1};
- L (labour input): the average full-time employment (*AFTE*) in the number of full-time employees calculated as the arithmetic mean of FTE_t and FTE_{t-1};
- $\mathbf{X}$: a vector of CSP, which covers one-year lagged corporate sustainability scores.

In this research, it is crucial to apply sales revenues as the dependent variable because, as mentioned, an improvement in sales revenues is one of the first signs of the positive impact of a company's increasing involvement in sustainable initiatives. Additionally, this positive impact may not be fully captured when measures of CFP that account for the costs of sustainability activities are used.

With regard to the extended Cobb-Douglas production function, sixteen panel regression models, which differ from each other by the vector $\mathbf{X}$, are proposed. These models are presented in Table 2. The vector $\mathbf{X}$ can consist of the following sustainability variables[2]:

- $ESGS$ is the joint environmental, social, and governance score, calculated as the sum of weighted scores in particular sustainability pillars;
- w_{EPS} is the weight for EPS: the environmental pillar score, which measures a company's impact on living and non-living natural systems (resource use, emissions, innovations);

Table 2. Panel regression models

No.	Formula
1	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 ESGS_{i,t-1} + \mu_{i,t}$
2	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{EPS} EPS_{i,t-1} + \mu_{i,t}$
3	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{SPS} SPS_{i,t-1} + \mu_{i,t}$
4	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{GPS} GPS_{i,t-1} + \mu_{i,t}$
5	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{EPS} EPS_{i,t-1} + \beta_2 w_{SPS} SPS_{i,t-1} + \mu_{i,t}$
6	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{EPS} EPS_{i,t-1} + \beta_2 w_{GPS} GPS_{i,t-1} + \mu_{i,t}$
7	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{SPS} SPS_{i,t-1} + \beta_2 w_{GPS} GPS_{i,t-1} + \mu_{i,t}$
8	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 w_{EPS} EPS_{i,t-1} + \beta_2 w_{SPS} SPS_{i,t-1} + \beta_3 w_{GPS} GPS_{i,t-1} + + \mu_{i,t}$
9	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \mu_{i,t}$
10	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{EPS} EPS_{i,t-1} + \mu_{i,t}$
11	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{SPS} SPS_{i,t-1} + \mu_{i,t}$
12	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{GPS} GPS_{i,t-1} + \mu_{i,t}$
13	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{EPS} EPS_{i,t-1} + \beta_3 w_{SPS} SPS_{i,t-1} + + \mu_{i,t}$
14	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{EPS} EPS_{i,t-1} + \beta_3 w_{GPS} GPS_{i,t-1} + + \mu_{i,t}$
15	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{SPS} SPS_{i,t-1} + \beta_3 w_{GPS} GPS_{i,t-1} + + \mu_{i,t}$
16	$\ln V_{i,t} = \alpha_0 + \alpha_1 \ln K_{i,t} + \alpha_2 \ln L_{i,t} + \beta_1 LTRPS_{i,t-1} + \beta_2 w_{EPS} EPS_{i,t-1} + \beta_3 w_{SPS} SPS_{i,t-1} + + \beta_4 w_{GPS} GPS_{i,t-1} + \mu_{i,t}$

Source: own elaboration.

[2] The description of corporate sustainability variables is based on information from the Revinitiv Eikon database and SLM.

- w_{SPS} is the weight for SPS: the social pillar score, which measures a company's capacity to generate trust and loyalty with its workforce, customers, and society (workforce, community, human rights, product responsibility);
- w_{GPS} is the weight for GPS: the governance pillar score, which measures the effectiveness of corporate systems and processes ensuring that board members and executives act in the best interests of long-term shareholders of a company (management, shareholders, corporate social responsibility);
- $LTRPS$ is the long-term returns pillar score, which measures the ability of a company to manage its long-term economic sustainability (earnings sustainability, credit risk, investment).

The sustainability scores take values between 0 and 100.

The proposed models were estimated with the use of two balanced panels for 21 companies analysed in periods of ten (panel A: models 1–8) and six years (panel B: models 9–16). To deepen the analysis based on all four dimensions of sustainable development, the models with $LTRPS$ (models 9–16) were also estimated for CSP measured by the net profit margin (NPM), which reflects sales profitability. Using profitability of sales as a dependent variable instead of other profitability indicators counts for a sensitivity check.

NPM represents the return on sales (ROS) in percent and is calculated as the ratio of net profit to sales revenues. In this case, 14 firm-year observations had to be excluded from panel B because the profitability of sales revenues was negative and therefore inappropriate for logarithmic transformation. This means that the models with $LTRPS$ (models 9–16), where ROS is the dependent variable, were estimated for the unbalanced panel of 112 observations (corrected panel B). The decision of which kind of a panel model should be chosen—specifically, pooled OLS, fixed-effects, or random-effects model—was taken by analysing the results of the *F* test, the Breusch-Pagan test, and the Hausman test.

3. Results and discussion

The descriptive statistics of dependent and independent variables in the ten-year period (panel A) and in the six-year period (panel B) are presented in Table 3. The mean of sales revenues (SR) for a ten-year period is lower than that of a six-year period. For the ten-year period, the mean of $ESGS$ is satisfactory. All average particular sustainability pillar scores, being the sub-components of $ESGS$, are higher for the six-year period than for the ten-year period. The values of $LTRPS$, an additional sustainability variable considered in a six-year period, fluctuate from the satisfactory to the excellent level of sustainability. Finally, the mean of return on sales (ROS) for the six-year period exceeds 13%.

Table 3. Descriptive statistics

Spec.	Dependent variable V		Independent variables					
			operating variables		sustainability variables			
Panel A								
Metrics	SR		$K = ATFA$	$L = AFTE$	$ESGS$	EPS	SPS	GPS
Mean	17,069,670.69		9,820,522.37	18,394.98	48.14	40.82	45.12	55.69
Standard deviation	19,504,829.34		12,995,130.26	10,941.62	16.89	21.28	23.88	18.45
Min	1,222,849.88		142,638.07	1,360.50	5.28	0.00	0.00	11.30
Max	111,205,138.89		54,643,238.36	42,796.50	87.03	78.07	91.08	94.18
Q1	6,731,977.34		698,073.61	8,107.88	34.71	23.61	28.05	41.79
Median	10,395,387.32		2,777,075.45	16,882.25	50.24	41.40	42.53	56.08
Q3	19,999,085.70		15,580,154.20	26,741.88	58.41	58.12	64.06	69.29
N	210		210	210	210	210	210	210
Panel B								
Metrics	ROS	SR	$K = ATFA$	$L = AFTE$	$LTRPS$	EPS	SPS	GPS
Mean	13.40	17,553,630.28	10,486,281.98	18,922.08	58.01	47.80	52.09	57.35
Standard deviation	10.35	18,910,805.15	13,856,220.51	11,037.19	11.70	18.70	22.66	18.09
Min	0.07	1,222,849.88	148,695.82	2,948.50	31.67	0.00	0.00	17.96
Max	46.86	106,005,649.72	54,643,238.36	42,391.00	79.67	78.07	91.08	94.18
Q1	6.33	7,543,663.10	751,703.10	8,071.00	51.33	32.89	34.37	43.93
Median	9.57	10,611,581.94	3,362,650.13	17,045.00	59.00	49.91	51.67	57.94
Q3	22.12	206,142,89.03	17,758,872.50	26,529.88	67.08	62.26	71.27	71.05
N	112	126	126	126	126	126	126	126

Note: $V = ROS$ is presented in %; $V = SR$ and K are expressed in thousands of PLN ($CPI_{2010=100}$); L is measured as the number of employees.

Source: own calculations.

The coefficients of pairwise correlation between variables in two analysed research periods are shown in Table 4. In the analysis of the ten-year period, all correlations between the dependent variable, measured as SR, and independent variables are significant at 1%, apart from $ESGS$. Correlations between SR and operating variables (K and L) are positive. The dependence with $WEPS$ is positive while correlations for both $WSPS$ and $WGPS$ are negative. In the six-year period, the same correlations between SR and independent variables are significant at 1%. The dependence with $LTRPS$ is positive and significant at 1%. When the dependent variable is measured as ROS, all correlations for independent variables are significant, except for the one with $LTRPS$. The dependence of ROS with $WEPS$ is negative, while it is positive with both $WSPS$ and $WGPS$. Additionally, this analysis reveals that correlations among the independent variables selected for individual panel regression models are not strong in either of the two research periods, as none exceed the critical threshold of |0.8| (Fooladi, 2012, pp. 691–692).

Table 5 demonstrates the estimation results of eight panel regression models (models 1–8), where the dependent variable is SR and sustainability variables are represented by the basic dimensions of *CS*. Model 1 shows that the coefficient on $ESGS$ is positive and statistically significant at 1%. This means that an improvement in the sustainability score for integrated environmental, social, and governance pillars leads to an increase in sales revenues. In models 2–8, sub-components of $ESGS$ are considered. The estimation results reveal that the coefficients at $WEPS$ and $WSPS$ are positive and statistically significant in all models. However, their significance becomes lower when both scores are included in the same model (models 5 and 8). What is more, the social effect in these models is weaker than the environmental effect. The coefficient on $WGPS$ is positive but statistically insignificant in all models, thus the governance pillar score has no discernible impact on sales revenues. Models 9–16 incorporate $LTRPS$ as the additional sustainability variable reflecting sustainability in the economic dimension. These models were estimated using two different dependent variables.

Table 6 shows the estimation results of eight panel regression models on SR. Model 9 reveals how the coefficient at $LTRPS$ is positive but statistically insignificant, and this result does not change when sub-components of $ESGS$ are added to the subsequent models. The coefficient on $WEPS$ is positive in all models, but it is statistically significant only in two of them, which do not include $WSPS$ (models 10 and 14). The coefficient at $WSPS$ is positive and statistically significant in all models, but its significance is higher in models where $WEPS$ is not included (models 11 and 15). The coefficient on $WGPS$ is not statistically significant in any model.

Table 7 presents the estimation results of eight panel regression models on ROS. Model 9 reveals that the coefficient on $LTRPS$ is positive and statistically significant, and it remains unchanged in all subsequent models ex-

Table 4. Pearson correlation matrix

Spec.	Dependent variable ln *V*		Independent variables					
			operating variables		sustainability variables			
Panel A								
Variables	**ln *SR***		**ln *K***	**ln *L***	***ESGS***	***WEPS***	***WSPS***	***WGPS***
ln *SR*	1.0000							
ln *K*	0.7501***		1.0000					
ln *L*	0.6088***		0.5740***	1.0000				
ESGS	–0.0379		–0.1562**	–0.0980	1.0000			
WEPS	0.5113***		0.6230***	0.2305***	0.3171***	1.0000		
WSPS	–0.1960***		–0.2877***	–0.2469***	0.8872***	0.0734	1.0000	
WGPS	–0.2404***		–0.4633***	–0.0256	0.4957***	–0.3444***	0.2761***	1.0000
Panel B								
Variables	**ln *ROS***	**ln *SR***	**ln *K***	**ln *L***	***LTRPS***	***WEPS***	***WSPS***	***WGPS***
ln *ROS*	1.000							
ln *SR*	–0.2923***	1.0000						
ln *K*	–0.2939***	0.7488***	1.0000					
ln *L*	–0.2082**	0.6274***	0.5388***	1.0000				
LTRPS	0.0573	0.2855***	0.4150***	–0.0924	1.0000			
WEPS	–0.1684*	0.4707***	0.6448***	0.1770**	0.3550***	1.0000		
WSPS	0.2526***	–0.2655***	–0.4088***	–0.3051***	–0.2016**	–0.1599*	1.0000	
WGPS	0.3129***	–0.2331***	–0.5094***	0.0131	–0.3601***	–0.4493***	0.3213***	1.0000

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Source: own calculations.

Table 5. Estimation results of random-effects models without *LTRPS* where the dependent variable is *SR* (panel A)

Specification	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	9.928*** (17.060)	9.614*** (17.020)	9.739*** (16.820)	9.339*** (16.180)	9.871*** (17.090)	9.699*** (16.870)	9.845*** (16.730)	9.937*** (16.950)
ln *K*	0.184*** (3.514)	0.156*** (2.821)	0.197*** (3.752)	0.236*** (4.503)	0.153*** (2.770)	0.160*** (2.854)	0.199*** (3.753)	0.156*** (2.771)
ln *L*	0.350*** (4.760)	0.435*** (5.794)	0.359*** (4.843)	0.343*** (4.356)	0.408*** (5.340)	0.416*** (5.207)	0.340*** (4.398)	0.395*** (4.892)
WEPS		0.012*** (3.633)			0.009** (2.269)	0.012*** (3.361)		0.008** (2.145)
WSPS			0.005*** (3.389)		0.003* (1.877)		0.005*** (3.156)	0.003* (1.821)
WGPS				0.004 (1.538)		0.002 (0.757)	0.003 (0.928)	0.002 (0.588)
ESGS	0.004*** (3.939)							
F test (*p*-value)	120.933 (0.000)	117.100 (0.000)	119.713 (0.000)	112.228 (0.000)	119.692 (0.000)	116.020 (0.000)	119.231 (0.000)	118.470 (0.000)
Breusch-Pagan; $\chi 2(1)$ (*p*-value)	786.804 (0.000)	787.327 (0.000)	789.764 (0.000)	783.796 (0.000)	787.520 (0.000)	778.807 (0.000)	786.112 (0.000)	778.756 (0.000)
Hausman; $\chi 2(K)$ (*p*-value)	4.760 (0.190)	3.076 (0.380)	4.053 (0.256)	2.035 (0.565)	4.339 (0.362)	3.481 (0.481)	4.371 (0.358)	4.676 (0.457)
R^2	0.601	0.600	0.596	0.605	0.596	0.602	0.597	0.597
N	210	210	210	210	210	210	210	210

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively; *t*-statistic in parentheses.

Source: own estimations.

Table 6. Estimation results of random-effects models with *LTRPS* where the dependent variable is *SR* (panel B)

Specification	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
Intercept	10.474*** (9.778)	10.656*** (10.050)	10.834*** (10.220)	10.579*** (9.706)	10.904*** (10.270)	10.668*** (9.876)	10.861*** (10.060)	10.892*** (10.070)
ln *K*	0.252*** (4.069)	0.192*** (2.921)	0.230*** (3.720)	0.254*** (4.048)	0.196*** (2.970)	0.190*** (2.840)	0.228*** (3.626)	0.191*** (2.849)
ln *L*	0.192 (1.531)	0.254** (1.995)	0.165 (1.328)	0.174 (1.328)	0.209 (1.623)	0.256* (1.898)	0.167 (1.288)	0.219 (1.622)
WEPS	0.003 (0.957)	0.003 (0.950)	0.004 (1.513)	0.003 (0.970)	0.004 (1.358)	0.003 (0.939)	0.004 (1.507)	0.004 (1.349)
WSPS		0.012** (2.521)			0.008 (1.448)	0.012** (2.471)		0.008 (1.472)
WGPS			0.006*** (2.815)		0.005* (1.924)		0.006*** (2.784)	0.005** (1.960)
ESGS				0.002 (0.439)		0.000 (–0.076)	–0.001 (–0.146)	–0.002 (–0.336)
F test (*p*-value)	65.867 (0.000)	69.003 (0.000)	71.920 (0.000)	64.639 (0.000)	71.714 (0.000)	67.055 (0.000)	70.511 (0.000)	70.076 (0.000)
Breusch-Pagan; $\chi 2(1)$ (*p*-value)	255.698 (0.000)	258.270 (0.000)	256.214 (0.000)	250.844 (0.000)	257.055 (0.000)	251.634 (0.000)	251.714 (0.000)	251.301 (0.000)
Hausman; $\chi 2$(K) (*p*-value)	5.388 (0.146)	5.385 (0.250)	9.863 (0.056)	6.452 (0.168)	8.569 (0.128)	6.018 (0.304)	9.972 (0.076)	8.776 (0.187)
R^2	0.625	0.634	0.625	0.627	0.636	0.633	0.623	0.634
N	126	126	126	126	126	126	126	126

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively; *t*-statistic in parentheses.

Source: own estimations.

Table 7. Estimation results of fixed-effects models with *LTRPS* where the dependent variable is *ROS* (corrected panel B)

Specification	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
Intercept	22.785** (2.278)	24.053** (2.417)	24.957** (2.557)	27.767*** (3.310)	24.563** (2.554)	27.917*** (3.293)	28.895*** (3.321)	28.208*** (3.331)
ln *K*	–1.797*** (–3.805)	–2.194*** (–4.171)	–1.929*** (–4.573)	–1.823*** (–4.750)	–2.196*** (–4.231)	–2.100*** (–4.597)	–1.908*** (–5.448)	–2.102*** (–4.639)
ln *L*	0.481 (0.563)	0.922 (1.080)	0.393 (0.470)	–0.131 (–0.177)	0.858 (0.996)	0.274 (0.359)	–0.153 (–0.199)	0.238 (0.294)
WEPS	0.029* (1.868)	0.025* (1.728)	0.033* (2.060)	0.030* (2.001)	0.027 (1.713)	0.027* (1.832)	0.033** (2.151)	0.028* (1.824)
WSPS		0.060 (1.469)			0.055 (1.179)	0.042 (1.020)		0.039 (0.846)
WGPS			0.017 (1.568)		0.005 (0.488)		0.011 (1.001)	0.003 (0.275)
ESGS				0.068** (2.423)		0.058** (2.173)	0.064** (2.344)	0.057** (2.154)
F test (*p*-value)	6.828 (0.000)	7.253 (0.000)	6.619 (0.000)	6.759 (0.000)	6.846 (0.000)	6.918 (0.000)	6.599 (0.000)	6.683 (0.000)
Breusch-Pagan; $\chi 2(1)$ (*p*-value)	32.077 (0.000)	32.197 (0.000)	26.473 (0.000)	24.854 (0.000)	26.089 (0.000)	25.046 (0.000)	21.733 (0.000)	21.742 (0.000)
Hausman; $\chi 2(K)$ (*p*-value)	10.476 (0.015)	13.886 (0.008)	13.278) (0.009)	16.215 (0.003)	15.373 (0.009)	17.860 (0.003)	18.126 (0.003)	18.873 (0.004)
R^2	0.659	0.674	0.665	0.683	0.674	0.690	0.685	0.690
N	112	112	112	112	112	112	112	112

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively; *t*-statistic in parentheses.

Source: own estimations.

cept for one, which considers both $WEPS$ and $WSPS$ (model 13). Moreover, the significance of $LTRPS$ is highest when $WEPS$ is not included in the model (model 15). The coefficients on $WEPS$ and $WSPS$ are not statistically significant in any model, indicating that the environmental and social pillar scores have no impact on the return on sales. The coefficient on $WGPS$ is positive and statistically significant at 5% in all models.

Comparing the results of model estimations and correlation analysis, two main findings regarding the relationship between CSP and sales performance among Polish companies listed in the WIG-ESG Index can be presented. Firstly, environmental sustainability performance has a positive impact on sales revenues in years 2012–2021. Secondly, governance sustainability performance positively influences the return on sales in years 2016–2021. The other results regarding the relationship between CSP and sales performance are inconsistent.

These results partially correspond with the findings of Yilmaz (2021), who identified no significant effect of CSP on the net profit margin across particular dimensions. His results differ only in the case of governance sustainability performance, which the current research found to exert a significantly positive impact on NPM. Meanwhile, the findings of this study are completely contrary to those of Bumin and Ertuğrul (2024), who not only found that NPM is significantly affected by both the environmental and social scores, but also revealed that the impact of the governance score is insignificant. On the other hand, the results of this study are in line with the findings of Agnese et al. (2024), who demonstrated that governance performance has a significantly positive effect on the EBITDA margin, while environmental and social performance has no impact.

The possible explanation for the positive effect of governance sustainability performance on NPM is that the relationship between board management and shareholders determines what proportion of the profit will be reinvested in the company and allocated to pro-development projects. The implementation of these projects positively impacts the relationship between sales revenues and costs, thereby enhancing ROS. Additionally, the company's commitment to corporate social responsibility—particularly ensuring transparency in its activities—is regarded favourably by various stakeholders, who are more willing to support the company in different ways.

Considering the research results for sales revenues, the findings of this study are not fully aligned with those of Tram and Pham (2022), who found that a firm's social disclosure has a significantly positive impact on SR, while the impact of environmental and governance disclosures is insignificant. In this study, no sustainability performance showed a significant effect on SR. However, it must be emphasised that when considering years 2012–2021, SR is significantly influenced by environmental sustainability performance.

The positive effect of environmental sustainability performance on SR presumably stems from the company's involvement in eco-friendly initiatives,

which enhance its reputation. In times of climate crisis, a company that prioritises environmental sustainability is viewed much more favourably than its competitors, making customers more inclined to purchase its products. Additionally, current and potential employees are more motivated to work for a company with a strong reputation for sustainability, as it enhances their standing in the labour market. Highly motivated employees tend to work harder, improving customer service and satisfaction. In turn, satisfied customers are more likely to make repeat purchases, ultimately boosting sales revenues.

Conclusions

The paper presents the results of empirical research on the relationship between CSP and CFP conducted among Polish companies listed on the WIG-ESG Index. This research reveals that sales revenues in the long run are positively affected by environmental sustainability performance, while in the short run, they do not depend on any dimension of CSP. Governance sustainability performance has no impact on sales revenues in either the long or short run, but it influences the return on sales, expressed by the net profit margin. Referring to the five sub-hypotheses, it can be concluded that the impact of environmental sustainability performance on sales performance in terms of sales is positive only for long run, while the impact of governance sustainability performance on sales performance in terms of return on sales is positive for the short run.

In this paper, in line with the Quadruple Bottom Line Approach, economic sustainability performance was included as an additional dimension of CSP influencing CFP. Moreover, the study examines the effect of CSP on CFP, measured by sales performance—specifically, sales revenues and return on sales. The core limitation of this study is the small research sample and the short period of analysis, which arise from the lack of sustainability data on Polish companies over a longer timeframe, therefore preventing the application of more sophisticated research methods.

Given that the sustainability data provided by rating agencies is often incomplete and not freely available to a wide range of stakeholders, international institutions and national governments should work to tighten and harmonise requirements for companies to disclose sustainability information. At the same time, managers should create holistic strategies for CS, monitoring the results of their implementation over short-, medium-, and long-term horizons for the company and all its stakeholder groups as the effect of particular sustainability performance can vary across different sales performance measures and analytical periods.

Furthermore, researchers should broaden and deepen the analysis of the relationship between CSP and CFP, especially on the Polish market, as it has not yet been sufficiently examined. For instance, future studies could aim to verify a reverse or U-shaped relationship, but this would require a larger research sample and a longer analysis period.

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Social media disagreement and financial markets: A comparison of stocks and Bitcoin

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Abstract

We examine whether disagreement in social media discussions related to financial markets affects subsequent volatility and abnormal trading volume. We also compare how traditional and digital asset markets differ by comparing stocks and Bitcoin. We show that social media disagreement is positively associated with future market volatility and abnormal trading volume in the stock market. The effect of disagreement is more pronounced at the individual stock level than at the index level. A higher level of social media disagreement also increases the probability of extremely negative stock market returns. In contrast, disagreement in Bitcoin-related social media weakly affects subsequent volatility but does not affect trading volume or extremely negative returns. Our findings also reveal that market activity impacts the disagreement in the stock market and Bitcoin communities differently.

Keywords

- disagreement
- trading volume
- volatility
- Bitcoin
- Reddit

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Introduction

When investors have different beliefs about future market conditions, they can react differently to new information, market events, and changes in economic conditions. Varied expectations, in turn, can result in elevated levels of trading volumes and market volatility. Disagreement on market prospects can also lead to divergent trading strategies and market dynamics. Accordingly, the literature provides evidence of heterogeneous beliefs' volatility and volume-increasing effect in financial markets (Atmaz & Basak, 2018; Banerjee & Kremer, 2010; Carlin et al., 2014). Most studies use analyst forecasts to focus on disagreement among sophisticated investors. Yet analyst forecasts fail to provide information on the beliefs of retail investors, especially those interacting on social media platforms. Building upon the growing body of literature using social media content, we investigate how the disagreement among users of social media related to financial markets affects future market activity.

The rise of social media has provided retail investors with platforms like Twitter, Stocktwits, and Reddit to share their views and discuss their expectations on market movements in real time. The literature increasingly focuses on how social media discussions impact financial markets (Chen et al., 2014; Cookson & Niessner, 2020; Tan & Tas, 2021). However, much of the existing research focuses on the direct impact of social media sentiment and paid less attention to the role of disagreement, which refers to the extent to which investors hold opposing views on market direction. Understanding how heterogeneous beliefs impact market activity is important because they can lead to greater trading volume and volatility as investors act on their differing views. This study explores this possibility by analysing comments on Reddit posted between January 2019 and June 2022. Reddit's community-based structure allows us to link discussions to specific assets and facilitate the examination of disagreement's impact on market activity.

We focus on the opinions shared in two important communities about the stock market and Bitcoin. We hypothesise that increased disagreement in these communities will increase trading volume and volatility, as diverse opinions trigger more buying and selling activity. We also expect that disagreement in the stock market community will have a more substantial effect at the individual stock level compared to the index level, where opinions across various stocks can offset each other and reduce the disagreement's overall impact.

We quantify disagreement using the standard deviation of a binary sentiment index across users within a given day. We first average sentiment scores by means of two popular sentiment tools, VADER and TextBlob, and then convert them into a categorical index to capture positive and negative sen-

timents. The standard deviation of this index shows the belief dispersion. To measure daily volatility, we use the range between the daily highest and the lowest prices. Range-based volatility measures provide stationary and daily volatility measures and have been frequently used in the finance literature (e.g., Blau & Whitby, 2017).

Our findings reveal key differences between the stock market and Bitcoin communities. Disagreement in the stock market community significantly increases the next day's volatility and abnormal trading volume. On the contrary, disagreement in the Bitcoin community does not statistically significantly affect Bitcoin's volatility or abnormal trading volume. However, the influence of disagreement becomes statistically significant for Bitcoin during periods of market drawdowns. We suggest that the Bitcoin community's focus shifts toward immediate market actions when the market is in unfavourable conditions, which amplifies the effect of social media disagreement in such periods. Furthermore, when only posts from midnight until the markets open are considered, disagreement in both communities significantly increases subsequent trading volume and volatility. Since Bitcoin has no official trading hours, its community receives continuous market feedback, allowing before-the-market disagreement to significantly impact subsequent market activity. Considering that we observe statistically insignificant effects in interday models, the Bitcoin community can have a short-term impact on the markets, with possible intraday prediction ability. We also show that investor attention in both communities can affect future volatility. Our results are consistent with the view that online financial communities facilitate information dissemination, which can induce additional volatility in the near term. We also show that extremely negative returns in the stock market are more likely following increases in social media disagreement. Lastly, focusing on the comments mentioning the tickers of stocks listed in the S&P500 index reveals that the network disagreement effect on volatility and trading volume is more pronounced at the stock level than at the index level.

This study contributes to the literature in several ways. Firstly, we extend previous research on social media and financial markets by shifting the focus from sentiment to disagreement. Secondly, we provide a comparative analysis of the stock market and Bitcoin. By examining two distinct communities on Reddit, we demonstrate the importance of considering asset-specific dynamics in understanding the influence of social media on financial markets. Finally, we examine the discussions on Reddit, which received less attention than Twitter in the literature. Reddit's popularity allows us to reach the beliefs of a wide range of users about the market.

The remainder of the paper is structured as follows. In Section 1, we review related literature. Then, in Section 2, we develop hypotheses and explain our methodology. In Section 3, we report our empirical findings. In the last Section, we give concluding remarks.

1. Literature review

Different opinions, sentiments and strategies across investors concerning asset prices can cause market movements. Hong and Stein (2007) argue that disagreement about the future can emerge from two sources. The first is the different information sets investors might have. Due to gradual information flow or investors' limited attention, some investors can form expectations based on information others do not yet have, resulting in disagreement. The second is the differences in prior beliefs and economic models that allow investors to interpret the same information differently. Different models enable different investors to obtain and pay attention to the same information but reach different conclusions. Both mechanisms can increase disagreement about the future and have significant market implications. Hong and Stein (2007) suggest that for disagreement to create trading volume, investors should agree to disagree, meaning that they should not consider that they may be at an informational disadvantage. Indeed, studies provide evidence of how investors do not constantly update their beliefs based on others' transactions, making disagreement influential in financial markets.

Studies use different measures of disagreement but demonstrate that it significantly affects trading volume and volatility as heterogeneous opinions lead to more active buying and selling behaviours. In early studies, the measure of investor disagreement tends to rely on the dispersion in analyst forecasts and investment newsletter recommendations. These studies frequently explored the relationship between disagreement and trading volume at the stock level. Ajinkya et al. (1991) measure disagreement with dispersion in analyst forecasts and find that it is positively related to trading volume. Similarly, Atiase and Bamber (1994) find that the reaction of trading volume to earnings announcements increases with analyst forecast dispersion. Barron (1995) uses belief revisions and changes in forecast dispersion to measure disagreement. He finds that both disagreement measures are positively related to trading volume. Using analyst forecasts, Bamber et al. (1997) find that disagreement has three aspects that significantly affect trading volume. Their findings show that dispersion in prior beliefs, changes in dispersion, and different belief revisions across investors positively affect trading volume. D. Li and G. Li (2021) examine household belief dispersion in the US and show that disagreement increases trading volume at the market level as well. These findings emphasise the role of disagreement in driving market activity, particularly trading volume.

In addition to trading volume, disagreement is also linked to volatility and volatility-related phenomena. Graham and Harvey (1996) use dispersion in investment newsletters to capture disagreement and find that higher levels of disagreement predict increased future volatility at the market level. Banerjee (2011) shows that disagreement measured by analyst dispersion is

positively related to stock volatility. Wang et al. (2023) use the dispersion in analysts' long-term growth forecasts as a measure of disagreement and find that it is significantly related to the idiosyncratic volatility puzzle. These studies demonstrate that market-wide disagreement can have a destabilising effect and increase price fluctuations.

With the advent and widespread use of social media, there has been a noticeable shift in the way studies measure investor disagreement. The practice of people sharing their expectations about financial markets on social media has led to the quantification of investor sentiment in these posts. The extent of dispersion in the opinions of many users has also become observable. The dispersion of sentiment refers to the variability in sentiment scores among different users and serves as a measure of disagreement. A significant part of the literature investigates the market implications of disagreement among online social network interactions. Although the method of measuring disagreement has changed in recent years, its impact on trading volume has consistently been found to be positive. Antweiler and Frank (2004) examine messages posted on Yahoo! Finance and Raging Bull and find that social media disagreement is positively associated with stock-level trading volume. Similarly, Sprenger et al. (2014) use the dispersion in the sentiment of tweets about the stock market and find that disagreement increases trading volume at the stock level. Using tweets from StockTwits, Al-Nasseri and Menla Ali (2018) also show that disagreement increases stock-level trading volume. Although they follow different approaches to measure social media disagreement, both Giannini et al. (2019) and Cookson and Niessner (2020) also find that disagreement leads to higher stock trading volume.

Some studies investigate the impact of social media disagreement on volatility, in addition to the trading volume. Siganos et al. (2017) use the distance between positive and negative sentiment on Facebook's status updates to measure disagreement and find that it is positively associated with both trading volume and volatility at the market level. Similarly, T. Li et al. (2018) also find that higher disagreement leads to higher trading volume and volatility by examining Tweets related to the S&P 100 stocks.

Though disagreement has been widely explored in stock markets, its impact on Bitcoin has seen far less attention. In one of the few studies conducted in this area, Ahn and Kim (2020) find that social media disagreement increases Bitcoin's price volatility. Kantorovitch and Heineken (2021) document that high disagreement in online discussions is positively associated with the volatility of Bitcoin. In a related study, Kim and Ahn (2023) find that heterogeneous emotional feedback increases Bitcoin's intraday volatility.

Previous findings provide significant support for the claim that disagreement inflates trading volume and volatility. It appears that when people's beliefs differ, there are more trades in the market, resulting in increased volatility and trading volume. However, the majority of the findings concern the impact

of stock-specific disagreement. The impact of market-wide disagreement or disagreement related to other assets receives little attention in the literature.

2. Hypotheses, data and methodology

In this study, we extend earlier studies by examining two different markets. We examine the effects of social media disagreement on the stock market and Bitcoin. For the stock market, we examine the effects of disagreement both at the index level and the individual stock level. We measure and examine how disagreement in Reddit communities about the stock market and Bitcoin affects abnormal trading volume and volatility.

2.1. Hypotheses

We do not expect differences in how disagreement affects trading volume and volatility; rather, we expect the disagreement to have a stronger effect at the individual stock level than at the index level because, at the index level, some effects can neutralise each other. Thus, our hypotheses are as follows:

H1: Social media disagreement positively affects the next day's trading volume and volatility at both the index level and stock level in the stock market.
H2: Social media disagreement positively affects the next day's trading volume and volatility of Bitcoin.
H3: The positive effect of social media disagreement on the next day's trading volume and volatility is more pronounced at the stock level than at the index level in the stock market.

We investigate the effects of social media disagreement on both trading volume and volatility to provide a more comprehensive analysis. Although some studies have examined these effects separately, the literature shows that disagreement often impacts both trading volume and volatility.

2.2. Social media disagreement

We examine Reddit, a popular discussion platform, to explore the effects of social media disagreement on financial markets. Reddit is a platform allowing people to interact in theme-based online communities called subreddits. We

focus on interactions on two subreddits, r/stocks and r/Bitcoin. These subreddits are selected based on their high user activity and relevance to our research topic. We focus exclusively on Bitcoin and do not include other crypto assets due to Bitcoin's dominance in the cryptocurrency market. Bitcoin has significantly higher liquidity, larger trading volumes, and a more active online community than most other cryptocurrencies. In addition, Bitcoin serves as a benchmark for the cryptocurrency market due to its being the first and most widely recognised cryptocurrency, and its dynamics are often representative of the general behaviour of other cryptocurrencies.

We use comments posted in these subreddits using Pushshift Reddit API.[3] Our sample includes approximately 3.5 million comments in the r/stocks and 5 million in the r/Bitcoin posted between January 2019 and June 2022. Both subreddits become more popular in time, with subscribers growing by an average of 0.19% daily for the r/stocks subreddit and 0.11% for the Bitcoin subreddit. The main reason for this difference is the number of subscribers at the starting point. At the start of January 2019, the r/stocks subreddit had approximately 300,000 subscribers, while the r/Bitcoin subreddit had 1,000,000. Online activity for Bitcoin was high from the beginning, while it gained significant importance for stocks during the sampling period.

To calculate social media disagreement, we follow Cookson and Niessner (2020) and use the standard deviation of sentiment scores. Though the literature proposes several proxies to measure the disagreement among investors, such as dispersion in analyst forecasts and forecast revisions, Cookson and Niessner (2020) argue that their measure of disagreement is more practical because it directly captures the distribution of sentiment, does not rely on third-party opinions such as analyst expectations, and is available at a daily frequency. Since our study shares the same features and can benefit from these advantages, we follow this approach. We first determine each post's sentiment in the sample and calculate the standard deviation of sentiment scores across comments within a day.

To calculate the sentiment of comments, we use sentiment analysis tools of VADER and Textblob (Hutto & Gilbert, 2014; Loria, 2020). Both tools are rule-based models and provide a sentiment score ranging from –1 to +1. To reduce the noise that may arise from the differences between the two models and sentiment scores ranging from –1 to +1, we first average the sentiment scores given by both models. Then, we create a sentiment dummy variable that equals 1 if the average is greater than zero and –1 if it is smaller. If both models describe a comment as neutral, we remove that comment from the sample. We remove them because they do not reflect strong opinions that could drive market behaviour. Including them may weaken the impact of dis-

[3] https://github.com/pushshift/api

agreement. Nevertheless, we repeat our analysis with neutral comments as a robustness check.

Finally, we measure the daily disagreement based on the standard deviation of the binary sentiment index across users within a day. We first determine the sentiment of each post as either –1 or 1, then aggregate these to the daily level by calculating $sent_t$, the average sentiment of comments posted on day t. Since the sentiment of each comment is either 1 or –1, our disagreement measure is:

$$disagt_t = \sqrt{1 - sent_t^2} \tag{1}$$

where $disagt_t$ represents the disagreement on day t and $sent_t$ is the average sentiment on day t.

2.3. Data and variables

To investigate how social media disagreement affects the stock market, we first examine the aggregate impact by focusing on the S&P 500 index. Then, we investigate the relationships at the individual stock level. To do this, we filter comments mentioning the tickers of stocks included in the S&P500 at any time during the sample period, excluding those with tickers with generic meanings, such as "T" or "BALL". We only consider comments that mention the ticker of only one stock. If tickers of multiple stocks are mentioned in the same comment, we remove that comment from our sample. To ensure this exclusion does not affect our results, we conduct a robustness check, where we retain comments mentioning multiple stocks and assign the sentiment score to all referenced stocks.

After this elimination, our sample consists of 478 individual stocks that were part of the S&P 500 index during the sample period. After our initial filtering, we begin with 284,575 comments that mention tickers of these stocks. Eliminating comments with neutral sentiment reduces our sample to 233,652 comments. Additionally, we remove 74,368 comments that mention multiple stock tickers to avoid ambiguity in sentiment assignment. These procedures leave us a total of 159,284 comments for our analysis. On average, 127 comments per day mention the ticker of a single stock, with the number of comments ranging from 1 to 513. Per stock, we observe an average of 4 comments per day, ranging from a minimum of 1 to a maximum of 202. The high range between the minimum and maximum number of observations per stock per day reflects the variability in public interest and online discussions for different stocks. To further ensure reliability, we conduct an additional robustness check by removing stocks with only one comment daily. To study how

the Bitcoin community affects Bitcoin's trading volume and volatility, we obtain data from CoinMarketCap, a leading data provider on cryptocurrencies.

The calculations of the market variables are as follows:

$$avol_t = \frac{tvol_t}{\sum_{d=t-140}^{t-21} \frac{tvol_d}{120}} - 1 \tag{2}$$

$$prange_t = \ln\left(\frac{high_t}{low_t}\right) \tag{3}$$

where *avol* represents abnormal trading volume and prange represents the range between the intraday highest (*high*) and lowest (*low*) prices within day *t*. Following Cookson and Niessner (2020), we measure abnormal trading volume by comparing the trading volume (*tvol*) on day *t* with the average trading volume of the previous 140 days, leaving out the most recent 20 days.

2.4. Models

To test our hypotheses, we run the Vector Autoregression (VAR) models. In the first set of equations, we examine the impact of social media disagreement on abnormal trading volume:

$$\begin{aligned} avol_t = {} & \alpha + \beta_1 disagt_{t-1} + \beta_2 avol_{t-1} + \beta_3 lnusers_{t-1} + \beta_4 r_{t-1} + \\ & + \beta_5 prange_{t-1} + \varepsilon_t \end{aligned} \tag{4}$$

$$\begin{aligned} disagt_t = {} & \alpha + \beta_1 disagt_{t-1} + \beta_2 avol_{t-1} + \beta_3 lnusers_{t-1} + \beta_4 r_{t-1} + \\ & + \beta_5 prange_{t-1} + \varepsilon_t \end{aligned} \tag{5}$$

In the second set of equations, we shift focus to the relationship between social media disagreement and intraday price range:

$$\begin{aligned} prange_t = {} & \alpha + \beta_1 disagt_{t-1} + \beta_2 prange_{t-1} + \beta_3 lnusers_{t-1} + \\ & + \beta_4 r_{t-1} + \beta_5 avol_{t-1} + \varepsilon_t \end{aligned} \tag{6}$$

$$\begin{aligned} disagt_t = {} & \alpha + \beta_1 disagt_{t-1} + \beta_2 prange_{t-1} + \beta_3 lnusers_{t-1} + \\ & + \beta_4 r_{t-1} + \beta_5 avol_{t-1} + \varepsilon_t \end{aligned} \tag{7}$$

where $disagt_t$ represents the disagreement in the entire subreddit on day *t*, *avol* represents abnormal trading volume, *prange* represents intraday price

range, *lnusers* represents the natural logarithm of the number of users who comment in subreddits, *r* represents market returns in excess of the risk-free rate for the stock market and raw returns for Bitcoin, and *t* represents day. We control for several variables to adjust for the potential effects of investor attention, market activity, and volatility. We include lagged values of abnormal trading volume, price range, user activity, and market returns. We control for the number of users who comment to examine the possible effect of investor attention. Because we use the same controls in both VAR models, equation 5 and equation 7 are identical but belong to different systems of equations. In line with the usual presentation of VAR models, we include $disagt_t$ as the dependent variable in both models, even though the equation structure is the same. We standardise the social media variables so that coefficients show the effect of one standard deviation increase (decrease) in disagreement. The VAR models also provide evidence of how market activity influences future social media disagreement.

To examine the stock-level relationships, we estimate fixed-effects regressions with heteroskedasticity consistent standard errors. We also control for some stock characteristics that can affect trading volume and volatility, such as market value, book-to-market ratio, and relative spread between bid and ask prices. We estimate the following models:

$$\begin{aligned} avol_{i,t} = \alpha + \beta_1 disagt_{i,t-1} + \beta_2 r_{i,t-1} + \beta_3 prange_{i,t-1} + \beta_4 avol_{i,t-1} + \\ + \beta_5 lnmv_{i,t-1} + \beta_6 lnbm_{i,t-1} + \beta_7 spread_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (8)$$

$$\begin{aligned} prange_{i,t} = \alpha + \beta_1 disagt_{i,t-1} + \beta_2 r_{i,t-1} + \beta_3 prange_{i,t-1} + \beta_4 avol_{i,t-1} + \\ + \beta_5 lnmv_{i,t-1} + \beta_6 lnbm_{i,t-1} + \beta_7 spread_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (9)$$

where *disagt* represents the level of social media disagreement; *avol* and *prange* represent abnormal trading volume and intraday price range; *lnmv*, *lnbm*, *spread*, and *r* represent the natural logarithm of market value, the natural logarithm of book-to-market ratio, relative bid-ask spreads, and stock returns in excess of the risk-free rate; *i* and *t* represent stock and day.

We also investigate whether social media disagreement can predict extreme market movements. To do this, we separately examine extremely negative and extremely positive return days. We define an extremely positive (negative) day as one where the daily return is above (below) the two standard deviations of the prior 120 days. Based on these definitions, we define two categorical variables: *ext_pos* and *ext_neg* that take the value of 1 for days with respectively extremely positive and negative return, and 0 otherwise. We test the impact of social media disagreement with logistic regressions in which the dependent variable is either *ext_pos* or *ext_neg*. The logistic regression model is expressed as follows:

$$logit\left(P(ext\_event_t = 1)\right) = \alpha + \beta_1 disagt_{t-1} + \beta_2 avol_{t-1} + \\ + \beta_3 prange_{t-1} + \beta_4 ext\_event_{t-1} + \varepsilon_t \quad (10)$$

where *ext_event* represents the extreme event and is either *ext_pos* or *ext_neg*. *disagt* is the social media disagreement, *avol* is abnormal trading volume, *prange* is the range between high and low prices, and *t* indicates day. We include the one-day lag of the extreme event to capture potential persistence or autocorrelation in extreme market movements.

3. Empirical findings

Before reporting our findings, in Table 1 we first present summary statistics for the key variables used in this study. We see several differences between the r/stocks and r/Bitcoin subreddits. First, the average sentiment in the stock market community is higher compared to the Bitcoin community, but the latter has a smaller range. In addition, disagreement in the Bitcoin community is slightly higher, with less dispersion and a smaller range. Overall, the Bitcoin community seems to be less optimistic but also has a persistently high level of disagreement. The number of comments and commenting users is also higher in the Bitcoin community. The average number of comments per day in the Bitcoin community is 3070, while the stock market community averages 2469 comments. Likewise, the Bitcoin community sees an average of 1869 users commenting per day, compared to 1585 in the stock market community.

Bitcoin exhibits significantly higher volatility and abnormal trading volume than the S&P 500. Bitcoin's average price range is 0.0484, with a standard deviation of 0.0380, whereas the S&P 500's average price range is much lower at 0.0128. Similarly, Bitcoin's abnormal trading volume is also higher than that of the S&P 500. Summary statistics show the significantly higher volatility observed in the cryptocurrency market.

We run VAR models with one lag to examine whether social media disagreement in both communities affects future trading volume and volatility. The results, reported in Table 2 for both subreddits, show strong support for Hypothesis 1, which expects social media disagreement to positively affect the trading volume and volatility of the stock market. In contrast, the evidence for Hypothesis 2, which suggests that social media disagreement positively affects the trading volume and volatility of Bitcoin, is weaker.

The results for the r/stocks subreddit, reported in Panel A, show that social media disagreement significantly increases the subsequent abnormal trading volume and volatility of the stock market. More specifically, one stan-

Table 1. Descriptive statistics

r/stocks and S&P500	Observations	Mean	Standard deviation	Minimum	Maximum
Sentiment	866	0.3586	0.0752	0.1324	0.6279
Disagreement	866	0.9300	0.0288	0.7783	0.9912
Number of Comments	866	2469	1855	43	19285
Number of Commenting Users	866	1585	1083	71	8741
Return	866	0.0005	0.0144	–0.1198	0.0938
Abnormal Trading Volume	866	0.0233	0.3339	–0.6820	1.8289
Price Range	866	0.0128	0.0102	0.0017	0.0842
r/Bitcoin and Bitcoin	**Observations**	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
Sentiment	1255	0.3121	0.0441	0.1269	0.4410
Disagreement	1255	0.9489	0.0142	0.8975	0.9919
Number of Comments	1255	3070	1906	16	18745
Number of Commenting Users	1255	1869	1075	20	8220
Return	1255	0.0019	0.0384	–0.3717	0.1875
Abnormal Trading Volume	1255	0.1774	0.5743	–0.6861	6.6917
Price Range	1255	0.0484	0.0380	0.0046	0.4894

Source: own elaboration.

dard deviation increase in disagreement increases the next day's abnormal trading volume by 1.68% and volatility by five basis points. The volatility response roughly equals 4% of the sample mean volatility of 1.3%. In Panel B of Table 2, we see that, unlike our expectations, disagreement in the Bitcoin community is not significantly associated with the next day's trading volume. Nonetheless, it positively affects the next day's volatility, which is weakly significant at the 10% significance level. The disagreement's effect on volatility is slightly more pronounced for Bitcoin. One standard deviation increase in disagreement increases volatility by 16 basis points.

Differences in the asset-specific characteristics and dynamics of online communities can help explain the differences in the impact of social media disagreement on the stock market and Bitcoin. Bitcoin exhibits higher volatility and greater return dispersion compared to the stock market. External factors such as regulatory changes can cause significant price movements in cryptocurrency markets and may weaken the effect of social media disagreement. While interactions within the Bitcoin community can be related

Table 2. Disagreement, abnormal trading volume and volatility

	Dependent variable							
	Panel A: r/stocks				Panel B: r/Bitcoin			
	Model 1: *avol*		Model 2: *prange*		Model 1: *avol*		Model 2: *prange*	
	$avol_t$	$disagt_t$	$prange_t$	$disagt_t$	$avol_t$	$disagt_t$	$prange_t$	$disagt_t$
$disagt_{t-1}$	0.0168**	0.3758***	0.0005**	0.3758***	–0.0038	0.4396***	0.0016*	0.4396***
	(0.0082)	(0.0321)	(0.0002)	(0.0321)	(0.0107)	(0.0260)	(0.0010)	(0.0260)
$lnnodes_{t-1}$	–0.0036	0.0950***	0.0004*	0.0950***	–0.0130	–0.0587*	0.0086***	–0.0587*
	(0.0074)	(0.0288)	(0.0002)	(0.0288)	(0.0126)	(0.0304)	(0.0011)	(0.0304)
$avol_{t-1}$	0.6665***	0.2898**	0.0057***	0.2898**	0.7800***	–0.1288***	0.0024	–0.1288***
	(0.0305)	(0.1196)	(0.0009)	(0.1196)	(0.0200)	(0.0484)	(0.0018)	(0.0484)
r_{t-1}	0.1740	–2.1262	–0.0268*	–2.1262	0.1528	–0.2036	–0.0573**	–0.2036
	(0.4796)	(1.8807)	(0.0144)	(1.8807)	(0.2749)	(0.6663)	(0.0246)	(0.6663)
$prange_{t-1}$	4.7474***	16.1685***	0.6132***	16.1685***	–0.6350*	1.7411**	0.3350***	1.7411**
	(1.0691)	(4.1920)	(0.0321)	(4.1920)	(0.3488)	(0.8454)	(0.0312)	(0.8454)
Constant	0.2806***	–0.4944***	–0.0008	–0.4944***	0.0692***	–0.0611	0.0318***	–0.0611
	(0.0253)	(0.0992)	(0.0008)	(0.0992)	(0.0188)	(0.0456)	(0.0017)	(0.0456)
Observations	858	858	858	858	1247	1247	1247	1247
Granger	4.20**	5.87**	4.62**	14.88***	0.13	7.10***	2.84*	4.24**

Notes: The Granger row reports the χ^2 values from the Granger causality tests. Asterisks represent statistical significance: *** < 0.01, ** < 0.05, and * < 0.1.

Source: own elaboration.

to immediate price movements, they often involve long-term ideological debates, which may not necessarily correlate with immediate market activity. As a result, opinions in the Bitcoin community may become more static and entrenched. The Bitcoin community has many participants who follow an ideological perspective that values long-term trust in Bitcoin's technology over short-term market conditions (Knittel et al., 2019). Therefore, participants in the Bitcoin community may be less likely to adjust their trading behaviour based on social media discussions. Indeed, our data shows that sentiment levels are more stable in the Bitcoin community than in the stock market community, with significantly lower average daily sentiment change. Shifts in sentiment are more closely associated with market activity and volatility of the stock market, while sentiment in the Bitcoin community is less likely to drive immediate trading behaviour. Vlahavas and Vakali (2024) suggest that discussions in online cryptocurrency communities concentrate more on immediate market actions and focus less on regulatory issues during market downturns. Considering this finding, we further test whether the disagreement in the Bitcoin community is related to future market activity during unfavourable market conditions. To do this, we first calculate drawdowns in Bitcoin prices. Then, we run a regression model with an interaction term between social media disagreement and drawdowns. The estimation results that we do not report for brevity purposes are available upon request. Briefly, we see that disagreement decreases the next day's abnormal trading volume and volatility on days Bitcoin has no drawdowns. However, as we expected, the interaction term is significant and positive. Our results show that social media disagreement increases future abnormal trading volume and volatility as drawdowns increase. The possible shift of focus in discussions within the Bitcoin community toward immediate market actions during market downturns allows social media disagreement to play a more pronounced role in driving market activity in such periods.

In Table 2, we see that investor attention also affects market activity. Increases in the number of users in the stock market community, which serve as a proxy for investor attention, can only predict the increases in volatility, but the statistical significance is weak, with a p-value of 0.07. The effect size is similar to that of disagreement, with volatility increasing by approximately four basis points following one standard deviation increase in the number of users. In Panel B, we see that investor attention is more important for Bitcoin. One standard deviation increase in the number of users increases subsequent volatility by 86 basis points. This increase in volatility is consistent with the investor attention literature, which attributes this effect to the increase in information being processed into the prices because of increased information acquisition (Andrei & Hasler, 2015; Aouadi et al., 2013). Andrei and Hasler (2015) argue that information is gradually incorporated into prices when learning is slow, and investors pay little attention to the news, making great-

er investor attention lead to higher volatility. Social media participation and interactions can represent more attention to the market, which allows people to obtain and process more information and increases short-term volatility. Thus, our results imply that information transfer exists between participants in social media, and that information dissemination becomes easier as participation increases. Nevertheless, the results and our interpretation should be approached with caution because the statistical significance is weak for the stock market community.

We also detect that market dynamics affect the subsequent disagreement in social media. We see that prior volatility is particularly essential for both subreddits. Increases in market volatility lead to greater future disagreement, which, in turn, amplifies the subsequent volatility. Furthermore, prior trading volume and investor attention play significant roles for both communities, although with distinct implications for each. Following an abnormally high volume of transactions, disagreement significantly increases in the stock market community but decreases in the Bitcoin community. We also observe the same pattern for the number of users who comment, which has a positive effect on the disagreement of the stock market community and a negative impact on the disagreement of the Bitcoin community. However, the latter is statistically significant only at the 0.1 level. These differences may arise from the distinct factors that contribute to the trading volume of each asset. Abnormally high trading volume in the stock market can signal that market participants interpret information differently or have diverse expectations about the future. On the other hand, an abnormally high Bitcoin volume may reflect periods of market stability, since there is significant controversy about its existence and future use. That is why higher volume can indicate widespread adoption, increased confidence in the asset, and reduced uncertainty about its future. Consistent with these differences, Table 2 shows that volatility has a positive effect on the future trading volume of the stock market but a negative impact on Bitcoin's volume. Furthermore, the r/stocks subreddit can have participants interested in different individual stocks or industries, whereas the r/Bitcoin subreddit can be relatively more homogenous. Participants of the Bitcoin community may share a common interest in adopting Bitcoin, which can enable them to converge with similar opinions following high trading volume. The impact of the number of users on disagreement is consistent with this argument. The results show that as more people comment about the stock market community and interact with one another, overall disagreement tends to increase, implying that giving a dissenting opinion and debating may be more common in the stock market community than in the Bitcoin community. On the contrary, disagreement tends to decrease in the Bitcoin community. It appears that participants in the Bitcoin community have a greater tendency to be in an echo chamber because Bitcoin is more controversial as an asset class than stocks.

Our findings show that social media dynamics affect financial markets to some degree of confidence. The positive effect of disagreement on abnormal trading volume and volatility implies that divergence in people's sentiments in online communities can serve as a proxy for the overall disagreement in the markets. Additionally, the effect of social media participation on volatility suggests that people disseminate information among social media users. More involvement in online financial communities induces additional volatility in the near term, suggesting that people can get more information due to online social interactions. We see that the social media activity of the previous day can influence the markets, but evaluating the timing of interactions can lead to a better understanding of the implications of social media on financial markets. Social media disagreement before trading activity begins may provide additional insights if pre-market discussions have more future-oriented content. To test this possibility, we conduct a separate examination of the period from midnight until the markets open. Although Bitcoin exchanges do not have official trading hours, we apply the same methodology to see whether we still observe differences between the two asset classes. Table 3 reports the results of Hypothesis 1 for the r/stocks subreddit, and Table 4 reports the results of Hypothesis 2 for the r/Bitcoin subreddit.

In Table 3, we see that the effect of before-the-market disagreement on abnormal trading volume and market volatility is similar to that of one-day lagged disagreement. One standard deviation increase in disagreement before the market opens increases the abnormal trading volume by 1.26% and volatility by six basis points. The results of the Bitcoin community reported in Table 4 further demonstrate the importance of the timing of interactions. Although one-day-lagged social media dynamics do not have significant predictive power for Bitcoin, comments made from midnight until the market opening reveal pronounced and considerable effects. One standard deviation increase in the before-the-market disagreement in the Bitcoin community creates a 2.23% increase in abnormal trading volume and a 33-basis-points increase in volatility. These results show that even though there are no official trading hours for Bitcoin, the timing of interactions also matters for it, and pre-market interactions have more substantial effects. The results support our initial premise that the interactions before market opening are more future-oriented. Additionally, the fact that Bitcoin does not have official trading hours and its community receives price feedback even during pre-market hours suggests that the Bitcoin community has predictive power over the short term, with intraday implications.

In addition to investigating the effects of social media disagreement on abnormal trading volume and volatility, we also examine how it affects extreme market movements by isolating negative and positive return days. Further examining extreme movements may be helpful for predictive insights and anomaly detection. Considering this reason, we investigate the

Table 3. The effects of before-market disagreement in the r/stocks

	$avol_t$	$prange_t$
$disagt\_before_t$	0.0126**	0.0006***
	(0.0064)	(0.0002)
$lnnodes_{t-1}$	–0.0024	0.0004**
	(0.0063)	(0.0002)
r_{t-1}	0.1340	–0.0271
	(0.6137)	(0.0271)
$prange_{t-1}$	5.1443***	0.6204***
	(1.3929)	(0.0417)
$avol_{t-1}$	0.6654***	0.0056***
	(0.0506)	(0.0013)
Constant	0.2771***	–0.0008
	(0.0376)	(0.0011)
Observations	857	857
R^2	0.6414	0.6542

Notes: Asterisks represent statistical significance: *** < 0.01, ** < 0.05, and * < 0.1.

Source: own elaboration.

Table 4. The effects of before-market disagreement in the r/Bitcoin

	$avol_t$	$prange_t$
$disagt\_before_t$	0.0232***	0.0033***
	(0.0082)	(0.0012)
$lnnodes_{t-1}$	–0.0103	0.0088***
	(0.0249)	(0.0013)
r_{t-1}	0.1849	–0.0590*
	(0.4280)	(0.0352)
$prange_{t-1}$	–0.7645	0.3280***
	(0.8636)	(0.0517)
$avol_{t-1}$	0.7827***	0.0024
	(0.1010)	(0.0018)
Constant	0.0743**	0.0320***
	(0.0309)	(0.0024)
Observations	1244	1244
R^2	0.5943	0.2638

Notes: Asterisks represent statistical significance: *** < 0.01, ** < 0.05, and * < 0.1.

Source: own elaboration.

predictive power of social media disagreement over extremely negative or positive returns.

We conduct logistic regressions to test whether social media disagreement can successfully categorise extremely positive and negative days. Table 5 reports estimation results. In Panel A, we observe that social media disagreement is positively associated with the probability of an extremely negative return event in the stock market. More specifically, the likelihood of an extremely negative return event doubles following one standard deviation increase in disagreement. Higher levels of disagreement can be a sign of varying quality of information within the community. Increased disagreement among social media users can reflect uncertainty or conflicting interpretations of market conditions, increasing the likelihood of extreme negative events. This finding shows that social media dynamics can be a risk management tool. Disagreement is important when assessing the probability of extreme negative return events, which can prevent investors from suffering high drawdowns. Nevertheless, in Panel B, we see that social media disagreement does not have a statistically significant coefficient, demonstrating that social media dynamics cannot predict extreme return movements of Bitcoin.

We further investigate the relationship between social media disagreement and the stock market at the individual stock level. While investigating the effect of disagreement at the index level provides a broad overview of how social

Table 5. Disagreement and extreme returns

	Panel A: r/stocks		**Panel B: r/Bitcoin**	
	ext_neg_t	ext_pos_t	ext_neg_t	ext_pos_t
$disagt_{t-1}$	0.719***	0.460	0.015	–0.030
	(0.267)	(0.363)	(0.157)	(0.184)
$avol_{t-1}$	0.559	1.744***	0.316	0.252
	(0.678)	(0.485)	(0.220)	(0.187)
$prange_{t-1}$	0.221	0.194	0.434***	0.461***
	(0.235)	(0.198)	(0.150)	(0.122)
ext_neg_{t-1}	–1.479*		0.000	
	(0.894)		(0.000)	
ext_pos_{t-1}		–1.802		–0.063
		(1.553)		(0.685)
Constant	–3.443***	–4.311***	–3.778***	–3.435***
	(0.216)	(0.311)	(0.202)	(0.168)
Observations	865	865	1224	1254

Notes: Asterisks represent statistical significance: *** < 0.01, ** < 0.05, and * < 0.1.

Source: own elaboration.

media dynamics impact overall market activity, examining the relationship at the individual stock level provides a detailed perspective and allows us to observe stock-specific effects that are not evident at the index level. Separately examining how individual stocks are affected by social media discussions also enhances the validity of our study and acts as a robustness check. Stocks with an active social media presence may experience more significant effects, as information can disseminate rapidly within their community, influencing market dynamics. Therefore, the impact of social media disagreement may be more substantial at the individual stock level than at the index level. We closely follow our methodology but adjust for additional variables such as market value, book-to-market ratio, and bid-ask spreads to account for stock-specific factors that can confound our results. We include these variables to control for stock-specific factors that may affect trading volume and volatility independently of social media disagreement, as they have been linked to trading volume and volatility due to factors such as visibility, liquidity, and information asymmetry (Aouadi et al., 2013; Ding & Hou, 2015). We are still testing hypothesis 1, investigating the effect of social media disagreement on abnormal trading volume and volatility. The results are reported in Table 6.

Table 6. Lagged effects of disagreement at the individual stock level

	$avol_t$	$prange_t$
$disagt_{t-1}$	0.0592***	0.0008***
	(0.0107)	(0.0001)
r_{t-1}	2.4455***	–0.0277***
	(0.8900)	(0.0076)
$prange_{t-1}$	9.0845***	0.5475***
	(1.0071)	(0.0210)
$avol_{t-1}$	0.2152***	0.0000
	(0.0011)	(0.0000)
$lnmv_{t-1}$	–0.1241	–0.0023
	(0.1602)	(0.0020)
$lnbm_{t-1}$	–0.0788	0.0038***
	(0.1243)	(0.0013)
$spread_{t-1}$	0.4572	0.0363**
	(0.3198)	(0.0142)
Constant	1.1214	0.0451**
	(1.6157)	(0.0217)
Observations	30416	30416
R^2	0.8363	0.3927

Notes: Asterisks represent statistical significance: *** < 0.01, ** < 0.05, and * < 0.1.

Source: own elaboration.

We see that stock-specific disagreement can significantly predict the next day's abnormal trading volume and volatility. One standard deviation increase in disagreement leads to a subsequent rise in abnormal trading volume of approximately 6%. This effect is much more significant compared to the abnormal trading volume response of 1.68% observed at the index level. As expected, we see more pronounced effects of disagreement on the stock market when we precisely match disagreement with individual stocks. At the index level, some community effects are attenuated, resulting in smaller increases in trading volume. We demonstrate similar findings for the impact of disagreement on stock volatility. One standard deviation increase in stock-specific disagreement induces an additional eight-basis-points increase in the next day's volatility. This impact on stock volatility is 60% higher than the disagreement's effect on index volatility.

We also investigate whether disagreement's predictive power over extreme return movements exists at the individual stock level. Table 7 reports our results. We see that disagreement is still significantly associated with future extreme movements but provides less precision. Increases in disagreement are positively related to extreme negative returns at the 0.1 level of significance, but they are also positively associated with extreme positive returns at the 0.01 level. In other words, while an increase in disagreement is associated with a higher probability of subsequent extreme movement at the individual stock level, it cannot provide reliable information about its direction as it does at the index level. More specifically, one standard deviation increase in disagreement increases the probability of subsequent extremely negative returns by 7% and extremely positive returns by 12%. Social media disagreement is still a volatility-increasing factor, but its ability to act as a warning signal diminishes at the individual stock level.

To test the robustness of our results, we conduct additional analyses by including neutral comments in the disagreement calculation. For the sake of brevity, we summarise these results without reporting complete estimations. We obtain results similar to those of our main models in most cases. At the stock market level, the effects of social media disagreement on the next day's volatility and the likelihood of extreme negative returns remain. We also still observe the significant effects of disagreement on both abnormal trading volume and volatility at the individual stock level. However, we observe some slight changes. Specifically, the effect of disagreement on the next day's abnormal trading volume in the stock market becomes statistically insignificant when neutral comments are included. Similarly, for Bitcoin, including neutral comments reveals before-the-market results to become insignificant. Although the results are similar in most cases, they suggest that opinions without strong sentiment may weaken the measurement of disagreement.

In addition, we run a robustness check to test the impact of excluding comments that mention multiple stock tickers. Instead of removing these com-

Table 7. Disagreement and extreme returns at the individual stock level

	ext_neg_t	ext_pos_t
$disagt_{t-1}$	0.0635*	0.1098***
	(0.0338)	(0.0312)
$lnmv_{t-1}$	0.5153***	–0.0411
	(0.0876)	(0.0743)
$lnbm_{t-1}$	0.0931	0.2206**
	(0.0927)	(0.0865)
$avol_{t-1}$	0.0707***	–0.0005
	(0.0185)	(0.0021)
$prange_{t-1}$	0.2192***	0.2186***
	(0.0180)	(0.0158)
ext_neg_{t-1}	0.4034***	
	(0.0956)	
ext_pos_{t-1}		0.0387
		(0.0956)
Observations	27091	27755

Notes: Asterisks represent statistical significance: *** < 0.01, ** < 0.05, and * < 0.1.

Source: own elaboration.

ments, we assign their sentiment scores to all referenced stocks. The results remain consistent with our primary findings and show that excluding comments with multiple stock tickers does not affect our overall results. We observe no significant changes in the effects of social media disagreement on abnormal trading volume or volatility.

Moreover, we perform a robustness check for our stock-level results by excluding stocks with only one comment per day to ensure that these minimal observations do not skew the results. The results remain consistent with our primary findings. The positive impact of social media disagreement on abnormal trading volume and volatility is robust to eliminating stocks with only one daily comment.

Finally, to see the impact of social media disagreement over a longer period, we rerun our VAR models using lags of up to five days. The results indicate that only the one-day lag model produces statistically significant effects on abnormal trading volume and volatility. The effects of social media disagreement on markets appear to be short-lived, with no significant results observed for longer lags. These findings demonstrate the short-term nature of the relationship between social media disagreement and market dynamics.

Conclusions

In this study, we examine how social media disagreement affects future trading volume and volatility in financial markets. We investigate this relationship in two popular Reddit communities related to the stock market and Bitcoin to compare and examine whether different asset classes exhibit different community effects. Our findings show that social media disagreement is more influential in the stock market than Bitcoin. Specifically, disagreement is positively associated with increased trading volume and volatility in the stock market, whereas for Bitcoin, disagreement only weakly predicts future volatility. We also show that higher levels of social media disagreement increase the likelihood of extreme negative returns in the stock market. Disagreement at the individual stock level also creates more substantial increases in both trading volume and volatility compared to disagreement at the index level. We also demonstrate high autocorrelation in abnormal trading volume and price range, which emphasises the persistence of these market measures.

Our study highlights the role of disagreement on social media platforms, which has received less attention than sentiment in prior research. We use established methodologies in the literature to explore discussions about different asset classes on social media platforms. Our results suggest that the dispersion of beliefs in online financial communities plays a significant role in market dynamics, particularly in the stock market, where disagreement drives short-term market behaviour. We also demonstrate the differences between the stock market and Bitcoin communities. Unlike the stock market community, the Bitcoin community frequently discusses Bitcoin's underlying technology and usefulness and tends to be more ideologically driven. As a result, participants in the Bitcoin community are less likely to react to daily market fluctuations based on social media disagreements. However, our findings suggest that during significant market drawdowns, the impact of disagreement becomes more pronounced. A shift of focus in discussions in the Bitcoin community from ideological discussions to market activity may explain the stronger influence of disagreement during downturns.

Our study has some limitations that should be acknowledged. First, we only focus on two communities on Reddit. Future studies can expand the scope to include other social media platforms or less popular subreddits and investigate other crypto assets, such as Ethereum or other less liquid altcoins. Moreover, exploring additional characteristics that drive differences between asset classes and communities could further refine our understanding of social media's influence on investor behaviour. Lastly, understanding the behavioural or cultural factors that drive disagreement might contribute to a better understanding of the relationship between social media and financial markets.

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