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RESEARCH PAPER

Are blockchain-based digital transformation and ecosystem-based business models mutually reinforcing? The principal-agent conflict perspective

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Abstract

This paper explores the implications of digitalization and business model innovation for the principal-agent conflict. Continuous digital transformation has recently become a feature sine qua non for companies. It is also stimulating business model innovation resulting in the growing adoption of ecosystem-based models. These trends may have significant implications for the principal-agent relationship, essential for understanding value creation by a firm. In order to analyze the impact of digital transformation, we use blockchain technology as a proxy. To measure the potential impact on the principal-agent conflict, we study management and shareholder-sponsored proposals at annual meetings. The level of shareholder involvement in governance is measured based on the number of shareholder-sponsored proposals received. In addition, we measure shareholder support for management-sponsored proposals. A sample of 2481 NYSE, Nasdaq and AMEX-traded firms for the period 2015–2019 is used. First of all, we show that digitalization per se has a mitigating impact on the agency conflict. Shareholders become more active, albeit not more hostile towards management. Secondly, we have identified the strongest impact in such sectors as information technology, communications, finance, and healthcare. These are the most significantly impacted by ecosystem-based business model innovation. We conclude that digitalization and ecosystem-based business models are mutually reinforcing in mitigating the principal-agent conflict.

Keywords Corporate governance · Digital transformation · Ecosystems · Corporate voting · Shareholder activism

JEL Classification G32 · G34

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1 Introduction

For more than 40 years since the publication of the seminal paper (Jensen & Meckling, 1976), the principal-agent conflict between shareholders and management has been at the center of corporate governance research. Certain trends, however, appear to be exacerbating this conflict. They appear to indicate a "lack of balance" in the application of corporate governance mechanisms. First of all, we are observing the growth of shareholder activism (Cohn et al., 2018; Foldsey et al., 2015). Secondly, researchers have demonstrated that the growth of index investment funds encourages a more passive behavior among retail investors (Fich et al., 2015), something which lies at the core of the conflict (Roe, 1991). Shareholders, therefore, are either becoming excessively passive or tend to proceed directly towards activism.

At the same time, certain other trends have a potentially mitigating impact upon the conflict. First of these is digital transformation which has become a feature sine qua non for companies and their governing bodies (Grove et al., 2018). Technologies such as blockchain and artificial intelligence create gains in efficiency for adopters, enabling them to build and enhance their competitive advantages. Research has shown that digital champions perform much better (Westerman et al., 2012). Secondly, business models are evolving towards the growing adoption of platform/ecosystem-based models. Researchers interpret this as "the end of corporate governance, hello platform governance" (Fenwick et al., 2019). At the time of writing this paper, the most highly valued firms (measured by market capitalization) globally were operating as ecosystems, albeit in different configurations (e.g. Apple, Amazon, etc.). A number of authors have argued that these trends are mutually reinforcing (Chong et al., 2019; Fehrer et al., 2018; Schweiger et al., 2016; Yrjölä, 2020). Both create greater trust among the firms' stakeholders (incl. suppliers, clients, etc.)—digital transformation reduces the reliance on human decisions while ecosystem-based business models change create an environment where value is created by an open exchange of information among the stakeholders instead of hiding inside a "black box" of a firm. We provide an extended discussion of this effect in the Sect. 2 of the paper. Hence, the firms leveraging both opportunities would reap the most performance benefits. These improvements should in turn result in weaker principal-agent conflict (Karpoff et al., 1996). To the best of our knowledge, however, there is yet scarce direct empirical evidence about the impact of digitalization on the principal-agent relationship. The missing direct evidence may potentially prevent practitioners from leveraging the opportunities and creating value for the corporate stakeholders.

The motivation of our research is twofold. First, we establish the empirical link between digital transformation and ecosystem-based business models—exploring whether there is indeed a reinforcement between the two trends. Second, we provide business practitioners (as boards of directors) with evidence on the implications of leveraging these opportunities: (a) whether they should expect an increased conflict with shareholders resulting from digital transformation and business model innovation which are often considered risky decisions; (b) whether digital transformation and new business models should be applied in parallel for maximum effects.

The aim of this paper is to contribute to the discussion about the implications of digitalization and business model innovation with regard to the principal-agent conflict. We explore the principal-agent conflict from two standpoints: the level of shareholder activity; and the level of shareholder support for management. To measure the level of conflict, we use the dynamics on the shareholder meetings following (Iliev et al., 2021; Renneboog & Szilagyi, 2011). We deliberately looked at the implications for conflict, rather than at the question of direct shareholder value creation by means of abnormal stock returns, for example. We believe that this should be the topic of a separate paper.

In order to assess the impact of digital transformation, we selected a set of companies which are adopting blockchain technology which per se has strong implications for corporate governance and has a strong synergetic effect with ecosystem-based business models. We offer evidence that shareholders become more active yet not more hostile towards management. This leads to a conclusion that increased shareholder activity is "healthy", in the sense that it reflects a mitigated principal-agent conflict. In order to assess the existence of a reinforcing effect between these two trends, we performed a sectoral analysis. In this analysis we compared the impact of digitalization in those sectors which are more significantly affected by eco-systems with those lesser affected. We identified the most significant impact in such sectors as information technology (IT), communications, finance, healthcare and industrials, where platforms are particularly widespread, thus indicating a reinforcement effect.

We analyzed a sample of NYSE, AMEX and Nasdaq traded firms over the period 2015–2019. It should be noted, and we acknowledge that the results would have benefited from the inclusion of the COVID-19 pandemic years, during which digital adoption was boosted. However, when this paper was submitted, 2020 data was not yet available. The choice of the US sample was driven by the availability of data on companies with comparable corporate governance contexts and financial reporting standards. In future research, the extension of the study to firms based in Europe, Asia and other regions should add further important insights into regional specifics.

The paper is structured in the following way: Sect. 2 contains a short theoretical background of the research and a review of the literature on implications of both ecosystem-based business models and digitalization for corporate governance; Sect. 3 discusses our empirical analysis technique, variables, and hypotheses; while Sects. 4 and 5, respectively, present the data we used, and our results. In Sect. 6, we summarize our conclusions and discuss the limitations of our study, as well as the next steps for research.

2 Literature review: changes in business environment driven by digital technology

As the theoretical framework of our research, we use the principal-agent conflict between shareholders and management. As shown by Jensen and Meckling (1976), the primary source of the conflict is the information asymmetry between the two parties, which may be abused by the management to act not in the best interest of the shareholders. Ultimately, information asymmetry abuse results in a poorer

performance of the firms. Shareholders experiencing weak performance would be increasingly dissatisfied with the management and use one of the tools available for them—starting with soft measures as "voting with their feet"—that is, selling their shares (Parrino et al., 2003) and ending with extreme measures as a firm's buyout (Fama & Jensen, 1983). Hence, when exploring the implications of digital transformation and ecosystem-based business models, we look at these two aspects of corporate life—information asymmetry and performance implications.

Both of the trends explored in this paper stem from the adoption of digital technologies which have contributed to the creation of the 4th industrial revolution. Technologies such as artificial intelligence (AI) and blockchain are changing the ways companies operate and have raised their efficiency to a new level (Grove et al., 2018; Schwab, 2017). These innovations create opportunities for information asymmetry reduction and corporate financial performance improvements by bringing together buyers and sellers from distant locations, as well as empowering new ways of working and collaboration. We witnessed the importance of these technologies during the COVID-19 pandemic, when online retailers such as Amazon enabled clients to maintain consumption patterns largely unchanged despite the lockdown. At the same time, communication tools such as Slack or Zoom enabled remote working. In this section, we explore the trends and their implications for the principal-agent conflict from these two perspectives: information asymmetry reduction and corporate financial performance improvement.

2.1 Digital transformation

As mentioned above, transformative digital technologies offer enhanced efficiency for companies. Research shows that AI and blockchain technologies have a particularly strong impact on corporate governance (Fenwick & Vermeulen, 2019; Grove et al., 2018; Zhu, 2019).

The impact of digital transformation from a corporate governance point of view is manifold. First of all, it provides direct opportunities for improvement. Technologies contribute to an increase in transparency and restricting information asymmetry abuse by management. Examples include blockchain applications optimize voting procedures at shareholder meetings (Van der Elst & Laffare, 2017) or to create greater clarity in the ownership structure of firms. This helps to prevent such strategies as "empty voting" (Yermack, 2017). AI has an equally strong potential impact. Evidence shows that Big Data, which is at the heart of AI, can by itself mitigate the principal-agent conflict by reducing insider trading (Zhu, 2019).

Secondly, there are more radical applications which minimize the need for management and governance bodies. Blockchain applications enable certain Board of Directors (BoD) functions such as internal audit to be automated (Byström, 2019; Peters & Panayi, 2016). They can even support the creation of companies without any management at all. These are known as "decentralized autonomous organizations" (DAOs) (DuPont, 2017; Kristof, 2017). (See Ivaninskiy (2019) for a literature review of blockchain applications in corporate governance, and Lafarre & Van der Elst (2018) for a description of applications currently at the pilot stage.)

AI in the form of machine learning can create even greater opportunities for automation (Wang et al., 2020) by enabling management to scan the external environment for the actions of competitors (Libert et al., 2017), etc. AI may also outperform humans in appointing directors (Erel et al., 2018). Even simple AI applications such as Robotics Process Automation (automation of mundane processes such as drafting reports, etc. (Moffitt et al., 2018)) can enhance the work of auditors and their important role in corporate governance (Issa et al., 2016; Manita et al., 2020). AI has even been used experimentally in the capacity as a member of a Board of Directors (Fenwick & Vermeulen, 2019; Mosco, 2020). A detailed review of studies about the impact of AI on corporate governance is given in Ivaninskiy & Ivashkovskaya (2020).

Thirdly, even if not applied specifically to corporate governance, digital transformation may mitigate the conflict. As mentioned in the introduction, Westerman et al. (2012, p. 8) show that firms committed to digital transformation are, on average, "by 9–26% more profitable than their average industry competitors on a basket of measures, including EBIT margin and net profit margin". Better-performing firms typically have a weaker principal-agent conflict (Karpoff et al., 1996).

While previous research on the impact of digital transformation suggests that it can have a mitigating effect on the principal-agent conflict, the opposite may also be true. For example, Rückeshäuser (2017) and Kaal (2020) argue that blockchain may be manipulated fraudulently by management. Kristof (2017) describes a failed DAO investment fund which undermined the very idea of DAOs and blockchains in governance. Another issue with blockchains is their lack of legal clarity (Fry, 2018; Kajtazi & Moro, 2019). There are also potential problems with AI. Dignam (2020) argues that AI may exacerbate issues such as discrimination or create problems of liability attribution. Therefore, the technologies must be treated with caution. The growing adoption of Big Data and AI is creating a challenge of navigating the increasing volume of data and its quality (Libert et al., 2017). Furthermore, country level research suggests that the adoption of information and communication technologies plays a relatively modest role in boosting productivity (Hawash & Lang, 2020). These, therefore, are reasons why shareholders oppose the aggressive introduction of such emerging technologies. It is also important to stress that the absolute majority of papers reviewed are conceptual in nature.

2.2 Platform and ecosystem business models

While platform and ecosystem business models are receiving growing attention in research literature, so far, no universally accepted definitions have been proposed. Certain authors distinguish between these two terms (e.g., Gawer & Cusumano, 2014), while others use them interchangeably (Tsujimoto et al., 2018). Fenwik et al. (2019, p. 11) define platform businesses as companies which "leverage networked technologies to facilitate economic exchange, transfer information and connect people". The authors also emphasize that value is generated for the platform owner by facilitating interactions between creators and extractors of value. The key characteristic of platforms is value generation by bringing

scattered agents together. Well-known examples of platforms include Uber and Airbnb which aggregate the services of drivers and rental properties respectively. Kamargianni and Matyas (2017, p. 6), following Moore (1993), define a business ecosystem as "the wider network of firms that influences how a focal firm… creates and captures value". Perhaps the best-known ecosystems are Apple, Amazon, WeChat, inter alia, which bring together goods and service providers. Platforms and ecosystems rely on a network of third parties, in order to generate value for direct customers, as well as for the partner network. This has led researchers to classify them as "open business models" following Chesbrough, (2006), Weiblen, (2014). In our research, we do not differentiate between these terms.

Research shows that ecosystems generate a tangible business performance improvement opportunity, while ignoring them on the other hand creates a tangible threat. A recent BCG survey shows that a quarter of executives believe that within 3 years digital ecosystems will account for over 60% of sales in their industries. According to the survey, executives expect ecosystems in such industries as telecommunications, media and technology, finance, consumer goods and healthcare to be particularly urgent and relevant, while industrials and energy are seen to be less urgent and relevant (Bhatnagar et al., 2021). However, certain authors (e.g., Fenwick & Vermulen, 2019) argue that no one is immune from this threat: "The rule is straightforward: 'You either become a platform, or you will be killed by one'."

There are three major ways in which ecosystems can influence the principal-agent conflict. Firstly, the key difference between ecosystems and traditional business models lies in the value generation process. Traditional companies generate value by building a closed, centralized, and hierarchical structure with "a clear boundary between the firm and the 'outside world'" (Fenwik et al., 2019). Platforms share information about suppliers with customers, thus generating value by exchanging information rather than hiding it. An important feature of ecosystems is trust among stakeholders. It would, therefore, be reasonable to expect ecosystems to generate greater trust between shareholders and management and, hence, a weaker principal-agent conflict.

Secondly, certain researchers (e.g., Fenwik et al., 2019) argue that traditional corporate governance mechanisms are not well-suited to ecosystem-based businesses and need fundamentally redesigning. Hence, ecosystems may well end up having a stronger principal-agent conflict, not as well mitigated by traditional mechanisms.

Thirdly, there is strong interaction between the ecosystem-based business model and digitalization. Application of technologies such as blockchain tends to shift the "center of trust" from the ecosystem founder towards the underlying technology or algorithm (Xia et al., 2017). Since trust and transparency are key sources of value for ecosystem-based businesses, researchers argue that digitalization and business model innovation are mutually reinforcing (Schweiger et al., 2016; Yrjölä, 2020). It is reasonable, therefore, to expect the impact of digitalization on corporate governance to be more significant for companies which leverage ecosystem business models. Given that we expect digitalization, as mentioned above, to have an overall mitigating impact on the principal-agent conflict, it is reasonable to expect companies which leverage both trends to experience even weaker conflict. However, as in the case of digitalization, direct empirical evidence regarding the implications of

ecosystem-based business models for corporate governance is limited. This study is an attempt to try and fill this gap.

3 Hypotheses and empirical analysis approach

The following section will describe hypotheses based on prior research and the modeling approach used to test them. The principal-agent conflict between shareholders and management is related to the passive position of shareholders not involved in corporate governance (Roe, 1991). Hence, the first way we measure the conflict is to assess the level of shareholder involvement in the management of the firm. Shareholders can become involved in corporate management in a number of ways. The simplest of these is "voting with their feet", i.e. selling shares in a company (Parrino et al., 2003). The most radical is shareholder activism in the form of a corporate buyout (Fama & Jensen, 1983). A middle way of shareholder involvement is by submission of a shareholder-sponsored proposal to the annual meeting (Gillan & Starks, 2007). However, we believe that the level of shareholder activity is not a sufficient metric for the intensity of conflict, as a higher activity may signify a dissatisfaction of shareholders with management actions and the stronger conflict. To control for this, we directly measure the level of "agreement" between shareholders and management. We discuss the variables in the respective subsection of the paper.

As discussed in the literature overview section, we believe digital transformation should have a mitigating influence on the conflict. The primary reason is reduction of opportunities for information asymmetry abuse by the management which is particularly relevant for blockchain technology and AI. The secondary reason is improved performance (including expected improvements) driven by the digitalization. Furthermore, a preliminary attempt to empirically assess the implications of digitalization for the principal-agent conflict is taken by Ivaninskiy et al., (2021). Using the data from 2018 authors show that digitalization has a partially mitigating impact for the conflict. However, the research is limited to 1 year only and does not include the analysis of business model innovation which, as discussed earlier, is important from the practical point of view. Hence, the first hypothesis is the following:

> H1: a) Digital transformation has a positive impact on the likelihood and number of shareholder-sponsored proposals, which is a sign of more active shareholders.
> b) Digital transformation has either a positive impact on the share of management-sponsored proposals which pass the vote or no significant impact.

As discussed, theoretical research shows that there is a synergetic effect between platform-based business models and digital technologies (Schweiger et al., 2016; Yrjölä, 2020). This is due to the fact that both trends reduce the asymmetry between the principal and the agent and have potential to improve the corporate performance. Therefore, our second hypothesis is the following.

H2: Digital transformation has a stronger mitigating impact on the principal-agent conflict in those sectors where ecosystems are more widespread.

3.1 Dependent variables

Dependent variables in our research reflect the level of shareholder activity and the level of "agreement" between shareholders and management. In this paper we apply two methods of measuring shareholder activity level using shareholder-sponsored proposals. First, following Renneboog and Szilagyi (2011), we use the likelihood of receiving a shareholder-sponsored proposal at the annual meeting. In this model, the variable is equal to 1 if there is at least one shareholder proposal at the meeting and 0 otherwise. Secondly, following Iliev et al. (2021), we use the number of shareholder proposals received by a company. According to this logic, the greater likelihood or larger number of shareholder-sponsored proposals signifies more active shareholders and hence a weaker conflict in the company.

However, as discussed, we measure not only the activity of shareholders, but also the "agreement" between shareholders and management. We measure this using the share of management-sponsored proposals pass at the voting (Renneboog & Szilagyi, 2011). A stronger conflict would be reflected in a lower fraction of proposals passed.

3.2 Independent variables

We use blockchain technology, in order to account for active digital transformation. Several authors maintain that blockchain technology offers the highest transformative potential (Cong & He, 2019; Yermack, 2017). This technology is, at the same time, mature enough to be acknowledged and applied even by governments worldwide. It was said at the 2021 World Economic Forum in Davos that "86% of central banks are exploring the benefits and drawbacks of central bank digital currency".[1] Prominent investors such as Warren Buffet also acknowledge the importance of blockchain.[2] As already mentioned, blockchain has a strong effect when applied in combination with ecosystem-based business models, since it enables "trustless" systems to be created. We acknowledge that blockchain is just one technology among many, and as such in subsequent research we intend to expand the set of technologies being studied, in order to include, AI, for example.

In our model, we use a dummy variable equal to 1, if a company is actively exploring blockchain technology, and 0 if it is not. We use the following data collection approach: first we survey annual reports by firms; then we explore their official websites; and, finally, we look at news feeds about the companies. We record not

[1] https://www.weforum.org/agenda/2021/02/key-takeaways-on-digital-currency-from-the-davos-agenda/.

[2] De N. Warren Buffet: Bitcoin Is a 'Delusion' But Blockchain Is 'Ingenious'. Coindesk. 2019. Available at https://www.coindesk.com/warren-buffet-bitcoin-is-a-delusion-but-blockchain-is-ingenious., accessed on 28.02.2021. Full interview to CNBC is available at https://www.youtube.com/watch?v=2hdDE7XYr30 accessed on 11.10.2021.

Table 1 Expected impact of the control variables

Control variable	The expected impact on the likelihood of receiving a shareholder proposal	The expected impact on the level of shareholder support for the proposals
Company size	+	−
Growth	−	−
Profitability	−	+
Valuation (market to book value)	−	−
Leverage	+	−
Institutional ownership	−	+
Insider ownership	+	−

only the fact that a given company has adopted blockchain technology but also the year in which blockchain technology was first mentioned. An example of a company actively involved in the blockchain sphere is IBM which offers multiple blockchain-based solutions for clients.[3] We acknowledge that our definition of blockchain is very general and not limited to corporate governance per se. In the future, as more data becomes available and the adoption of the technology expands, we will be able to focus more on corporate governance.

In order to test hypothesis 2, we run a set of regressions by sector. We assume that the impact of digital transformation will be most significant in sectors where platforms are more widespread: finance, consumer goods, communication and IT. We acknowledge that this is an imperfect way of measuring the adoption of the ecosystem business model. A more accurate way would be to collect corporate level data, in order to identify which companies are using the new business model. We intend to use this approach when more data becomes available. However, as with the case of blockchain adoption, there is no structured dataset on the topic, and it will have to be collected manually.

3.3 Control variables

Since the use of shareholder-sponsored proposals as a proxy for shareholder involvement is a well-established procedure, a relatively standard set of control variables is used. According to Karpoff et al. (1996) and Thomas & Cotter (2007), the following set of characteristics is used: (1) company size, (2) growth, (3) profitability, (4) valuation, (5) leverage, (6) institutional ownership, (7) insider ownership. This paper applies a similar set; data is collated from the S&P Capital IQ database. We provide definitions and data sources in Appendix. Based on prior research, we expect the impact of controls to be as shown in Table 1. We also add dummy variables for sectors where the firm operates (Table 2).

[3] Please see https://www.ibm.com/blockchain.

Table 2 Descriptive statistics

Statistic	Blockchain adopters			Blockchain non-adopters		
	N	Mean	St. dev	N	Mean	St. dev
Company size	405	9.1	2.5	10,038	7.1	2.1
Market capitalization	405	56.5	111.4	10,038	8.4	31.6
Growth rate	405	0.1	0.2	10,038	0.1	0.2
Profitability	405	0.2	0.3	10,038	0.1	0.2
Market to book ratio	405	4.2	11.0	10,038	3.9	42.0
Leverage	405	1.2	3.7	10,038	1.1	12.2
Institutional ownership	405	0.7	0.2	10,038	0.6	0.3
Insider ownership	405	0.1	0.2	10,038	0.1	0.1
At least 1 shareholder proposal	405	0.4	0.5	10,038	0.1	0.3
Number of shareholder proposals	405	0.9	1.6	10,038	0.2	0.8
Share of management proposals passed	405	1.0	0.1	10,038	1.0	0.1

We use logistic regression to measure the likelihood of receiving a shareholder-sponsored proposal, and linear regression to analyze the number of proposals received, as well as of the support levels for management-sponsored proposals.

4 Sample

For the purposes of our analysis we used panel data on a set of 2481 companies whose shares were traded on the NYSE, AMEX or Nasdaq stock exchanges over a period of 2015–2019. In order to arrive at the final sample, we began with the set of all traded companies and cleared potentially erroneous data (e.g., data with missing values). We chose this data range, since it is marked by the rapid adoption of digital technologies driven by increased data availability (e.g., Miklosik et al., 2019) showed that 90% of data had been generated over the previous 2 years). As mentioned in the Introduction, the choice of region for the sample was determined by data availability. As we shall see below, the total number of companies adopting the blockchain technology still remains relatively low. Hence, an analysis of US-traded companies guarantees that data is sufficient, in order to draw conclusions.

An analysis of descriptive statistics shows that the adoption of blockchain has grown and accelerated over time. The final sample consists of 228 companies which used blockchain in 2019. We see non-uniform distribution of blockchain adoption among sectors. The highest proportion of adopters is to be found in IT, communications, consumer goods, industrials and financials sectors.

When comparing the number of shareholder-sponsored proposals received by adopters and non-adopters, it can be seen that the former group receives a much higher number of proposals: an average of 0.9 proposals per meeting vs. only 0.2 proposals. This supports the hypothesis that companies actively committed to digital

transformation have more active shareholders. Remarkably, when we compare adopters to non-adopters within each sector, we see that the difference is highest in sectors more strongly affected by ecosystems (with the notable exception of energy). This seems to indicate that the hypothesis about the reinforcing nature of digital transformation and business model innovation is also correct (Figs. 1, 2).

When analyzing the share of management-sponsored proposals that pass the vote, we do not see any significant differences between blockchain adopters and non-adopters. This confirms the hypothesis that shareholders are not more hostile towards the management of companies actively committed to digital transformation. A comparison between sectors shows the same results.

An analysis of control variables shows that blockchain adopters have significantly higher market capitalization on average ($56.5 billion for adopters vs. $8.2 billion for non-adopters) and are more profitable, as measured by the EBITDA margin (20% for blockchain adopters vs. 10% for non-adopters), while other variables have similar averages. This suggests that digital transformation requires both scale and resources.

5 Results

This section describes the modeling results. First, we review the results of regressions on the overall sample to validate our hypothesis about the impact of digitalization on the principal-agent conflict. We then present the results of analysis by sector to check for a synergetic effect between the two trends explored. In both cases we

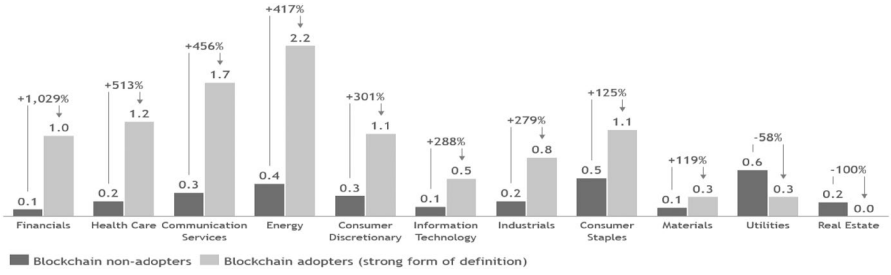

Fig. 1 Difference in the number of shareholder-sponsored proposals received by sector

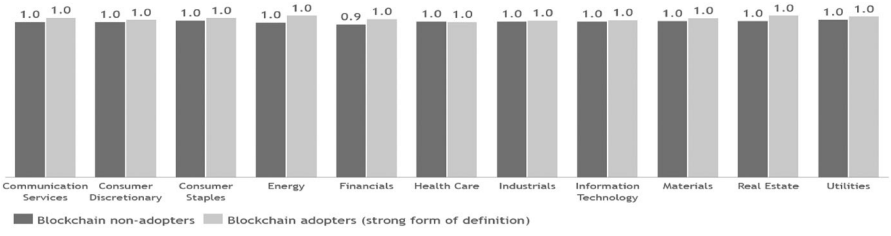

Fig. 2 Difference in the share of management-sponsored proposals that pass the vote

ran 3 sets of regressions: a logistic regression on the likelihood of receiving a shareholder-sponsored proposal; a regression on the number of shareholder-sponsored proposals received; and a regression on the share of management-sponsored proposals that pass the voting.

5.1 Regression on the overall sample of firms

When analyzing the impact of digital transformation on the likelihood of receiving a shareholder-sponsored proposal, we see that, even taking control variables into account, blockchain adoption has a significant positive impact on the likelihood. The results lead us to conclude that shareholders of companies committed to digitalization are indeed more active.

In order to test the robustness of the results, we ran a linear regression on the number of shareholder-sponsored proposals received by a given company. We saw that blockchain adoption has a significant positive impact on the number of proposals. Hence, we conclude that the shareholders of blockchain adopting firms not only are more likely to submit the proposal, but also submit more proposals for the meetings. Most control variables are significant with the coefficient signs in line with hypothesis.

However, as mentioned above, the level of activity is not sufficient to evaluate the level of the conflict. Thus, we ran the regression on the impact of the digital transformation on the share of management-sponsored proposals pass the voting. We see that blockchain as a slightly positive impact on the share of management-sponsored proposals passing the vote. As before, most of the control variables are significant, with their expected signs in line with the hypothesis. The results are in line both with our hypothesis and the results of the prior studies. Digital transformation seems to be perceived by the shareholders as the means for the information asymmetry reduction and financial performance improvement. The results are shown in Table 3.

To ensure the absence of endogeneity we run a set of control regressions where instead of using *Blockchain* variable for the same period as voting, we use the value lagged by 1 period (e.g., for the 2019 voting we use 2018 values of *Blockchain* variable). The results are summarized in the Table 4. We see that the results are similar to those presented in Table 3, indicating absence of endogeneity. The control variables are relatively standard we do not run dedicated endogeneity check for them.

The results for the full sample support the hypothesis that companies committed to digitalization have more active shareholders who are not more hostile towards management. Hence, we conclude that firms committed to digitalization have a weaker principal-agent conflict, which is consistent with suggestions by Yermack (2017) and Lafarre and Van der Elst (2018), and earlier empirical results by Ivaninskiy et al., (2021).

Table 3 Results of regressions on the overall sample of firms

	Results of logistic regression on likelihood of receiving a shareholder proposal	Results of linear regression on the number of shareholder proposals received	Results of linear regression on share of proposals passed
	Dependent variable		
	At least 1 shareholder proposal	Number of shareholder proposals	Share of management proposals passed
Blockchain	0.569*** (0.139)	0.382*** (0.043)	0.009* (0.005)
Company size	0.817*** (0.026)	0.171*** (0.005)	0.004*** (0.001)
Growth rate	− 1.560*** (0.237)	− 0.186*** (0.036)	0.007 (0.004)
Profitability	− 0.525** (0.240)	− 0.146*** (0.044)	0.004 (0.006)
Market to book ratio	0.0001 (0.001)	− 0.0001 (0.0002)	− 0.00000 (0.00003)
Leverage	0.001 (0.002)	0.001 (0.001)	− 0.00002 (0.0001)
Institutional ownership	− 0.175 (0.185)	− 0.525*** (0.036)	0.023*** (0.004)
Insider ownership	0.099 (0.374)	− 0.189*** (0.065)	0.043*** (0.008)
sector_energy	0.314 (0.265)	0.260*** (0.059)	− 0.004 (0.007)
sector_materials	− 0.077 (0.269)	− 0.125** (0.058)	0.004 (0.007)
sector_industrials	0.546** (0.231)	0.037 (0.050)	0.0004 (0.006)
sector_cons_discr	0.690*** (0.235)	0.101** (0.051)	− 0.005 (0.006)
sector_cons_stapl	0.827*** (0.259)	0.143** (0.061)	0.006 (0.008)
sector_healthcare	0.315 (0.243)	− 0.004 (0.053)	0.0002 (0.007)
sector_finance	− 0.208 (0.247)	− 0.118** (0.050)	− 0.011* (0.006)
sector_IT	− 0.321 (0.242)	− 0.054 (0.050)	0.001 (0.006)
sector_communication	0.526* (0.285)	0.184*** (0.062)	− 0.001 (0.008)
sector_utilities	1.129*** (0.252)	0.131** (0.066)	0.011 (0.008)
Constant	− 8.781*** (0.339)	− 0.635*** (0.057)	0.916*** (0.007)
Observations	10,443	10,443	10,443

Table 3 (continued)

	Results of logistic regression on likelihood of receiving a shareholder proposal	Results of linear regression on the number of shareholder proposals received	Results of linear regression on share of proposals passed
	Dependent variable		
	At least 1 shareholder proposal	Number of shareholder proposals	Share of management proposals passed
	Log likelihood = − 2713.648	$R^2 = 0.142$	$R^2 = 0.018$
	Akaike inf. crit. = 5465.295	Adjusted $R^2 = 0.140$	Adjusted $R^2 = 0.017$
		Residual std. error (df = 10,424) = 0.832	Residual std. error (df = 10,424) = 0.104
		F statistic (df = 18; 10,424) = 95.604***	F statistic (df = 18; 10,424) = 10.789***

Results of the logistics regression on the likelihood of receiving the shareholder-sponsored proposal; results of the linear regression on the number of receiving the shareholder-sponsored proposal; results of the linear regression on the share management-sponsored proposals that pass the meeting. Value in parenthesis next to the coefficients is standard error. Dependent variables: *At least 1 shareholder proposal* is a dummy variable equal to 1 if in the given year the given firm received at least one shareholder-sponsored proposal and 0 otherwise; *Number of shareholder proposals* is the number of shareholder-sponsored proposals received by the firm in a given year; *Share of management proposals passed* is the share of passed management-sponsored proposals at the meeting. Blockchain is the variable reflecting whether the company is engaged in active digitalization in a form of blockchain implementation; *Company size, Growth rate, Profitability, Market to book ratio, Leverage, Institutional ownership, Insider ownership* are control variables reflecting the size, growth rate, profitability, market capitalization, size of the leverage as well as the institutional and insider ownership of the firm; *sector_energy and other* is the set of dummy variables for the main sector of operations of the firm

*p < 0.1; **p < 0.05; ***p < 0.01

Table 4 Results of the regressions on the full sample of firms with lagged blockchain variable

	Results of logistic regression on likelihood of receiving a shareholder proposal	Results of linear regression on the number of shareholder proposals received	Results of linear regression on share of proposals passed
	Dependent variable		
	At least 1 shareholder proposal	Number of shareholder proposals	Share of management proposals passed
Blockchain lagged	0.733*** (0.202)	0.423*** (0.062)	0.014* (0.007)
Company size	0.814*** (0.029)	0.176*** (0.006)	0.004*** (0.001)
Growth rate	− 1.206*** (0.261)	− 0.163*** (0.042)	0.005 (0.005)
Profitability	− 0.514* (0.279)	− 0.118** (0.053)	− 0.004 (0.006)
Market to book ratio	− 0.002(0.003)	− 0.0001(0.001)	− 0.00003 (0.0001)
Leverage	0.002 (0.004)	0.0001 (0.001)	0.0001 (0.0001)
Institutional ownership	− 0.618*** (0.221)	− 0.661*** (0.043)	0.021*** (0.005)
Insider ownership	− 0.326 (0.454)	− 0.381*** (0.083)	0.042*** (0.010)
sector_energy	0.089 (0.316)	0.205*** (0.067)	− 0.001 (0.008)
sector_materials	− 0.036(0.309)	− 0.159** (0.066)	0.002 (0.008)
sector_industrials	0.659** (0.268)	0.031 (0.057)	0.0002 (0.007)
sector_cons_discr	0.730*** (0.273)	0.071 (0.059)	− 0.006(0.007)
sector_cons_stapl	0.769** (0.300)	0.130* (0.069)	0.002 (0.008)
sector_healthcare	0.343 (0.281)	− 0.011 (0.061)	− 0.002 (0.007)
sector_finance	− 0.165 (0.286)	− 0.148** (0.058)	− 0.011 (0.007)
sector_IT	− 0.266 (0.279)	− 0.060 (0.058)	− 0.002 (0.007)
sector_communication	0.598* (0.329)	0.206*** (0.071)	− 0.007 (0.008)
sector_utilities	1.074*** (0.290)	0.038 (0.075)	0.009 (0.009)
Constant	− 8.428*** (0.388)	− 0.543*** (0.066)	0.915*** (0.008)
Observations	8033	8033	8033
	Log Likelihood = − 2121.759	$R^2 = 0.142$	$R^2 = 0.017$
	Akaike Inf. Crit. = 4281.518	Adjusted $R^2 = 0.140$	Adjusted $R^2 = 0.015$

Table 4 (continued)

	Results of logistic regression on likelihood of receiving a shareholder proposal	Results of linear regression on the number of shareholder proposals received	Results of linear regression on share of proposals passed
	Dependent variable		
	At least 1 shareholder proposal	Number of shareholder proposals	Share of management proposals passed
		Residual std. error (df = 8014) = 0.826	Residual std. error (df = 8014) = 0.098
		F statistic (df = 18; 8014)73.740***	F statistic (df = 18; 8014)) = 7.635***

Results of the logistics regression on the likelihood of receiving the shareholder-sponsored proposal; results of the linear regression on the number of receiving the shareholder-sponsored proposal; results of the linear regression on the share management-sponsored proposals that pass the meeting. Value in parenthesis next to the coefficients is standard error. Dependent variables: *At least 1 shareholder proposal* is a dummy variable equal to 1 if in the given year the given firm received at least one shareholder-sponsored proposal and 0 otherwise; *Number of shareholder proposals* is the number of shareholder-sponsored proposals received by the firm in a given year; *Share of management proposals passed* is the share of passed management-sponsored proposals at the meeting. *Blockchain lagged* is the variable reflecting whether the company is engaged in active digitalization in a form of blockchain implementation in the year before the voting takes place; *Company size, Growth rate, Profitability, Market to book ratio, Leverage, Institutional ownership, Insider ownership* are control variables reflecting the size, growth rate, profitability, market capitalization, size of the leverage as well as the institutional and insider ownership of the firm; *sector_energy and other* is the set of dummy variables for the main sector of operations of the firm

*p < 0.1; **p < 0.05; ***p < 0.01

Table 5 Results of regression on the likelihood of receiving a shareholder-sponsored proposal

Results of logistic regression by sector											
	Dependent variable										
	At least 1 shareholder proposal										
	IT	Communi-cations	Finance	Consumer discretion-ary	Consumer Staples	Health care	Industrials	Energy	Materials	Utilities	Real estate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Blockchain	0.587* (0.304)	1.275** (0.608)	0.208 (0.321)	0.364 (0.414)	0.154 (0.535)	0.600 (0.494)	1.096*** (0.353)	0.701 (1.057)	1.976* (1.139)	− 0.952 (0.927)	− 11.547 (882.744)
Company size	0.829*** (0.079)	0.722*** (0.128)	1.017*** (0.075)	0.706*** (0.064)	0.668*** (0.089)	0.832*** (0.079)	1.083*** (0.078)	0.895*** (0.122)	1.133*** (0.198)	1.080*** (0.199)	− 0.047 (0.190)
Growth rate	− 3.645*** (0.933)	− 1.010 (1.403)	− 0.466 (0.433)	− 2.795*** (0.886)	− 1.997 (1.266)	− 1.321* (0.686)	− 0.161 (0.675)	− 3.620*** (0.982)	− 3.107* (1.791)	− 7.868*** (2.770)	0.435 (0.967)
Profitability	− 0.603 (0.647)	2.011 (1.667)	− 0.897 (0.653)	0.746 (0.915)	− 1.065 (1.020)	− 0.182 (0.566)	− 1.034 (0.810)	0.407 (0.730)	− 6.126*** (1.727)	2.724 (1.765)	− 1.303 (0.957)
Market to book ratio	− 0.050*** (0.017)	0.052 (0.044)	− 0.005 (0.021)	− − 0.0003 (0.008)	− 0.008 (0.010)	0.011 (0.009)	− 0.0004 (0.004)	− 0.205 (0.142)	− 0.125** (0.056)	− 0.291 (0.222)	0.044 (0.094)
Leverage	0.022 (0.066)	− 0.030 (0.079)	0.033** (0.014)	0.001 (0.008)	0.121** (0.059)	− 0.062* (0.033)	− 0.014 (0.023)	0.214** (0.100)	0.162* (0.083)	0.467* (0.255)	0.252* (0.144)
Institutional owner-ship	− 0.164 (0.617)	0.932 (0.811)	− 0.480 (0.492)	0.454 (0.479)	− 1.281** (0.590)	− 0.483 (0.638)	− 0.700 (0.501)	1.629 (1.172)	0.780 (1.001)	1.063 (1.086)	− 0.649 (0.939)
Insider owner-ship	− 1.233 (1.446)	− 2.508 (1.835)	0.140 (0.987)	0.818 (0.823)	− 0.601 (1.010)	− 1.408 (1.802)	1.288 (0.938)	4.421*** (1.693)	− 2.001 (3.908)	− 11.320 (26.337)	− 6.174* (3.288)
Constant	− 8.740*** (0.891)	− 8.798*** (1.315)	− 10.566*** (0.681)	− 7.823*** (0.691)	− 5.792*** (0.857)	− 8.411*** (0.911)	− 10.169*** (0.799)	− 11.000*** (1.751)	− 11.153*** (1.878)	− 11.932*** (2.168)	− 1.227 (1.205)

Table 5 (continued)

Results of logistic regression by sector

	Dependent variable										
	At least 1 shareholder proposal										
	IT	Communications	Finance	Consumer discretionary	Consumer Staples	Health care	Industrials	Energy	Materials	Utilities	Real estate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Observations	1497	380	2269	1354	460	1083	1745	462	533	285	375
Log Likelihood	− 288.595	− 88.777	− 366.608	− 457.684	− 192.305	− 286.216	− 450.782	− 118.949	− 124.836	− 121.482	− 95.560
Akaike Inf. Crit	595.189	195.554	751.217	933.369	402.610	590.432	919.565	255.898	267.673	260.964	209.120

Results of the logistics regression on the likelihood of receiving the shareholder-sponsored proposal. Value in parenthesis next to the coefficients is standard error. Dependent variable *At least 1 shareholder proposal* is a dummy variable equal to 1 if in the given year the given firm received at least one shareholder-sponsored proposal and 0 otherwise; *Number of shareholder proposals* is the number of shareholder-sponsored proposals received by the firm in a given year; Blockchain is the variable reflecting whether the company is engaged in active digitalization in a form of blockchain implementation; *Company size, Growth rate, Profitability, Market to book ratio, Leverage, Institutional ownership, Insider ownership* are control variables reflecting the size, growth rate, profitability, market capitalization, size of the leverage as well as the institutional and insider ownership of the firm

*p < 0.1; **p < 0.05; ***p < 0.01

Table 6 Results of regression on the number of shareholder-sponsored proposals

Results of linear regression by sector											
	Dependent variable										
	Number of shareholder proposals										
	IT	Communications	Finance	Consumer discretionary	Consumer Staples	Health care	Industrials	Energy	Materials	Utilities	Real estate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Blockchain	0.184*** (0.064)	0.972*** (0.218)	0.623*** (0.064)	0.428** (0.168)	0.076 (0.296)	0.593*** (0.127)	0.280*** (0.088)	0.632 (0.668)	0.148 (0.205)	− 0.381 (0.330)	0.176 (0.858)
Company size	0.133*** (0.011)	0.230*** (0.033)	0.135*** (0.008)	0.163*** (0.018)	0.275*** (0.033)	0.136*** (0.011)	0.216*** (0.011)	0.342*** (0.039)	0.059*** (0.021)	0.295*** (0.046)	− 0.108** (0.043)
Growth rate	− 0.432*** (0.096)	0.216 (0.323)	− 0.059 (0.041)	− 0.274 (0.179)	− 0.635* (0.361)	− 0.068 (0.052)	− 0.369*** (0.103)	− 0.455 (0.285)	− 0.119 (0.168)	− 2.027** (0.852)	0.293 (0.233)
Profitability	− 0.085 (0.085)	0.314 (0.355)	− 0.266*** (0.084)	− 0.182 (0.287)	− 0.442 (0.410)	0.077 (0.063)	− 0.334** (0.132)	− 0.330 (0.222)	− 0.319 (0.207)	1.614*** (0.543)	0.074 (0.219)
Market to book ratio	− 0.006** (0.002)	0.056*** (0.013)	− 0.005 (0.004)	− 0.001 (0.003)	− 0.008** (0.003)	− 0.0002 (0.001)	0.001 (0.001)	− 0.070* (0.041)	− 0.005 (0.008)	− 0.180** (0.070)	− 0.015 (0.025)
Leverage	0.008 (0.009)	− 0.086*** (0.021)	0.003* (0.002)	0.002 (0.003)	0.075** (0.030)	− 0.008 (0.005)	− 0.002 (0.003)	0.015 (0.045)	0.007 (0.011)	0.354*** (0.082)	0.087** (0.040)
Institutional ownership	− 0.514*** (0.075)	− 0.501** (0.239)	− 0.292*** (0.049)	− 0.199 (0.127)	− 0.948*** (0.251)	− 0.506*** (0.083)	− 0.832*** (0.077)	− 1.187*** (0.324)	0.047 (0.117)	− 0.703** (0.327)	− 0.113 (0.230)
Insider ownership	− 0.180 (0.133)	− 0.375 (0.344)	− 0.027 (0.094)	0.238 (0.232)	− 0.097 (0.323)	− 0.395** (0.174)	− 0.320** (0.141)	− 0.223 (0.572)	0.267 (0.298)	2.153** (1.072)	− 0.788* (0.443)
Constant	− 0.375*** (0.067)	− 1.109*** (0.234)	− 0.644*** (0.052)	− 0.752*** (0.139)	− 1.039*** (0.265)	− 0.406*** (0.084)	− 0.643*** (0.082)	− 0.973*** (0.301)	− 0.318** (0.149)	− 2.097*** (0.437)	1.023*** (0.286)
Observations	1497	380	2269	1354	460	1083	1745	462	533	285	375
R^2	0.129	0.296	0.187	0.087	0.175	0.204	0.214	0.170	0.023	0.293	0.075
Adjusted R^2	0.124	0.280	0.184	0.081	0.160	0.198	0.211	0.155	0.008	0.273	0.055

Table 6 (continued)

Results of linear regression by sector											
	Dependent variable										
	Number of shareholder proposals										
	IT	Communications	Finance	Consumer discretionary	Consumer Staples	Health care	Industrials	Energy	Materials	Utilities	Real estate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Residual Std. Error	0.649 (df = 1488)	1.130 (df = 371)	0.551 (df = 2260)	1.002 (df = 1345)	1.268 (df = 451)	0.608 (df = 1074)	0.679 (df = 1736)	1.586 (df = 453)	0.571 (df = 524)	0.899 (df = 276)	0.851 (df = 366)
F Statistic	27.454*** (df = 8; 1488)	19.463*** (df = 8; 371)	65.036*** (df = 8; 2260)	15.955*** (df = 8; 1345)	11.966*** (df = 8; 451)	34.365*** (df = 8; 1074)	59.181*** (df = 8; 1736)	11.558*** (df = 8; 453)	1.535 (df = 8; 524)	14.320*** (df = 8; 276)	3.697*** (df = 8; 366)

Results of the linear regression on the number of received shareholder-sponsored proposal. Value in parenthesis next to the coefficients is standard error. Dependent variable *Number of shareholder proposals* is the number of shareholder-sponsored proposals received by the firm in a given year. Blockchain is the variable reflecting whether the company is engaged in active digitalization in a form of blockchain implementation; *Company size, Growth rate, Profitability, Market to book ratio, Leverage, Institutional ownership, Insider ownership* are control variables reflecting the size, growth rate, profitability, market capitalization, size of the leverage as well as the institutional and insider ownership of the firm

*p < 0.1; **p < 0.05; ***p < 0.01

Table 7 Results on the share of management-sponsored proposals that pass the voting

Results of regression on share of management-sponsored proposals passed by sector											
	Dependent variable										
	Share of management proposals passed										
	IT	Communications	Finance	Consumer discretionary	Consumer Staples	Health care	Industrials	Energy	Materials	Utilities	Real estate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Blockchain	− 0.001 (0.009)	0.015 (0.016)	0.016 (0.018)	0.004 (0.015)	0.017 (0.017)	0.001 (0.016)	− 0.001 (0.011)	0.041 (0.039)	0.008 (0.024)	0.006 (0.019)	0.008 (0.074)
Company size	0.004*** (0.001)	0.002 (0.002)	0.005* (0.002)	0.006*** (0.002)	0.002 (0.002)	0.002 (0.001)	0.006*** (0.001)	0.003 (0.002)	0.002 (0.002)	0.002 (0.003)	0.008** (0.004)
Growth rate	− 0.003 (0.013)	− 0.007 (0.024)	0.017 (0.012)	− 0.027 (0.016)	− 0.008 (0.021)	0.006 (0.006)	0.028** (0.013)	− 0.032* (0.017)	0.016 (0.020)	0.098* (0.050)	− 0.012 (0.020)
Profitability	0.020* (0.011)	0.002 (0.026)	− 0.046* (0.024)	− 0.027 (0.026)	0.024 (0.024)	0.006 (0.008)	− 0.054*** (0.016)	0.073*** (0.013)	− 0.019 (0.024)	− 0.037 (0.032)	− 0.007 (0.019)
Market to book ratio	− 0.0003 (0.0003)	− 0.001 (0.001)	0.001 (0.001)	− 0.001* (0.0003)	− 0.0001 (0.0002)	− 0.0001 (0.0002)	0.00001 (0.0001)	− 0.002 (0.002)	− 0.0003 (0.001)	− 0.0004 (0.004)	0.001 (0.002)
Leverage	− 0.0003 (0.001)	0.002 (0.002)	0.001 (0.001)	0.0004 (0.0003)	0.001 (0.002)	0.0003 (0.001)	− 0.00003 (0.0003)	0.005* (0.003)	− 0.00003 (0.001)	− 0.003 (0.005)	− 0.004 (0.003)
Institutional ownership	− 0.011 (0.010)	0.016 (0.018)	0.078*** (0.014)	− 0.016 (0.011)	− 0.010 (0.014)	0.010 (0.010)	0.015 (0.009)	− 0.014 (0.019)	0.012 (0.014)	0.031 (0.019)	− 0.007 (0.020)
Insider ownership	0.020 (0.018)	− 0.024 (0.025)	0.159*** (0.027)	− 0.027 (0.021)	0.001 (0.019)	0.013 (0.022)	0.009 (0.017)	− 0.016 (0.034)	0.078** (0.035)	− 0.002 (0.063)	0.001 (0.038)
Constant	0.937*** (0.009)	0.946*** (0.017)	0.857*** (0.015)	0.940*** (0.013)	0.960*** (0.015)	0.942*** (0.010)	0.917*** (0.010)	0.935*** (0.018)	0.941*** (0.017)	0.952*** (0.026)	0.916*** (0.025)
Observations	1497	380	2269	1354	460	1083	1745	462	533	285	375

Table 7 (continued)

Results of regression on share of management-sponsored proposals passed by sector

	Dependent variable										
	Share of management proposals passed										
	IT	Communications	Finance	Consumer discretionary	Consumer Staples	Health care	Industrials	Energy	Materials	Utilities	Real estate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
R^2	0.016	0.023	0.036	0.016	0.010	0.010	0.023	0.090	0.012	0.045	0.032
Adjusted R^2	0.011	0.002	0.033	0.010	− 0.007	0.002	0.019	0.074	− 0.003	0.018	0.011
Residual std. error	0.086 (df = 1488)	0.084 (df = 371)	0.159 (df = 2260)	0.090 (df = 1345)	0.073 (df = 451)	0.075 (df = 1074)	0.083 (df = 1736)	0.093 (df = 453)	0.066 (df = 524)	0.053 (df = 276)	0.073 (df = 366)
F statistic	3.086*** (df = 8; 1488)	1.088 (df = 8; 371)	10.610*** (df = 8; 2260)	2.732*** (df = 8; 1345)	0.585 (df = 8; 451)	1.337 (df = 8; 1074)	5.125*** (df = 8; 1736)	5.611*** (df = 8; 453)	0.779 (df = 8; 524)	1.640 (df = 8; 276)	1.503 (df = 8; 366)

Results of the linear regression on the share management-sponsored proposals that pass the meeting. Value in parenthesis next to the coefficients is standard error. Dependent variable *Share of management proposals passed* is the share of passed management-sponsored proposals at the meeting; Blockchain is the variable reflecting whether the company is engaged in active digitalization in a form of blockchain implementation; *Company size, Growth rate, Profitability, Market to book ratio, Leverage, Institutional ownership, Insider ownership* are control variables reflecting the size, growth rate, profitability, market capitalization, size of the leverage as well as the institutional and insider ownership of the firm

*p < 0.1; **p < 0.05; ***p < 0.01

5.2 Regression by sector

As mentioned earlier, we do not yet possess data on business models at the firm level. Therefore, to test the hypothesis that digitalization has a stronger impact when coupled with business model innovation, we have conducted an analysis by sector. As we can see from Table 5, the results differ by sector. Only in three sectors does the blockchain variable have a significant impact on the likelihood of receiving a shareholder-sponsored proposal. In other sectors, this variable does not have a significant impact. The blockchain variable is significant mostly in sectors which are more significantly affected by the business model transformation trend, which is in line with our hypothesis. At the same time, we did not see a significant impact in several sectors where we had expected it (Finance, Consumer, Healthcare).

As in the previous subsection, we verified the robustness of the results by running a set of regressions on the number of shareholder-sponsored proposals received. The results (cf. Table 6) are generally in line with our hypothesis. We see that the blockchain variable is significant in most sectors affected by ecosystems. The only exceptions are in the consumer staples sector, where we do not see a significant impact, and industrials, where we do see a significant impact. Significance of the control variables differs by sector, indicating that analysis by sector requires dedicated specifications by sector.

Overall, we see that consistent with hypothesis, digital transformation has the strongest impact on the level of shareholder activity in the sectors affected by the ecosystems. To test whether the conclusion holds for the level of the conflict, we run the final set of regressions on the share of management-sponsored proposals that pass the voting. We provide the results in the Table 7. We see that the blockchain variable is significant in neither of the sectors analyzed. This leads to conclusion that the results that we received when analyzing the overall sample hold on the sector level as well—the level of shareholder hostility is not affected by digitalization. Since we did not detect endogeneity for regressions on the full sample, we do not provide dedicated tables for the sectoral analysis with lagged values of Blockchain variable, however, this data is available upon request.

Summing up, the results of the regression analysis generally confirm the hypothesis explored in the paper. We see that firms active in digital transformation indeed have a lower level of the principal-agent conflict. The results indicate that the impact on the information asymmetry reduction and the agency conflict mitigation is the strongest when the two trends are leveraged in parallel, which leads to conclusion that the two trends explored in the paper are indeed mutually-reinforcing. The results also indicate that the potential performance improvements driven by digitalization and hence the mitigating impact on the conflict are the strongest in the sectors stronger affected by ecosystems. Our conclusion is consistent with propositions by Yrjölä (2020), Schweiger et al. (2016) and Fenwick et al. (2019).

6 Conclusions

In this paper we explored two ways in which digital technologies are changing the business environment: digital transformation driven by technologies as blockchain, AI, etc. and transformation of business model through adoption of ecosystem-based models. Previous empirical research and conceptual papers suggested that digitalization has a mitigating impact on the principal-agent conflict and this impact is the strongest when digitalization and business model transformation occur together. In order to test this hypotheses, we analyzed the dynamics of annual shareholder meetings. We looked at the number of shareholder-sponsored proposals received for voting as a proxy for shareholder activity and the percentage of management-sponsored proposals that pass voting as a measure of shareholder hostility towards the management.

Consistent with our hypotheses, we found that digital transformation has a mitigating impact on the principal-agent conflict in the organization. Shareholders are more active yet not more hostile towards the management. The results are most significant in sectors where ecosystem-based business models are widespread, indicating that the two trends reinforce each other. To the best of our knowledge, our paper is among the first providing the direct empirical evidence on the two trends explored with regards to corporate governance and the agency conflict mitigation.

We believe that the results have important practical implications. Overall, they indicate that leveraging the emerging transformative digital technologies and ecosystem-based business models is an opportunity for shareholder value creation and should not be missed out. First, we see that active digitalization creates corporate environment less prone for information asymmetry abuse which results in a weaker agency conflict. Second, the results indicate that shareholders appreciate the performance improvement potential from applying ecosystem-based business models in parallel with digitalization which also results in agency conflict mitigation.

We acknowledge a number of important limitations of our study. First of all, we use a very general proxy for digital transformation, i.e. any application of blockchain technology. Our analysis would have been more accurate if we had considered only applications specific to corporate governance. Secondly, we understand that blockchain is just one example of a digital technology and that the analysis would benefit from a robustness check with other digital technologies. Thirdly, since we do not have an explicit proxy at corporate level for the adoption of an ecosystem-based business model, we remained at the sector level in our analysis. We understand that even in sectors unaffected on the whole by business model innovation, certain individual companies are adopting the platform business model. At the same time, it is possible that certain sector characteristics make the impact of the digital transformation stronger. Fourthly, we acknowledge that there may be other unobserved corporate characteristics that result in higher numbers of shareholder-sponsored proposals, not currently captured by our analysis. Fifthly, we understand that the cause-effect relationship needs further exploration. Investments in digital technologies are typically long-term and our analysis is currently limited to the short-term. Sixthly, due to data availability our analysis is based on a sample of US-traded firms. We understand that expanding the analysis to other

geographies and other research methods (e.g., case studies) may provide additional important insights.

Nevertheless, we believe that our study is a valuable contribution to the literature on both corporate governance and digitalization. We intend to overcome the identified limitations in subsequent research.

Appendix: Variables used in the research

Variable	Description
Blockchain	Dummy variable equal to 1 if a company has a confirmed blockchain initiative, such as participation in a consortium or development of a in-house blockchain solution (Source: open sources, internet search)
At least 1 shareholder proposal	Dummy variable equal to 1 if a company received at least one shareholder-sponsored proposal for the annual meeting (source: ISS voting database)
Number of shareholder proposals	Number of shareholder-sponsored proposals received by a firm for the annual meeting (source: ISS voting database)
Share of management proposals passed	% of passed management-sponsored proposals at the meeting (source: ISS voting database)
Company size	Natural logarithm of the company's market capitalization (Source: CapitalIQ)
Growth rate	Compound annual growth rate of revenues for 3 years prior to the meeting (Source: CapitalIQ)
Profitability	Company's EBITDA divided by the company's revenues (Source: CapitalIQ)
Market to book ratio	Ratio of company's market capitalization to the company's book value of equity (Source: CapitalIQ)
Leverage	Ratio of company's total debt to the total book value of equity (Source: CapitalIQ)
Institutional ownership	Fraction of company's shares owned by institutions (Source: CapitalIQ)
Insider ownership	Fraction of company's shares owned by company's insiders (Source: CapitalIQ)
Sector dummies	Set of variables identifying the main sector of operations for a firm (Energy, Materials, Industrials, Consumer discretionary, Consumer staples, Healthcare, Financials, IT, Communication services, Utilities, Real Estate) as reported in CapitalIQ database (Source: CapitalIQ)

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