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Original Research

Voluntary Disclosure Dynamics under Risk and Ambiguity for Digital Corporates in Tehran Stock Exchange

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ABSTRACT

This study aims at investigating the effects of the change in the information environment from risk to ambiguity, disclosure dynamics, and the ambiguity aversion behaviour of investors on the disclosure of integrated information for selected corporates operating in digital industry listed on the Tehran Stock Exchange during 2012-2022. The corporate voluntary disclosure lag, stock return volatility, and the probability of favourable returns incidence represent respectively the disclosure dynamics, firm risk, and investors' ambiguity aversion, within dynamic panel models. To investigate robustness of the estimates we have also included capital market ambiguity, firm size and stock liquidity indices in the model. The findings are consistent with existing theories. Firm risk and the capital market ambiguity have an increasing impact on the integrated information voluntary disclosure. However, the ambiguity at firm's level has decreased its voluntary disclosure. Likewise, a rise in ambiguity aversion (independent of the ambiguity level), which makes investors more pessimistic about the firm's cash flows, makes the manager to increase the level of voluntary disclosure. Further, inertia in voluntary disclosure has been detected among the studied digital corporates. Depending on the magnitudes of the risk, ambiguity, ambiguity aversion, and the source of investors' ambiguity, the corporate managers decide on their voluntary disclosure policy appropriately.

1 Introduction

Information disclosure by companies acts as a significant tool for managers to use in developing a relationship between a corporate governance and its performance with the outsider investors [1]. The information presented in the firm's reports can be divided mainly into two categories: "Forward-Looking Information" and "Backward-Looking Information"[2]. However, there are several reasons to disclose information in an integrated manner. First, companies tend to voluntarily increase transparency in order to meet stakeholders' expectations [3]. The presentation of integrated reports, along with the information required by stakeholders to evaluate long-term prospects clearly and concisely, increases

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the company's transparency [4]. Furthermore, the development of integrated reporting through optimizing the use of corporate resources and reducing costs of capital develops strategic tools for relating financial and non-financial performance [5]. Despite the significance of voluntary disclosure for stakeholders both inside and outside the firm, some theoretical and empirical evidence indicates that firms vary in their level of voluntary disclosure of information [6, 7]. As a result, the focus of this study is on the determinants of voluntary disclosure of integrated information for selected digital firms listed on the Tehran Stock Exchange from March 2012 to March 2022. The theoretical literature in the area of voluntary disclosure focuses on either static model in which the stakeholder (company's manager) has access to private information [8, 9] or dynamic models in which disclosure timing does not play a role [10] since the manager decides what to disclose rather than when to disclose. Nevertheless, the firm's information environments are composed of multidimensional and multi-period information flows from firm to market, where information asymmetry between the firm and the capital market is caused by when and what informative information the firm is likely to have obtained [11]. The multidimensional nature of the disclosure game (multi-periodic and multi-signal) plays an important role in shaping equilibrium; For instance, the firm's manager should consider the possibility of learning and potentially disclosing another piece of new information in the future when deciding to disclose a piece of information [11]. Therefore, one of the most important hypotheses of this research will be the concurrent investigation of the effects of lag in the disclosure of information in risk and ambiguity environments.

Knight [12] distinguished between risk (certain probability distribution) and uncertainty (uncertain probability distribution) and proposed that economic returns could be achieved to hedge uncertainty rather than only risk. Generally, uncertainty is divided into two distinct components. The first is fundamental uncertainty created by underlying factors of the economy that cannot be resolved through obtaining information; the second is information uncertainty that can be resolved through collecting information [13]. The present study concentrates on fundamental uncertainty and its effects on voluntary disclosure.

The effect of voluntary disclosure on stock return volatility has been investigated in at least four aspects in the existing literature: The first hypothesis concerned the effect of disclosure on investors' learning rates, reducing the degree of information asymmetry among firm stakeholders, and improving stock liquidity, all of which would eventually lead to risk reduction [14]. The second hypothesis points to the role of information disclosure in improving accuracy in estimating parameters related to the probability distribution of stock returns by investors [15]. The third hypothesis is based on the research conducted by Lambert, Leuz and Verrecchia [16], which points to the role of information disclosure in reducing the covariance of the firm's cash flows with the cash flows of other firms and ultimately reducing the company's risk. The fourth hypothesis is about how information disclosure improves investors' decisions, which results in an increase in the quality of information available to managers. [17]. Consequently, using similar argument, we expect that raising the firm's risk will cause it to expand the voluntary disclosure of information.

Previous research on voluntary information disclosure focused solely on the role of risk, assuming that individuals are ambiguity-neutral, and ignoring ambiguity resulted in an incomplete understanding of firm's disclosure decisions under uncertainty conditions [18]. Stock price volatility rises as the level of ambiguity increases, assuming the existence of ambiguity-averse and risk-averse investors, since ambiguity causes ambiguity-averse investors to give more weight to the perceived probabilities of a bad future circumstance (the worst possibilities in the investors' set of possible beliefs), and price volatility is exacerbated when firms provide news [19], [20]. According to the theoretical literature, while the

attitude toward risk is constant in different returns, the attitude toward ambiguity varies in different amounts of probabilities of expected returns, and the probability of occurrence of a favorable condition plays a crucial role in investors' ambiguity aversion [21]. Based on this analytical framework and assuming ambiguity-averse investors, increasing the probability of the occurrence of higher returns (for example, a positive deviation in the probability of stock returns from the risk-free rate) of a firm's stocks increases investors' ambiguity-aversion and makes them more pessimistic. In such circumstances, the company manager should control ambiguity aversion by modifying the investors' level of ambiguity to create new equilibrium conditions. Based on this rationale, we expect that ambiguity aversion will have direct effects on the firm's voluntary information disclosure in the current study. In order to investigate the effects of the level of ambiguity and ambiguity aversion separately and independently from each other on the level of voluntary disclosure, we employ the approach introduced by Izhakian [22]. One of the most significant advantages of utilizing this approach over other approaches is the ability to distinguish between beliefs and the decision-makers tastes, as well as the ability to distinguish the degree of ambiguity from tastes(attitude) for ambiguity. [22]

In addition, to strengthen the research findings, we will consider several control variables in regression models. We expect that various aspects of ambiguity will affect the decisions made by investors and firm managers, which may affect the level of voluntary disclosure. For this purpose, with all the prerequisites set forth by Izhakian [22], we will utilize the Tehran Exchange Dividend and Price Index (TEDPIX) to calculate the ambiguity of the whole market and investigate the effects of systematic information asymmetry governing the whole market on the level of voluntary disclosure. On the other hand, we will take into consideration controls for firm size and information asymmetry related to the firm, which will improve the comprehensiveness of the examined models.

The different parts of the article are as follows: First, we shall have a review based on empirical foundations and previous investigations, followed by a review of the theoretical foundations and the estimated model of the research. The results of the estimation will be analyzed in the next section, and the research's findings will be presented in the concluding section.

2 Literature Review

Didar, Mansourfar and Khojaste, looked for an answer to the question of why some Iranian companies disclose less information than others, despite the importance of disclosure for consumers. Based on the findings of this study, corporate characteristics are more effective in voluntary disclosure (including the inverse relationship between financial leverage and the lack of a significant relationship between liquidity and company size with voluntary disclosure), but no such finding was achieved with obligatory disclosure. [23]

Hajian, Anvary Rostamy, Rahmani and Azar, using 510 company-year data for the years 2008-2012, investigated the influencing factors on the level of voluntary information disclosure of companies in the Tehran stock market. Contrary to previous research, the findings of this study reveal that there is no significant relationship between firm size, financial leverage, and company age with the level of information disclosure among listed companies in the Tehran Stock Exchange [24].

In their research, Billings, Jennings and Lev, [25] investigate whether stock return volatility influences the spread of earnings announcement disclosure. All companies in the Compustat and Thomson Reuters databases between 2001 and 2010 comprise the geography of this study. By dividing the change in stock return volatility before and after the firm's announcements, they concluded that the disclosed earnings and accompanying announcements play an effective role in reducing the abnormally large

volatility after the disclosed announcements, and the managers of these firms react to the increase in volatility with the announcements they provide.

Agbetonyo, Fromont and Viviani,[26] examined how uncertainty at the macro level leads to an impact on how capital market prices in France react to corporate dividend announcements. They used dividend policy as a variable to measure investors' reactions to ambiguity and the weighted average implied volatility for the French market (VCAC) as an alternative to the uncertainty variable. The findings revealed that investors show an asymmetric response to the firm's dividend policy depending on the overall state of the economy.

In a study conducted by Asthana and Kalelkar [27], two significant questions were raised by separating the uncertainty related to the firm from the market: First, does the uncertainty in economic policies have short-term and long-term effects on the interpretation of earnings news or not? And, depending on the level of uncertainty, do firm managers have a specific strategy for disclosing good or bad news? The scope of this study included all of the firms in the Compustat and CRSP databases between 1990 and 2016. According to the findings, uncertainty reduces investors' confidence in earnings-related information, which leads to a decrease in the intensity of investors' response to this information during periods of high uncertainty. Furthermore, uncertainty has long-term adverse effects on earnings-related news and cannot be addressed by disclosing public information. In his empirical research, Rava [18] investigates the effect of ambiguity (along with the impact of risk) on corporate disclosure policies in the U.S. stock exchange. Data from Brenner and Izhakian [21] are used to measure the degree of ambiguity in this study. This study's results demonstrate that by providing more information to risk-averse investors, managers increase the rate of investors' learning about the firm's economic foundations and reduce risk. However, as the ambiguity of risk-averse and ambiguity-averse investors increases, providing more information increases stock price volatility. This occurs since more ambiguity causes ambiguity-averse investors to give more weight to the worst possible scenario, which ultimately exacerbates price volatility. In general, according to empirical studies conducted on the Tehran stock exchange and abroad, researchers have primarily focused on certain dimensions of the firm's information environment in determining the voluntary disclosure of firms. However, in this study, in addition to examining the stickiness effects of voluntary disclosure of information, the effects of investors' ambiguity aversion on voluntary disclosure will also be investigated, along with other variables used in the empirical literature (risk and ambiguity). As a result, in this study, to develop the existing literature, we will attempt to demonstrate new dimensions influencing the voluntary disclosure of firms.

3 Methodology

In this section, we describe two models that were used to test the factors influencing a firm's level of voluntary information disclosure. The majority of previous studies on the Tehran stock exchange have focused on the conventional determinants of voluntary disclosure level, such as company size, profitability, leverage, and industry [23, 24, 28]. However, several foreign studies attempted to more thoroughly examine the factors that influence the firm's level of voluntary disclosure in addition to other explanatory variables by including environmental factors like risk and ambiguity [18, 25]. However, none of the studies simultaneously examined the effects of risk, ambiguity, ambiguity aversion, and voluntary disclosure dynamics variables as explanatory variables of the firm’s voluntary information disclosure. These factors are modeled in two distinct models at the same time. Both models differ in the employed ambiguity indices. In the specification of model (1), the firm's ambiguity index from the

viewpoint of investors is used, whereas in the specification of model (2), the investor's ambiguity aversion index, which is calculated under ambiguity conditions, is used. The specification of model (1) is as follows:

$$\text{disclosure}_{i,t} \cong \delta \cdot \varepsilon_1 \text{disclosure}_{i,t01} \cdot \varepsilon_2 \text{Dafirm}_{i,t} \cdot \varepsilon_3 \text{DaMarket}_{i,t} \cdot \varepsilon_4 \text{Risk}_{i,t} \cdot \varepsilon_5 \text{Turnover}_{i,t} \cdot \varepsilon_6 \text{Size}_{i,t} \cdot \pi_i \cdot o_t \cdot \eta_{i,t} \quad (1)$$

In model (1), ($\text{disclosure}_{i,t-1}$) is the status of voluntary disclosure by the firm with a time interval, ($\text{DaFirm}_{i,t}$) is investors' ambiguity related to the firm i at time t, ($\text{DaMarket}_{i,t}$) is market-wide ambiguity, ($\text{Risk}_{i,t}$) is the risk of investors related to the firm i at time t, ($\text{Turnover}_{i,t}$) is the stock liquidity of the firm at time t, ($\text{Size}_{i,t}$) is the size of the firm i at time t, (μ_i) is cross-sectional effects, (λ_t) is time effects, and ($\varepsilon_{i,t}$) is the error term model. Model (2) is described as follows to investigate how investors' ambiguity aversion influences the level of voluntary disclosure:

$$\text{disclosure}_{i,t} \cong \delta \cdot \varepsilon_1 \text{disclosure}_{i,t01} \cdot \varepsilon_2 \text{AA}_{i,t} \cdot \varepsilon_3 \text{DaMarket}_{i,t} \cdot \varepsilon_4 \text{Risk}_{i,t} \cdot \varepsilon_5 \text{Turnover}_{i,t} \cdot \varepsilon_6 \text{Size}_{i,t} \cdot \pi_i \cdot o_t \cdot \eta_{i,t} \quad (2)$$

In model (2), except for the common variables with model (1), ($\text{AA}_{i,t}$) shows the ambiguity aversion of investors.

In this study, to estimate the dynamic panel model, the bias-corrected estimator provided by [29] was used. This estimator, which is based on least squares dummy variables estimator (LSDV), acceptably maintains the estimated variance at a low level while directly correcting the dynamic panel data bias of conventional fixed-effects estimator. This estimator has a significant advantage over the (GMM) estimator in that its performance is not dependent on the ratio of the variance of individual-specific effects to the error term variance. Furthermore, this estimator has a relatively simple calculation compared to the estimators of instrumental variables and the generalized method of moments. This estimator performs best by default under a variety of circumstances, including 1) limited T (limited time period) and large N (number of sections), 2) strictly exogenous explanatory variables, and 3) small samples with a balanced panel. However, in conditions other than the default conditions, where the type of explanatory variables is predetermined, this estimator retains its efficiency compared to the past. However, the first-order (AR1) and second-order (AR2) autocorrelation tests have been used to determine the validity of the estimated model in light of the existing theoretical literature. Therefore, according to [30], when estimating the bias-corrected and generalized method of moments, the error terms should have first-order serial correlation AR (1) but not second-order serial correlation AR (2). In the following subsection, the theoretical literature for each explanatory variable, as well as how to calculate them, will be explained in detail.

3.1. Dependent Variable

A checklist of voluntary disclosure cases was prepared based on previous research to calculate the level of voluntary disclosure in each company. Table 1 presents the general titles and elements of the voluntary disclosure checklist used in the study, as well as the sources from which they were collected. When

selecting the disclosed sectors and sub-sectors, the fundamental parameters that affect the value of the companies were attempted to be taken into account, since securities with a lack of such information are considered riskier and more ambiguous due to valuation uncertainties [31]. This checklist includes the firm's 20 voluntary disclosures. If the relevant firm discloses each item on the checklist, the number one will be assigned to that item; if not, the number zero will be assigned. Finally, the optional disclosure index is calculated by dividing the sum of the disclosed items by the total number of items that should be disclosed:

$$\text{disclosure}_i \cong \frac{\sum_{i=1} d_i}{n} \tag{3}$$

If the elements are disclosed in this equation, d_i is equal to one; otherwise, it is equal to zero.

Table 1: Voluntary Disclosure Checklist Elements

Row	Title	Voluntary disclosures
1	Company forecasts	➢ Prediction of future sales ➢ Comparison of previous sales forecast with actual sales ➢ Prediction of future earnings ➢ Comparison of previous earnings forecasts with actual earnings ➢ Forecasting cash receipts and payments for future periods ➢ Capital expenditure forecast ➢ Market share forecast
2	Information related to the analysis of the financial and operational status of the company	➢ Profitability ratios ➢ Liquidity ratios ➢ Activity ratios ➢ Market evaluation ratios ➢ Leverage ratios ➢ break even sales of products or services
3	General risk management	➢ Description of the Company's Business risk ➢ Information and details regarding other risks (liquidity risk, inflation, interest rate, etc.)
4	Information about market parameters	➢ Stock price and its trend ➢ Trading Volume and its trend ➢ Equity market value and its trend ➢ Percentage ownership of major shareholders ➢ The type of ownership of the company's shareholders (whether the owners are actual or legal)

Source: Taken from previous studies

3.2. Dynamics of Dependent Variable

The multi-dimensional nature of the disclosure game (multi-period and multi-signal) plays a significant role in shaping the equilibrium, and when deciding to disclose a piece of information, the firm manager should take into account the possibility of learning and potentially disclosing a new piece of information in the future [11]. Moreover, empirical studies indicate that a fixed procedure is usually used in companies' voluntary information disclosure policies over time [32]. According to [17], unfavorable information (bad news) is more credible than favorable information (good news), but it is disclosed with a longer delay. This finding highlights the impact of information content on stakeholders' beliefs. The managers' career concerns in the event of disclosing this information are the most important reasons for

the delay in information disclosure. The findings of these studies on the structure of the firm's voluntary disclosure policies reveal some kind of stickiness in the content of the information disclosed by the firm over time. We use the lagged dependent variable in our model to investigate the dynamic effects of voluntary disclosure, and based on the information provided above, we expect this variable to positively affect the level of voluntary disclosure of the firm.

3.3. Ambiguity Aversion

Brenner and Izhakian [21] discovered that ambiguity aversion increases as the expected probability of favorable returns increases (gains), while love for ambiguity grows as the expected probability of unfavorable returns increases (losses). Therefore, to calculate the ambiguity aversion variable, the cumulative probability of favorable returns was calculated as follows:

$$E\left[P(r>r_f)\right] \cong E\left[1-\Phi(r_f;\kappa,\varpi)\right] \quad (4)$$

In the above relationship, r is the stock return rate, r_f is the risk-free rate, η is the cumulative distribution average of Φ, σ is the standard deviation of the cumulative distribution, and E is mathematical expectation. In the above relationship, a positive deviation from the risk-free return rate is regarded as favorable returns. To calculate the above relationship using daily return and risk-free return rates, there is a possibility of 20 to 22 positive deviations in return per month. The ambiguity aversion is calculated monthly by dividing the number of days that satisfy such a condition by the total trading days, and its average over the 12 trading months of each year then indicates the ambiguity aversion of that year. Additionally, the interest rate of term investment deposits, which is equal to 18%, was used in the above calculations. Concerning the variable sign of investors' ambiguity aversion on voluntary disclosure, it should be noted that the effects of ambiguity aversion have not been directly examined in the existing empirical literature. In other words, as ambiguity rises, investors become more ambiguity-averse because they become more pessimistic (that is, the probabilities shift from a high-cash-flow state to a low-cash-flow state). In such circumstances, the expansion of voluntary information disclosure increases stock price volatility since investors give more weight to the worst possible scenarios in their set of beliefs [18], [20], [21]. However, considering that the current study is looking for an analysis of the independent effects of ambiguity aversion on the firm's voluntary disclosure, it seems that the above argument will change its direction. It is argued that with the rise in investors' ambiguity aversion, the firm manager should constantly reduce investors' ambiguity level to prevent this incident. This will be achieved by increasing investors' voluntary disclosure of information. As a result, we expect that ambiguity aversion has a direct effect on the level of voluntary disclosure.

3.4. Investors Ambiguity

In theoretical and empirical studies, the degree of risk is described as the volatility in outcomes, while the degree of ambiguity is defined as the volatility in the probability of outcomes [20], [21]. [22] uses the following relationship to calculate the degree of ambiguity $U^2(\bar{r})$:

$$U^2(\bar{r}) \cong \int E(\mu(r))\, \mathrm{Var}(\mu(r))\, d\bar{r} \quad (5)$$

In this relationship $\mu(.)$ is the probability density function, $E(\mu(r))$ is the expected probability of return rate of r, and $\mathrm{Var}(\mu(r))$ demonstrates the variance of return probabilities. According to the above relationship, the degree of ambiguity depends on the probability of returns. To calculate the degree of

annual ambiguity (firm and market), however, relationship (5) is used. To do this, first, we adjust the range of possible changes of daily returns from -3% to -3% and then divide this allowed range into 30 equal parts so that the distance between each range is 0.2%. For values greater than 3% and less than -3%, we also add two new ranges, resulting in a total of 32 separate ranges per trading month. In the following, the average and variance of probabilities for each defined range are calculated for one trading year, and the degree of annual ambiguity is then determined using the following relationship:

$$U^{2} \perp r \cong \frac{1}{\zeta(10\zeta)} \partial \begin{bmatrix} E\perp\!\!\!\perp(r_0;\kappa,\varpi)\ \overline{Var}\perp\!\!\!\perp(r_0;\kappa,\varpi) \\ \left| \sum_{i\cong 1}^{30} E\perp\!\!\!\perp(r_i;\kappa,\varpi)0I(r_{i01};\kappa,\varpi)\ \overline{Var}\perp\!\!\!\perp(r_i;\kappa,\varpi)0I(r_{i01};\kappa,\varpi) \right. \\ E\perp\!\!\!\perp 0I(r_{30};\kappa,\varpi)\ \overline{Var}\perp\!\!\!\perp 0I(r_{30};\kappa,\varpi) \end{bmatrix} \quad (6)$$

In this relationship $r_0 \cong 00.03$, $\zeta \cong r_i 0 r_{i01} \cong 0.002$ and $\frac{1}{\zeta(10\zeta)}$ is the coefficient that makes the weighted-average volatility of probabilities proportional to the size of the ranges. According to the theoretical and empirical literature that is currently available and under the assumption that investors are ambiguity-averse, we expect that as firm ambiguity increases, investors will give more weight to the worst scenarios in their belief set [21]. In these situations, the expansion of information disclosure by firm managers causes more price volatility as a result of the news released during the period of ambiguity [19]. As a result, according to the relevant literature, we expect that an increase in firm ambiguity will be accompanied by a decrease in information disclosure.

3.5. Market Ambiguity

Following the procedure described in the previous section, we use data related to the daily return of the Tehran Exchange Dividend and the Price Index (TEDPIX) to measure market-wide ambiguity. The studies conducted by Asthana and Kalelkar [27], [33] and [34] on the impact of variable $(DaMarket_{i,t})$ on disclosure level are available in the literature. According to Asthana and Kalelkar [27], economic policies uncertainty with a distinctive effect from firm uncertainty has an increasing impact on the earnings response coefficient. Furthermore, according to [33], firm managers increase their voluntary disclosure policies in response to the rise in economic policies uncertainty. More specifically, from their viewpoint, an increase in market-wide uncertainty results in a rise in systematic information asymmetry, which they respond to by increasing voluntary disclosure. However, variables that are dependent on the risk variable have been used in both of these studies to demonstrate the effects of market-wide uncertainty. Rava [18] conducted a study in which he used the Vix index in accordance with the Brenner and Izhakian [21] approach, and this variable was considered to be market-wide ambiguity that is independent of risk. According to the existing literature, we expect that increasing market-wide ambiguity will increase systematic asymmetry in the market, and then firm managers will increase their voluntary disclosure in order to adjust investors' information asymmetry.

3.6. Firm Risk

Following the approach presented by [35], stock return volatility is calculated as a measure of firm risk in this section by making the adjustments for nonsynchronous trading as follows:

$$\varpi_t^2 \cong \left| \sum_{i\cong 1}^{N_t} (r_{t,i} 0 E\lfloor r_{t,i} \rfloor)^2 . 2 \left| \sum_{i\cong 2}^{N_t} (r_{t,i} 0 E\lfloor r_{t,i} \rfloor)(r_{t,i01} 0 E\lfloor r_{t,i01} \rfloor) \right. \right. \quad (7)$$

In the above relationship, r stands for the return rate, index t is the year, and i shows each month. Therefore, $r_{t,i}$ represents the return rate in month i (i =1...12) for the year t and ϖ_t^2 demonstrates stock return variance. The existing literature on the effect of risk on a firm's voluntary disclosure shows that managers tend to disclose more when earnings volatility is lower and easier to predict [36]–[38]. In other words, managers will be less committed to voluntary disclosure in circumstances where stock return volatility is high [25]. Additionally, [17], highlighting the significance of the information content disclosed by the firm's managers, demonstrate that the disclosure of unfavorable information as compared to favorable news (good news) makes investors more motivated to demand higher returns in response to the increase in the risk of the firm, which ultimately increases the firm's stock return volatility. However, additional empirical research demonstrates that when stock return volatility is high, firm managers provide risk-averse investors with more information, which causes an increase in their learning rate and, as a result, leads to a reduction in risk and stock price volatility [18], [25], [39]. Given that the dependent variable in this study is the firm's level of voluntary disclosure and the effects of information content in the examined sample are not accurately identified, we expect a positive risk effect on voluntary disclosure.

3.7. Stock Turnover

According to empirical research, voluntary disclosure increases stock liquidity by reducing information asymmetry among investors and transaction costs caused by adverse selection[14], [40]. These studies demonstrate that voluntary disclosure has an endogenous impact on stock liquidity, but few empirical studies have examined the exogenous effect of stock liquidity on the level of voluntary disclosure. The stock turnover ratio is used to measure stock liquidity and investigate its effects on the level of voluntary information disclosure:

$$\text{Turnover}_{i,t} \cong \frac{\text{Number of Shares Traded}_{i,t}}{\text{Number of Shares Outstanding}_{i,t}} \tag{8}$$

Where i is the firm and t are the intended year. However, in regards to the sign of the stock liquidity variable on a firm's voluntary disclosure, [41] demonstrated in their research that a decrease in stock liquidity may have a reducing effect on the market's reaction to voluntary disclosure and may also decrease managers' incentives to disclose and investors' demand for voluntary disclosure. Consequently, managers' ability to influence stock prices using disclosure is diminished, and the expected benefits of voluntary disclosure for them are also reduced. Since low liquidity imposes additional transaction costs, investors may trade less and thus have less demand for disclosure in such circumstances. Therefore, fewer transactions reduce investors' willingness to request information from managers and prevent managers from disclosing more information. Based on this, we expect that stock liquidity will have a positive impact on the level of voluntary disclosure.

3.8. Firm Size

Firm size is one of the most frequently used and significant variables affecting the level of voluntary disclosure of firm information in the empirical literature, and it can be argued that this variable has a positive impact on the voluntary disclosure level of firms for a variety of reasons. First, larger firms face a higher level of agency costs than small firms due to high information asymmetry [42]. Second, larger firms, in comparison to smaller firms, have more resources to pay for information production [43]. Additionally, larger firms utilize capital markets more widely than smaller firms, and this fact

increases the significance of integrating disclosed information for interacting with various stakeholders [4]. Furthermore, [44] demonstrated that the size of the firm is a function of its growth and that for further firm growth, there is a greater need for external funds. As a result, in order to obtain more external funds, the firm should meet claim holders' information demands more than ever before. In this study, the firm sales amount logarithm is used as a measure of firm size.

4 Variables and Descriptive Statistics

In this study, data from 8 firms active in the digital industry of the Iranian capital market from March 2012 to March 2022 were used to estimate the types of dynamic panel models (Table 2).

Table 2: Information related to the time period and the studied companies

Name	Activity	Period
Telecommunication Company of Iran	Communication Services	2012-2022
Mobile Communications of Iran	Communication Services	
Informatics Services Corporation	Communication software and services	
System Group	Communication software and services	
Parsian E-Commerce Company	Communication software and services	
Irankish	Communication software and services	
DP Iran CO	Hardware and electronic equipment	
Afranet	Communication Services	

Source: research findings

Table 3: Description of research variables

variable	Source	Describe
Disclosure	Information contained in annual reports and interpretative reports of the board of directors	Voluntary disclosure of Integrated reports, which is calculated based on the scoring approach to various indicators used by previous empirical studies.
Disclosure(t-1)	-	Lagged variable of dependent variable to represent temporal dynamics
AA	Research calculations	Investors' aversion to ambiguity, is extracted based on the approach of Brenner and Izhakian (2018).
DaFirm	Research calculations	Investors' degree of ambiguity about the Firm, is extracted based on the approach of Brenner and Izhakian (2018).
DaMarket	Research calculations	Investors'edegree of ambiguity about the Market, is extracted based on the approach of Brenner and Izhakian (2018).
Risk	Research calculations	Volatility in stock returns, is extracted based on the approach of Scholes and Williams (1977).
Stock Turnover	Research calculations	The ratio Number of shares traded to Number of Shares Outstanding by the Firm in a certain period of time
Ln Size	Research calculations	The natural logarithm of the Firm's sales amount

Source: research findings

These eight companies account for more than 63% of the digital industry's total market value. In addition, a summary of the research variables, as well as the sources of their collection, is provided in Table 3 variety of descriptive statistics for research variables are presented in Table 4.

According to the results of Table 4, the average information disclosure level of firms is 0.61, which is in the third quartile and shows that corporates maintain their information disclosure levels on average in high ranges. As to the AA variable, the descriptive statistics indicate an average investors ambiguity aversion towards the corporates studied in industry equal to 0.47. In addition, the mean and dispersion

of market ambiguity (DAmarket) is much higher than firm ambiguity (DAfirm). Therefore, it seems that the corporate's voluntary disclosure level is more affected by market ambiguity. The firm risk variable has the least dispersion compared to other variables, while the maximum volatility in the firm's stock returns was about 0.23. But the maximum stock turnover of the firm's is 2.4, which shows that more than twice the firm's issued shares have been bought and sold during the corporate's annual trading.However, in Table 5, the correlation between the research variables and the probability level of this correlation are reported, and it is necessary to investigate and verify the accuracy of this information in the form of a regression relationship to ensure its accuracy.

Table 4: Descriptive statistics of variables

Variable	Obs	Mean	Min	Max	Std. Dev.
Disclosure	80	0.6140	0.189	0.99	0.1845
AA	80	0.4706	0.2489	0.6007	0.0769
DaFirm	80	1.4930	0.7179	4.1704	0.7124
DaMarket	80	3.0049	0.8051	7.0346	1.7611
Risk	80	0.0268	0.00007	0.2315	0.0411
Turnover	80	0.2198	0.0029	2.4753	0.3619
Ln Size	80	15.418	10.842	19.513	1.9758

Source: research findings

Table 5: Correlation matrix between variables

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Disclosure	1						
(2)	AA	0.15	1					
(3)	DaFirm	-0.38***	-0.51***	1				
(4)	DaMarket	-0.04	-0.09	0.08	1			
(5)	Risk	0.23**	0.23**	-0.13	-0.45***	1		
(6)	Turnover	0.26**	0.03	-0.05	-0.34***	0.48***	1	
(7)	Ln Size	0.24**	-0.14	0.04	-0.14	0.003	-0.16	1

Source: research findings

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

The appendix of the results related to the stationarity of variables has been reported in Table 6 since it is necessary to examine the stationarity of variables prior to regression estimates. Since 8 different sections (firms) were used in this study during the period of 2012–2022, unit root tests should be used in panel data. In both tests, the null hypothesis is the presence of a unit root (common or individual), and based on the probability level reported in Table 5, it can be inferred that all variables used in the research are stationary at the 95% confidence level.

Table 6: Stationarity of variables

Variable	LLC t- Statistic	ADF-Fisher Inverse chi-squared Statistic
Disclosure	-1.83**	32.7***
AA	-5.33***	77.03***
DaFirm	-1.75**	43.3***
DaMarket	-1.65**	47.7***
Risk	-7.26***	29.65**
Turnover	-5.66***	45.21***
Ln Size	-1.89**	28.27**

Source: research findings

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

5 Research Findings

In this section, the two dynamic panel models specified in the previous section are estimated. The output of model (1) is shown in Table 7. The pooled and fixed effects methods have been estimated in the first two columns of Table 7. The reason for examining these two methods is to see if the intended model can be estimated using a pooled method or if it is possible to make our estimates using panel data, which can be deduced using the F-Limer test. Considering the probability level of this test, it can be inferred that the panel data method is a more suitable model for estimating coefficients. Furthermore, the Hausman test indicates that the fixed effects model is a more appropriate method than the random effects model at the 99% confidence interval, so the final results based on the fixed effects model are reported in Table 7. Additionally, the dynamic panel data model was estimated using a bias-corrected fixed effects estimator in order to significantly improve the fixed effects model's coefficients and increase its explanatory power. The results of this estimation are shown in column 3 of Table 7. The Arellano-Bond test is based on the assumption that there is no first-order autocorrelation among the error terms model, and the null hypothesis is rejected at approximately the 95% confidence interval. Furthermore, the second part of this statistic strongly confirms that there is no second-order autocorrelation among the error terms model. As a result, it can be inferred that the obtained estimate has the required validity.

The argument that voluntary disclosure has a stickiness over time and that the disclosure of the previous periods acts as a force to increase voluntary disclosure in the subsequent periods can be confirmed in accordance with our expectations and at the 95% confidence interval. This is the first significant result of this study and one of its distinguishing features in comparison to the achievements of other empirical studies in this field conducted both within and outside of Iran. However, based on the findings of the bias-corrected fixed effects model and in line with those of Rava [18], if investors experience ambiguity regarding the key parameters of the company's cash flows[1] and this type of ambiguity increases, firm managers will react by reducing the level of voluntary information disclosure. More specifically, an increase in investors' ambiguity about the firm's cash flow[1] parameters in the digital industry listed on Iran's capital market causes investors to become more pessimistic and, as a result, to give the highest probability to the worst possible scenarios in their set of beliefs about the distribution of firms' cash flows. According to the theory of decision-making in terms of ambiguity, in these situations, increasing information disclosure by firm managers results in greater price volatility as a reaction to the news released during the ambiguity period [19]. Therefore, by reducing voluntary disclosure, industry managers have attempted to decrease the price volatility of corporates in this industry. Furthermore, as investor's ambiguity regarding the parameters of the whole market has grown, firm managers have responded by increasing voluntary disclosure. In other words, the disclosure of information from firms has had an impact on investors' initial beliefs about the firm's cash flows, paving the way for resolving the information asymmetry that has been systematically established throughout the market, and these findings are consistent with those of [27], [33], [45]. Therefore, it can be concluded that the studied digital firm managers during the study period responded differently in terms of voluntary disclosure of information, depending on the source of investors' ambiguity.

Table 7 demonstrates that the risk variable had a positive and significant effect on voluntary disclosure, which is consistent with the findings of [18, 25,39]. In situations where the firm's risk grows, managers increase voluntary disclosure to reduce stock return volatility, so that by influencing investors' beliefs (information) about the distribution of the firm's cash flows, managers can enhance the amount of learning in investors and thus control stock price volatility. Additionally, the decrease in stock liquidity has

[1] - For instance, investors' ambiguity about the average or variance of the firm's cash distribution

increased the information asymmetry associated with the firm, at the level of 90% confidence, which has reduced voluntary information disclosure. To be more precise, the decline in stock liquidity lessens the market's reaction to voluntary disclosure, which probably reduces managers' motivation to disclose and investors' demand for voluntary disclosure, and vice versa [36, 41].

However, as the firm's size grows, voluntary disclosure increases as well, which is consistent with the findings of the empirical literature in this field. Larger firms are more willing to disclose voluntarily for different reasons, including higher agency costs, more available resources, greater sustainability in profitability, and the diversity of stakeholders and their information needs. Furthermore, taking into account the interaction between the two variables of firm size and stock liquidity, which has been emphasized in the empirical literature of the firm's financial structure [46], results demonstrate that the size of the company grows as stock liquidity increases. More specifically, larger firms have less information asymmetry, which increases stock liquidity. Therefore, the direction in which firm size and stock liquidity influence the level of voluntary information disclosure is consistent with and confirms one.

Table 7: The Output of the Regression Model Includes the Investors' Ambiguity Level

Dependent Variable: Disclosure	Expected Sign	(1)	(2)	(3)
		Pooled	Fixed Effect	Fixed Effect Bias-corrected estimation
Lag Disclosure	+	0.67 (0.00)	0.25 (0.05)	0.5 (0.01)
DaFirm	-	0.04- (0.01)	0.04- (0.00)	0.04- (0.00)
DaMarket	+	0.027 (0.00)	0.33 (0.09)	0.024 (0.00)
Risk	+	0.39 (0.22)	0.47 (0.11)	0.52 (0.00)
Turnover	+	0.054 (0.15)	0.019 (0.37)	0.036 (0.07)
Ln Size	+	0.017 (0.00)	0.006 (0.25)	0.025 (0.01)
_Constant	(+/-)	0.085- (0.43)	-0.128 (0.44)	0.136 (0.48)
R-squared		0.73	0.66	-
F-Limer		-	3.29 (0.00)	-
Hausman Test		-	18.03 (0.00)	-
AR (1)		-	-	-2.02 (0.04)
AR (2)		-	-	0.24- (0.80)

Source: research findings

***, **, * denote significance at the 1%, 5%, and 10% level, respectively

In the following section of the study, we will examine the effects of investors' ambiguity aversion as well as other explanatory variables on the level of integrated information disclosure according to model (2) that we discussed in the previous section. Table 8 represents the results related to the estimation of model (2). The fixed effects method is more suitable than the pooled method, as before, based on the F-Limer test, and the fixed effects method has better explanatory power than the random effects method based on the Hausman test. However, similar to the output of model (1), a bias-corrected fixed effects estimator has been used to achieve more significant results in this section. The Arellano-Band test also

demonstrates the validity of the intended model in this section. However, according to the results of column 3 of Table 8, the variable AA, which demonstrates investors' ambiguity aversion, has had positive and significant effects on voluntary disclosure level. As a result, in response to the increase in ambiguity aversion of investors, firm managers enhance the level of voluntary disclosure to affect investors' worst beliefs about the firm's value and lead to the establishment of a new equilibrium. This is another remarkable result of this research that distinguishes it from other empirical studies in this field, including [25] and [18], in which the effects of investors' ambiguity aversion are investigated implicitly and indirectly. In Addition, the effects of ambiguity and ambiguity aversion on voluntary disclosure are considered concurrently and in the same direction.

Table 8: The Output of the regression model includes the Investors' ambiguity Aversion

Dependent Variable: Disclosure	Expected Sign	(1)	(2)	(3)
		Pooled	Fixed Effect	Fixed Effect Bias-corrected estimation
Lag Disclosure	+	0.75 (0.00)	0.31 (0.02)	0.60 (0.00)
AA	+	0.37 (0.02)	0.35 (0.09)	0.33 (0.00)
DaMarket	+	0.027 (0.00)	0.39 (0.22)	0.024 (0.00)
Risk	+	0.28 (0.39)	0.32 (0.16)	0.44 (0.02)
Turnover	+	0.049 (0.19)	0.004 (0.81)	0.024 (0.08)
Ln Size	+	0.016 (0.01)	0.002 (0.67)	0.022 (0.02)
_Constant	(+/-)	0.35- (0.01)	-0.33 (0.51)	-0.33 (0.00)
R-squared		0.733	0.63	-
F-Limer		-	3.15 (0.00)	-
Hausman Test		-	17.4 (0.00)	-
AR (1)		-	-	-1.99 (0.04)
AR (2)		-	-	0.45- (0.64)

Source: research findings

***, **, * denote significance at the 1%, 5%, and 10% level, respectively

6 Conclusions

In this study, we examined the effects of lag in voluntary disclosure, the investors' risk and ambiguity, the ambiguity of the whole market, and investors' ambiguity aversion on the integrated voluntary disclosure of information in the digital industry listed on the Tehran stock exchange during 2012–2022. The risk variable was first extracted using the approach presented by [35], and the degree of ambiguity related to the firm and the ambiguity of Iran's capital market was then extracted employing [21] approach. Moreover, to examine the robustness of the findings, the explanatory variables of stock liquidity and firm size were used to provide a more accurate analysis of key variables' effects on the level of voluntary disclosure.

The results show that the effects are consistent with the existing theories. Voluntary disclosure increased as the risk associated with the firm increased. However, the firm's level of ambiguity has reduced its voluntary disclosure. As a result of the increased ambiguity in the whole market, firm managers have

tried to seek their optimal policies for enhancing voluntary information disclosure. One of the most significant differences between this research and previous studies in this field was the investigation of the effects of investors' ambiguity aversion (independent of the ambiguity level) on the firm's voluntary disclosure. Previously, the effects of ambiguity aversion were implicitly investigated on the level of voluntary disclosure. As a result of the increase in investors' ambiguity aversion, which causes them to become more pessimistic towards the company's cash flows, the firm's manager is forced to increase voluntary disclosure of information in order to control the level of investors' ambiguity aversion. However, another distinctive finding of this study is the increasing effect of voluntary disclosure of previous periods on voluntary disclosure of subsequent periods, which in some ways confirms the existence of stickiness in voluntary disclosure policies in the industry under study. Also, according to the existing empirical literature, the interaction between the two variables of firm size and stock liquidity in the studied models is such that the size of the company grows as stock liquidity increases. More precisely, larger firms have less information asymmetry related to them, resulting in increased stock liquidity. As a result, the direction in which firm size and stock liquidity influence the level of voluntary information disclosure is consistent with and confirms one another.

In conclusion, the results of the current study not only identify various aspects of the information environment associated with the firm, such as risk, ambiguity, ambiguity aversion, and the dynamics of voluntary disclosure for investors and even firm managers but can also serve as a suitable guide for adopting appropriate policies in various information environments for decision-makers in this field. The findings of this research clearly show that only paying attention to risk conditions and not paying attention to ambiguity will lead to gross misspecification in modeling the decisions of investors and companies, which can even fuel crises in the macro economy on a wider scale. The experience of recent financial crises in global markets clearly emphasizes this point. As the conditions of financial crises worsen, the decision-making approach of economic agents will be different compared to normal conditions, so the effectiveness rate of disclosed information will also be different in such conditions. But this research also faces limitations. In this research, daily stock return data of firms were used to calculate market and corporate ambiguity variables. One of the limitations of using daily data is the loss of intraday information in lower time frames. Therefore, the use of lower time frame data, the analysis of the ambiguity situation by the corporate and the adoption of the optimal disclosure policy will be done with more accurately and easily. Also, in this research, the response tool of the corporate's manager to changes in the parameters affecting the firm's value is a combination of hard and soft information disclosure. Soft information (ex-ante) has a decisive role in corporates' voluntary disclosure policies due to its lower credibility for investors and the relative cost of issuing more than hard information (ex-post), which can change the relationships between the parameters of the empirical model. Therefore, the analysis of the determinants of voluntary disclosure of hard and soft information separately can be the goal of future research.

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