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Why do managers disclose risks accurately? Textual analysis, disclosures, and risk exposures

Alejandro Lopez-Lira

BI Norwegian Business School, Nydalsveien 37, 0484O, Oslo, Norway

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ABSTRACT

I provide an economic model that justifies using bag-of-words, topic modeling, and machine learning techniques to measure firms' risk exposures using the percentage they allocate to each risk in their financial statements. The model provides a theoretical set of sufficient conditions under minimal assumptions that make managers optimally disclose risk accurately and give more space to the most critical risks. I document that the SEC Regulation satisfies this set of sufficient theoretical conditions and induces rational managers to disclose risks truthfully.

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1. Introduction

Novel methods in machine learning and text analysis have recently enabled research exploiting firms' disclosures. In particular, many recent studies have focused on the 10-K annual reports, and specifically in Item 1 A — Risk Factors. A widespread set of textual analysis and machine learning methods rely on the assumption that a firm is more exposed to a specific risk if managers mention that risk more frequently.

For example, when using dictionary methods where the researcher specifies a list of words that proxy for a specific risk, several studies such as Bodnaruk et al. (2015) for financial constraints, Loughran et al. (2019) for oil risk, Li et al. (2020) for climate risk, and Hassan et al. (2020b) for Brexit risk use this assumption. Furthermore, it is also assumed in topic modeling methods, where the algorithm automatically discovers risk from firms' disclosures, as in Israelsen (2014), Bao and Datta (2014), Hanley and Hoberg (2019), and Lopez-Lira (2019). Finally, it is also used in supervised and semi-supervised methods, as in Hassan et al. (2019) and Hassan et al. (2020a). Additionally, researchers are increasingly applying these techniques to social media disclosures, such as in Wolfskeil (2020).

While the assumption is often justified using the empirical evidence in Skinner (1994), Skinner (1997), and Gaulin (2017), there remains a theoretical gap in the understanding of the economic incentives driving managers' behavior.

To address this gap in the literature, I introduce an economic model that rationalizes the empirical findings and provides conditions under which managers optimally write longer sections for the risks that most affect their firm. I further explain why the design of the SEC Regulation satisfies these conditions. In short, I provide a solid theoretical foundation that justifies the use of textual analysis and machine learning methods.

2. Model

The model consists of a collection of firms that differ in their risk exposure towards different risk sources. I consider two periods for tractability, but the model is equivalent to a model with infinite symmetric periods because there is no dynamic optimization.

Each firm is subject to multiple risks, and the exposure varies at the firm level. The risks may materialize next period and affect the profits of the company. Formally, firm j's profits at $t+1$ are:

$$\pi_{j,t+1} = x_{j,t+1} - \sum_{i=0}^{I} b_{j,i} R_{i,t+1} + \epsilon_{j,t+1}, \tag{1}$$

E-mail address: alejandro.lopez-lira@bi.no.

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where $\pi_{j,t+1}$ denotes firms profits, $x_{j,t+1}$ is a firm fixed effect, $R_{i,t+1}$ is the realization of the ith risk in the economy with a negative expected value, $b_{j,i}$ is the exposure of firm j to the ith risk and $\epsilon_{j,t+1}$ is, without loss of generality, a zero mean shock.[1] In what follows, I drop the time subscripts. Let $r_{ij} = b_{i,j}E[R_i]$ the total expected exposure of the firm to each risk. There is a finite number of risks in the economy, I.

In the model, investors have the option to sue the firm for not disclosing a particular risk. However, it is costly to sue the firm. Furthermore, the legal system is more likely to dismiss a lawsuit for a specific risk if the firm writes more about that risk in their financial reports. In the event of this lawsuit passing and the investors winning, the settlement amount decreases the more the firm elaborates on the disclosure and increases if the risk is more relevant.

The managers write the risk disclosures to minimize the sum of the expected cost of lawsuits and the reports' writing. For simplicity, there is no intertemporal discount rate.[2]

Formally, the manager optimizes the following function:

$$min_{\{L_i\}_{i=0}^{I}} \sum_{i=0}^{I} p(L_i)C(L_i, r_{ij}) + h(L_i). \tag{2}$$

$p(L_i)$ is the probability of receiving a lawsuit for when the section disclosing the ith risk is of length L_i. $C(L_i, r_{ij})$ is the (expected) cost of settling the lawsuit conditional on the lawsuit proceeding. Finally, $h(L_i)$ is the cost of writing the disclosure. Define $G(L_i, b_jR_i) = p(L_i)C(L_i, b_jR_i)$.

2.1. Tractable model

As a tractable example, assume the following functional forms.

The probability of receiving a lawsuit is a decreasing function of L_i, the length of the ith risk:

$$p(L_i) = (1 + L_i)^{-1}. \tag{3}$$

The cost of a lawsuit if received is a decreasing function of L_i, the length of the ith risk, an increasing function of $r_{ij} = b_{i,j}E[R_i]$ the total exposure of the firm to each risk and a positive parameter, a.

$$C(L_i, r_{ij}) = (1 + \frac{1}{L_i})(ar_{ij})^3, a > 0, \tag{4}$$

and the cost of writing the disclosure is an increasing function of L_i, the length of the ith risk and a positive parameter d, given by:

$$h(L_i) = \frac{d^3}{2}L_i^2, d > 0. \tag{5}$$

Which imply the optimization problem is

$$min_{\{L_i\}_{i=0}^{I}} \sum_{i=0}^{I} p(L_i)C(L_i, r_{ij}) + h(L_i) = min_{\{L_i\}_{i=0}^{I}} \sum_{i=0}^{I} \frac{(ar_{ij})^3}{L_i} + \frac{d^3}{2}L_i^2. \tag{6}$$

With first order conditions:

$$\frac{(ar_{ij})^3}{L_i^{*2}} = d^3L_i^*. \tag{7}$$

Intuitively, the firm is balancing the marginal benefit of increasing the risk disclosure on the left-hand side of the equality against the marginal cost of increasing the length of the disclosures on the right-hand side of the equality. The marginal benefit includes the decrease in the probability of receiving a lawsuit and the lawsuit's potential cost if received. The marginal cost in practice involves the management team spending time with lawyers and accountants. The second-order conditions guarantee that the first-order conditions define an optimum.

When we simplify:

$$L_i^* = \frac{a}{d}r_{ij}. \tag{8}$$

Each disclosure is linearly increasing in each risk exposure. Furthermore, firms with a higher cost of writing the disclosures, d, report shorter disclosures while firms with more costly lawsuits, characterized by parameter a, allocate more space to this risk. For this particular example, the proportion of space allocated to risk i, l_i is exactly proportional to the impact of each risk:

$$l_i = \frac{r_{ij}}{\sum_k r_{ik}}. \tag{9}$$

2.2. General result

The general result requires the following assumption.

Assumption 1. The following conditions hold.

1. $p : \mathbb{R}_+ \mapsto [0, 1]$ is twice continuously differentiable.
2. $C : \mathbb{R}_+ \times \mathbb{R} \mapsto \mathbb{R}_+$ is twice continuously differentiable in both arguments.
3. $h : \mathbb{R}_+ \mapsto \mathbb{R}_+$ is twice continuously differentiable
4. The probability of receiving a lawsuit, $p(\cdot)$, is decreasing in the length allocated to each disclosure, L_i.
5. The cost of the lawsuit, $C(\cdot, \cdot)$, is weakly decreasing in the length L_i, the first argument, and increasing in the total exposure of the firm to each risk, r_{ij}, the second argument.
6. The lawsuit cost is increasing in the risk exposure, but it increases at a lower rate with a longer disclosure: $\frac{\partial^2 C}{\partial L_i \partial r_{ij}} = \frac{\partial^2 C}{\partial r_{ij} \partial L_i} \leq 0$.
7. The regularity conditions: $\frac{\partial^2 G}{\partial L_i^2} + \frac{d^2 h}{dL_i^2} > 0$ and $\frac{\partial^2 G}{\partial L_i^2}\frac{\partial^2 G}{\partial r ij^2} - \left(\frac{\partial^2 G}{\partial L_i \partial r_{ij}}\right)^2 > 0$ to guarantee that the first order conditions define a local minimum.

Theorem 1. *Under Assumption 1 firms optimally choose to write longer disclosures for the risks that affect them the most.*

Proof. The firms' first order conditions for the disclosure L_i imply:

$$\frac{\partial G(L_i^*, r_{ij})}{\partial L_i} + \frac{dh(L_i^*)}{dL_i} = 0. \tag{10}$$

Define

$$F(L_i^*, r_{ij}) = \frac{\partial G(L_i^*, r_{ij})}{\partial L_i} + \frac{dh(L_i^*)}{dL_i} = 0. \tag{11}$$

Since F is continuous and differentiable (A1.1 and A1.2) the implicit function theorem applies, and there exist $\phi : \mathbb{R} \mapsto \mathbb{R}_+$ s.t. $L_i^* = \phi(r_{ij})$ around a neighborhood of r_{ij}. Furthermore,

$$\phi'(r_{ij}) = -\frac{\frac{\partial F}{\partial r_{ij}}}{\frac{\partial F}{\partial L_i^*}} = -\frac{\frac{\partial^2 C}{\partial L_i \partial r_{ij}}}{\frac{\partial^2 G}{\partial L_i^2} + \frac{d^2 h}{dL_i^2}} > 0. \tag{12}$$

[1] The risks $R_{i,t+1}$ in this economy are negative for the firm on average, contrasting with risks such as TFP shocks in macro models, which are absorbed by $\epsilon_{j,t+1}$.

[2] There is no maximum limit of pages allocated to risks in the regulation, although since 2020, more than 15 pages require a summary. In practice, we observe a finite number of pages and lawyers help write the section, which is costly.

Where we used A1.6 and A1.7. Hence, the optimal disclosure is (locally) increasing in the risk exposure of the firm for any given level of risk exposure. □

2.3. Assumptions and existing regulation

Besides the technical conditions, the results rely on three crucial assumptions. First, A1.4, the probability of receiving a lawsuit decreases when increasing the length of each disclosure. Second, A1.5, the cost of a court case falls when extending the size of each disclosure but increases the higher the firm's total risk exposure. Third, A1.6, the lawsuit cost increases with greater risk exposure, but it grows at a lower rate with a more extended disclosure.

Regulation S–K governs the disclosure of risks. Firms are directed to "provide under the caption 'Risk Factors' a discussion of the material factors that make an investment in the registrant or offering speculative or risky" (17 CFR §229.105 — Item 105 Risk factors, Federal Register (2020)). Failure to comply with the regulation can result in lawsuits by investors (Robbins and Rothenberg, 2005).

Furthermore, the prevailing legal point of view is that accurate disclosure of risk factors minimizes the firm's legal liability: "By providing disclosure of material risks of loss, risk factors limit the likelihood that a company will have liability to its shareholders if such a risk of loss should come to pass" (Robbins and Rothenberg, 2005). Naturally, this legal interpretation justifies Assumption 1.4: the probability of receiving a lawsuit decreases when increasing the length of each disclosure.

Moreover, "Risk factors can help protect the company from losing a shareholder lawsuit by helping to refute the claim that the company did not warn the shareholder of the possibility that something bad could occur" Robbins and Rothenberg (2005). This legal concept justifies Assumption 1.5: the cost of a lawsuit falls when extending the size of each disclosure, and Assumption 1.6, the lawsuit cost grows at a lower rate with a more extended disclosure.

Finally, for Assumption 1.5: the cost of a lawsuit is higher when the underlying risk is higher, Robbins and Rothenberg (2005) notes that "risk factors should be prioritized in the order of their importance to the company" and companies should "focus on the risks which management truly are concerned about in the daily and long-term management of the company". Naturally, the legal recommendation is so because more important risks are more likely to cause more consequential lawsuits if not disclosed.

Hence, the minimal assumptions about how a more extended discussion of a given risk affects a lawsuit's probability and potential cost are based on the existing regulation and legal doctrine.

3. Conclusion

Research using a widespread set of textual analysis and machine learning methods assumes that a firm is more exposed to a specific risk if managers mention that risk more often. To justify this common assumption, I introduce an economic model with minimal assumptions that provide conditions under which managers optimally write longer sections to the risks that most affect their firm. I further explain why the design of Regulation S–K and the existing legal doctrine satisfy these conditions. In short, I provide a solid theoretical foundation that justifies using textual analysis and machine learning methods in finance research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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