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Abstract

Purpose – The purpose of this paper is to use a theoretical and empirical model to investigate the adoption of the integrated reporting (IR) framework as a strategic choice to signal intellectual capital (IC) to equity investors, with specific reference to the pharmaceutical industry.

Design/methodology/approach – The choice of drafting an integrated report is modelled as a means for managers to strategically disclose price-relevant information related to IC. The voluntary disclosure model developed by Verrecchia (1983) is used, also introducing the role of financial analysts to derive a directly reproducible empirical equation.

Findings – Theoretically, as IR requires managers to exert an effort in reporting activity, this work shows that in equilibrium, only firms with sufficient IC have decided to adopt IR, resulting in rational investors' willingness to pay more only for the forecasted earnings of integrated reporters. This theory is tested in the pharmaceutical sector, where the modelling choice is probably more valid, with mixed results.

Research limitations/implications – When compliant with the International Integrated Reporting Council's (IIRC) standards, IR provides the means to disclose IC in a perfectly verifiable way. Furthermore, since the IIRC has only recently been established, the conclusions have only been tested on a limited data set.

Originality/value – This work connects the value relevance of IR to IC by adopting an equilibrium approach, which, in turn, provides specific indications of how to build a consistent empirical test of the theory.

Keywords Value relevance, Integrated reporting, Intellectual capital, Equilibrium, Pharmaceutical sector, Strategic information disclosure

Paper type Research paper

1. Introduction

The value relevance of intellectual capital (IC) and integrated reporting (IR) has been extensively studied in the literature. With a few exceptions (e.g. Garanina and Dumay, 2017), prior works have mostly considered them in isolation, either focussing on the impact of IC disclosure on a firm's value and financing cost or on the value relevance of IR. The theoretical foundations underlying a manager's choice to disclose IC and its relation to IR have been mostly left untouched. IC is largely subject to voluntary disclosure, which this paper considers a strategic communication decision to influence investors' perception of a company[1], as discussed in Verrecchia's (1983) and Dye's (1985) seminal works. If a manager is concerned with his or her company's market value and discloses "non-fundamental" information to offer its best representation, measuring the value relevance of IR and IC disclosure could be more difficult than expected, as the estimation of a standard linear regression model could be invalidated by self-selection (Heckman, 1978; Leuz and Verrecchia, 2000).

Based on the previous considerations, this paper aims to establish a concrete link between IC and IR and verify whether companies adopting the latter to disclose the former have, *ceteris paribus*, higher valuations, given their expected profits (consensus earnings). Combining different elements from the strategic accounting disclosure literature, this paper attempts to answer the following three research questions, specifically referring to sectors

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such as the pharmaceutical industry, where IC could be considered the key value-relevant information disclosed in an integrated report:

RQ1. (Theory): can IR be represented as an equilibrium phenomenon related to voluntary IC disclosure?

RQ2. (Theory-empirics): what are the consequences of the empirical testing of IR-IC value relevance?

RQ3. (Empirics): do the data support the conjecture that IR is a means to strategically disclose IC price-relevant information? Are companies that adopt IR valued more, *ceteris paribus*, given their short-term outlook (consensus earnings estimates)?

To provide concrete answers, this study builds an empirically testable general equilibrium model with imperfect information. The interaction between managers and investors is modelled as a persuasion game, where the former can withhold "unfavourable" information related to IC, but any disclosure must be truthful (Stocken, 2013). The roles of equity research firms and financial analysts are also introduced. This feature of the model relates to the consistent use of consensus estimates to assess the value relevance of IR, as stock market prices should reflect current unreported earnings rather than those already realised. Hence, when measuring the value relevance of IR/IC disclosure in terms of higher pricing of consensus earnings through simple linear regressions, it should also be considered whether analysts already include IC in their forecasts. In this case, observing a further "pricing effect" in regression coefficients could be less likely, especially if investors could be modelled as risk-neutral or minimally risk-averse.

From a theoretical perspective, this study's model provides formal support to traditional arguments related to the value relevance of IR and IC disclosure, also explaining why only some firms decide to adopt the IR framework (*RQ1*). The model presumes that managers gain direct benefits from their companies' market value and that IC positively contributes to the success of a company's business. Furthermore, IC is viewed as managers' private information, which can be credibly disclosed by adopting the IR framework. This, in turn, requires managers to put more effort into administrative, reporting and compliance activities; thus, only firms with sufficiently high IC decide to adopt the IR in equilibrium. Consequently, firms without sufficient IC should be, *ceteris paribus*, valued identically, while the others will be worth more, the higher their IC is (*RQ1* and *RQ3*).

From an empirical perspective, the model suggests that managers' strategic behaviour introduces a self-selection bias in standard linear regression models, which have been used extensively in prior empirical studies. If not properly treated, such bias eventually invalidates any statistical result, and this study's theoretical framework provides a solution consistent with the hypothesis to be tested (*RQ2*). Furthermore, explicitly introducing the role of financial analysts in its model, this paper shows that their forecasts hardly consider the effects of IR and IC disclosure. In this way, this paper provides additional support to several empirical strategies, including this study's (*RQ2*). In particular, this study suggests that the market value of companies adopting IR should be more sensitive to analysts' earnings forecasts, as a consequence of IC disclosure (*RQ2–RQ3*).

As a productive factor, IC is fundamental in knowledge-based industries (Hansson, 1997; Ellis and Seng, 2015). Thus, the assumptions used to build this study's equilibrium model are more likely to occur in the pharmaceutical industry, where IC plays a key role in successfully developing new drugs and obtaining approval from regulatory authorities (e.g. Zucker *et al.*, 1994; Boekestein, 2006; Kamath, 2008; Ghosh and Mondal, 2009; Kim and Kumar, 2009). Therefore, this study tests its model on large pharmaceutical companies and finds both positive and negative evidence regarding the value relevance of IR as a device to strategically disclose IC (*RQ3*).

This paper has a twofold novelty. First, it provides a concrete equilibrium link between the choice of adopting IR and disclosing IC, considering managers' self-interested behaviour to maximise their companies' market value. In doing so, this paper identifies the International Integrated Reporting Council's (IIRC) IR framework as a "natural" enforcement device that prevents managers from disclosing misleading information regarding IC. Second, this study tests the value relevance of IR as a means to strategically disclose IC with reference to a fully specified equilibrium model. This study's empirical model is derived from "first principles", supporting the econometric identification of key parameters. Although most of the components of this model are not novel in the microeconomic literature, to the authors' best knowledge, this is the first work that explicitly investigates the equilibrium relation between IR and IC, focussing on the related empirical consequences. This study's empirical results provide some evidence supporting the theory (*RQ1*), although the robustness to small sample or regression modifications is lower than expected (*RQ3*).

The rest of this paper is organised as follows. Section 2 reviews related contributions. Section 3 presents the theoretical framework that allows this study to establish IC and IR in equilibrium. Section 4 discusses the research methodology, and Section 5 deals with the results obtained for the pharmaceutical sector. Finally, Section 6 summarises this study's findings and conclusions.

2. Literature review

The disclosure of IC is a broadly accepted condition to assess a company's value efficiently and make investment decisions consciously (Brennan and Connel, 2001; Bukh, 2003; Yongvanich and Guthrie, 2005; Swartz *et al.* 2006; Ghosh and Wu, 2007; Zambon and Marzo, 2007; Li *et al.*, 2008; Alwert *et al.*, 2009; Abhayawansa and Guthrie, 2010; Gamerschlag, 2013). To this extent, several authors have pointed out that conventional value metrics have progressively become complementary and have therefore partially lost their absolute predominance (Collins *et al.,* 1997; Barth and Clinch, 1998; Francis and Shipper, 1999; Lev and Zarowin, 1999; Breton and Taffler, 2001; Bozzolan *et al.*, 2003; Brown *et al.*, 1999; Givoly *et al.*, 2016). Various studies suggest that investors and other stakeholders consider IC disclosure useful in understanding long-term growth opportunities (Edvisson and Malone, 1997; Cumby and Conrod, 2001; Eccles *et al.*, 2001; Holland and Johanson, 2003; Cuganesan and Dumay, 2009; Abhayawansa and Guthrie, 2010).

The relationship between IC disclosure and its impact on corporate value has been extensively studied in the literature. Van der Meer-Kooistra and Zijlstra (2001) were among the first researchers to show how IC disclosure positively influenced market capitalisation and stakeholder confidence. Considering a sample of Taiwanese companies, Chen *et al.* (2005) showed how IC positively correlated to market value and financial performance. In an empirical study of Fortune 500 company annual reports, Abdolmohammadi (2005) found evidence of a positive relationship between IC disclosure and market valuations. Vafaei *et al.* (2011) confirmed this result by analysing a sample of companies traded on the British, Australian, Hong Kong and Singapore stock markets. Similar results were obtained by Gamerschlag (2013) in Germany, as well as Ellis and Seng (2015) in New Zealand. Considering stocks listed on the ASX, Dumay and Tull (2007) observed that the diffusion of IC-related information in price-sensitive announcements had an impact on subsequent cumulative abnormal returns.

However, none of the previously mentioned works was based on a formal theory relating managers' preferences to the choice of disclosing IC or adopting the IR framework. The strategic nature of disclosing IC price-relevant information through IR had been mostly left untouched. As a consequence, empirical results based on simple linear regressions could be invalidated by self-selection (Heckman, 1978; Leuz and Verrecchia, 2000).

Nonetheless, Orens *et al.* (2009) showed that higher IC disclosure reduced capital cost, using a robust econometric methodology based on Botosan's (1997) and Leuz and Verrecchia's (2000) contributions.

Regarding financial analysts' behaviour, Ghosh and Wu (2007) showed how the analysts' opinions were also influenced by IC disclosure. On the contrary, Alwert *et al.* (2009) found that more complete information did not necessarily translate into better ratings (based on research conducted on German firms) because greater transparency tended to underline both strengths and weaknesses. This paper takes a different approach and explores equity research firms' incentive to include the effects of IC in their forecasts, the latter being managers' private information.

The value relevance of IR has been studied but not as the outcome of strategically disclosing IC, to the best knowledge of this paper's authors. For instance, Baboukardos and Rimmel (2016) documented that following the introduction of the King III reform (IR) in South Africa, investors were more willing to pay for corporate earnings. Bernardi and Stark (2018) argued that the compulsory adoption of IR improved the understanding about ESG performance, while Lee and Yeo (2016), Barth *et al.* (2017) and Zhou *et al.* (2017) extensively studied the economic benefits and opportunities gained by adopting IR.

Beattie and Thomson (2007), Alwert *et al.* (2009) and Abhayawansa (2013) suggested in more general terms that an integrated approach representing a company's business model (Bukh, 2003; Bini *et al.*, 2016) would likely increase the informative content of IC disclosure. Consequently, IR could overcome the limitations of standard financial reporting (Previs *et al.*, 1994; Wallman, 1995; Eccles and Krzus, 2010; Eccles *et al.*, 2010; Abeysekera, 2013; Beattie and Smith, 2013; Eccles and Krzus, 2014), depending on the change in the company's thinking approach (Camodeca and Almici, 2017a, b).

Nevertheless, Melloni *et al.* (2017) noticed a frequent lack of the required conciseness, completeness and balance in integrated reports, especially in conjunction with poor social performance. Other authors raised concerns about the role of IR as a means to disclose IC (Dumay, 2016; Dumay and Guthrie, 2017; Nielsen *et al.,* 2017). While this paper does not deal with the value relevance of corporate social and environmental performances, it acknowledges that IR could be a potential device for impression management (Melloni, 2015), used to persuade myopic investors. If the non-financial contents (e.g. IC) of IR are hardly verifiable, managers could be intentionally vague or overly optimistic in their messages to investors. Consequently, investors and other stakeholders might pay limited attention to IR. In other words, the assumption of "perfect verifiability" is the critical element of this paper's framework. However, such assumption is also implicitly embedded in all previously mentioned works related to the value relevance of IR and IC disclosure.

In general, there would be deep research and policy implications if the assumption of perfect verifiability was dropped. On one hand, prior results should be interpreted with more scepticism, especially in the absence of robust econometric modelling. On the other hand, policy makers should be concerned with the "quality" of IR contents before supporting its adoption. From a theoretical perspective, it would also be inappropriate to model IR/IC disclosure as a persuasion game. A costless signalling game would be more adequate to describe the interaction between managers and investors (Stocken, 2013). In particular, the communication between the two types of stakeholders could result in a babbling equilibrium (Crawford and Sobel, 1982) if managers had a strong incentive to inflate their companies' market value. In this case, investors would completely ignore the IR contents. Nevertheless, this paper proceeds in an orderly fashion and first investigates whether the data support the value-relevance implications of assuming perfect verifiability of the IC information disclosed in IR.

Finally, Dumay (2012) questioned the generic possibility to test formal theories of IC value relevance. This paper partially agrees with this view, to the extent that IC identification

in the currently available data remains challenging. However, this paper shows that starting from incentives that motivate managers to disclose more information, a falsifiable theory can be built despite the limited data available, restricting the significance of this study's empirical results.

3. Theoretical framework

This paper studies the choice of adopting an integrated report in a simple two-period exchange economy, where each manager holds private information regarding the probable success of one's business.

The model presented is a general equilibrium with imperfect information, involving three groups of optimising agents with rational expectations: investors, managers and research firms employing financial analysts. This study's approach extensively borrows from the strategic accounting disclosure literature (Stocken, 2013), particularly relying on Verrecchia's (1983) seminal work. Specifically, investors trade with each other in the shares of a continuum of companies listed on a competitive market and rationally process the signals provided by financial analysts and company managers. Each manager operates a different company, consisting of a risky project that in case of default returns nothing to its shareholders; otherwise, some positive, although random, real income is earned. This paper refers to the latter case as the project's success although the income returned to investors could be potentially lower than the initial share price.

This paper assumes that a company project's probability (θ) of success is a strictly increasing function of its IC and that such information is unknown to investors unless managers disclose it in a fully verifiable way by adopting the IR framework. Thus, the IIRC acts as an entity that certifies managers' signals to investors. Although in Verrecchia's (1983) study, disclosing additional information led to a straight penalty on firms' profits, this paper assumes that IR requires managers to spend more time on administrative, compliance and reporting activities, leading to their personal detriment[2]. Managers gain direct benefits from their companies' market value, and this paper shows that in equilibrium, IR is an optimal practice only for firms with sufficient IC, as distinguishing from other firms provide a benefit greater than the private detriment induced by the additional efforts of undertaking a more demanding reporting standard.

To consistently include earnings estimates in the empirical analysis (Sections 4 and 5), this study also explicitly models the interaction between the principal of an equity research firm and the financial analysts employed, assuming that the former is concerned with preserving the relationship with companies to receive coverage fees, while for the latter, it is only the precision of their estimates that matters. Since coverage contracts are signed before managers learn θ, this study shows that managers require analysts to withhold any information related to IC that could otherwise be discovered with due diligence. Consequently, financial analysts provide forecasts that are conditional to the success of each company's project.

3.1 Investors

A continuum of identical risk-neutral investors, with rational expectations, is bundled in a representative agent, which maximises their expected utility, presented as:

$$c_1 + \mathbb{E}(c_2|\mathscr{F}), \tag{1}$$

where c_t signifies the consumption of a single good available in the economy, while $\mathscr{F}$ denotes the information set available. Investors are endowed with an amount W of consumption goods and shares of the corporate sector, consisting of a continuum of firms $i \in (0, 1)$. Each firm's stock pays a non-negative random income y_i[3] per share in $t = 2$, and stocks can be traded only at $t = 1$ in exchange for the present consumption of goods.

Based on these assumptions, the sequence of budget constraints is as follows:

$$c_1 = \int_0^1 p_i \epsilon(i) di - \int_0^1 p_i h(i) di + W, \tag{2}$$

$$c_2 = \int_0^1 y_i h(i) di, \tag{3}$$

where $\in (i)di$ and $h(i)di$, respectively, denote the initial endowment and intended holdings of a generic firm's (i) shares, while p_i represents the related market price. Markets are all competitive in the sense that investors take prices as given, and since investors are all identical, a full interior solution requires the following first-order condition to hold:

$$p_i = \mathbb{E}\left(y_i \middle| \mathcal{F}\right), \tag{4}$$

so that investors are willing to keep their portfolios unchanged (aggregate consistency)[4], that is:

$$h(i) = \epsilon(i), \quad \forall i \in (0,1). \tag{5}$$

While the stock prices are set as usual by an "auctioneer", they are determined by investors' expectations, conditional on the information available in the economy.

3.2 Firms

Each firm (i) invests in a risky project that returns a non-negative amount of goods x_i per share if the project itself is successful; otherwise, nothing is earned. The project's probability of success (θ) defines the firm's type, which is private information held by the company's manager, while investors are assumed to dispose of sufficient information to derive the distribution of x_i on their own. The project's return in case of success is further intended as the net of a coverage fee, paid to an equity research firm in $t = 2$. Thus, y_i can be written as:

$$y_i = \begin{cases} x_i > 0, & \theta_i \\ 0, & 1-\theta_i \end{cases}. \tag{6}$$

Managers sign coverage contracts with the research firm prior to learning their types, while forecasts are issued in $t = 1$ after analysts have performed due-diligence investigations of each company, with the possibility to discover θ. This paper supposes that θ is a strictly increasing function of the firm's IC, which managers can credibly disclose by adopting the IR framework. The IIRC is supposed to act as an authority that certifies the information disclosed, preventing managers from lying about their companies' IC and the consequent value of θ. Furthermore, this paper assumes that θ is drawn independently across companies from a common probability distribution $G(s) := \Pr\{\theta \leqslant s\}$ and that x_i is stochastically independent from θ_i, with the consequence that $\mathbb{E}(x_i|\theta_i) = \mathbb{E}(x_i) = \mu_i > 0$. Such a hypothesis relates to the idea that the firm's economic size is not necessarily informative about the impact of IC on the success of its business.

While IR allows a manager to signal the firm's likelihood of success, it also requires the manager to invest additional effort in performing the related accounting, compliance and administrative activities. This paper posits that draughting an integrated report induces

private detriment (C) to the manager's utility, which becomes greater, the larger the company's (expected) size becomes:

$$C_i = \gamma\mu_i. \tag{7}$$

Each manager is a decision maker with rational expectations, taking the action of other agents as given, and gains direct benefits from the price of the company shares (p_i), which, in turn, depends on the investors' conjecture about the value of θ_i, as $\mathbb{E}(y_i) = \mathbb{E}(\theta_i|\mathcal{F})\mu_i$[5]. Thus, if analysts do not disclose θ through their reports, the manager of a generic company (i) decides whether to draft an integrated report to maximise the difference $p_i - C_i$, which represents the manager's utility function (U_i). Formally, the manager's problem is stated as:

$$\begin{aligned} &\max_{IR=\{0,\,1\}} \mathbb{E}\left(y_i \middle| IR\right) - \gamma\mu_i \mathbb{I}(IR = 1), \\ &\text{s.t.} \\ &\mathbb{E}\left(y_i \middle| IR\right) = \theta_i\mu_i \mathbb{I}(IR = 1) + \mathbb{E}(\theta|\theta_i : IR_i = 0)\mu_i[1 - \mathbb{I}(IR = 1)], \end{aligned} \tag{8}$$

where $IR = 1$[6] corresponds to the decision to draft an integrated report in $t = 1$ instead of adhering to standard accounting practices.

If analysts are interested in disclosing θ, either explicitly or implicitly through their forecasts, they should first perform an extended due-diligence examination of a company to assess its IC . This step could burden managers with additional requests (e.g. documentation, on-site visits, interviews). This paper assumes that managers cannot escape from these activities, entailing an additional effort equivalent to draughting an integrated report. Since coverage contracts are signed prior to the θ being known, managers are (*ex ante*) better off if analysts do not disclose θ as:

$$\mathbb{E}(U|\textit{Analysts disclose } \theta) = \mathbb{E}(\theta)\mu - \gamma\mu, \tag{9}$$

$$\mathbb{E}(U|\textit{Analysts do not disclose } \theta) = \mathbb{E}(\theta)\mu - Pr(IR = 1)\gamma\mu. \tag{10}$$

Indeed, it follows that $\mathbb{E}(U|\textit{Analysts disclose } \theta) \leqslant \mathbb{E}(U|\textit{Analysts do not disclose } \theta)$, as the probability that the firm will adopt IR in equilibrium ($Pr(IR = 1)$) cannot be greater than 1. In other words, because disclosing IC requires some effort in any case, managers prefer to decide themselves when it is worth doing so.

Thus, managers find it optimal to contractually require research firms to avoid disclosing θ. To enforce this requirement, this paper posits the existence of a contractual provision that in case of IC (θ) disclosure, managers are allowed to terminate coverage contracts without paying fees.

3.3 Financial analysts

A research firm's principal employs financial analysts to predict the outcomes of companies' projects, in exchange for coverage fees. Financial analysts are only concerned with the precision of their forecasts to maintain their reputation and minimise the risk of a quadratic loss function around each prediction (f) they make. Hence, analysts solve the following problem:

$$\min_f \mathbb{E}\left[(f - y)^2 \middle| \eta\right], \tag{11}$$

where η represents any conditioning variable. Taking a first derivative of the objective function with respect to f immediately reveals that analysts always find it optimal to predict y with its (conditional) expected value:

$$f = \mathbb{E}(y|\eta). \tag{12}$$

As stated, the research firm's profitability is subject to the non-disclosure of θ. Violating this agreement would always result in losing coverage fees, as managers could improve their companies' profits regardless of the actual effect of the disclosed information. The research firm principal's problem consists of deciding whether to ask analysts to issue a forecast conditional to the project's success ($y_i = x_i > 0$). Recalling the independence between θ_i and x_i, if the principal opts for this solution, analysts do not need to assess IC and let:

$$f_i = \mathbb{E}\left[y_i \middle| success\right] = \mathbb{E}[x_i] = \mu_i. \tag{13}$$

In this case, investors can discover θ_i only if firm i decides to disclose it through IR.

Conversely, in case of unconditional forecasts, analysts would try to predict y_i so as to achieve the highest precision possible; they would let:

$$f_i = \mathbb{E}\left[y_i|\theta\right] = \theta_i \mathbb{E}[x_i] + (1-\theta_i)\cdot 0 = \theta_i \mu_i, \tag{14}$$

after an extended due-diligence study of IC (θ). As investors hold enough information to compute $\mathbb{E}[x_i]$ on their own, Equation (14) implies that they could discover θ_i by reverse engineering, resulting in the violation of the agreement with the managers and lost coverage fees. Hence, the research firm's principal finds it optimal to ask analysts to issue forecasts conditional to $y_i = x_i > 0$, and forecasts are to some extent optimistically biased, as:

$$f_i = \mu_i > \theta_i \mu_i. \tag{15}$$

Financial analysts do not add any information to what is already in the hands of investors because the information needed to derive μ_i is common knowledge. Equation (15) states that analysts' estimates are not informative about a company's IC, consistent with the research firm principal's incentives. However, estimates are "precise", conditional on each project's success.

3.4 Equilibrium

By definition, in equilibrium, agents behave according to the assumptions made, and the resulting actions are consistent with each other[7]. Having included the investors' optimal behaviour in the managers' problem, what remains is deriving the solution to the latter, as the optimal behaviour of financial analysts has already been considered. Similar to Verrecchia's (1983) findings, *P1* contains the main result related to the persuasion game involving managers and investors[8], that is, a threshold θ^* exists such that only firms with $\theta \geqslant \theta^*$ adopt IR in equilibrium.

The main difference from Verrecchia's (1983) framework lies in considering several firms simultaneously. However, as each manager's disclosure problem appears independent from those of the others, this study obtains similar results. This is a consequence of having assumed θ as independently distributed across firms, as well as

independently from μ. For the sake of completeness, a formal proof of the previous statements is included as follows:

P1. If $G(\cdot)$ is a $C^1[0, 1]$ function, $\theta^* \in [0, 1]$ exists, such that in equilibrium, firms decide to adopt IR if $\theta \geqslant \theta^*$, and:

$$\mathbb{E}(\theta|\theta\text{: } IR = 0) = \frac{\int_0^{\theta^*} g(\theta)\theta d\theta}{G(\theta^*)}, \tag{16}$$

where $g(\theta) := \frac{d}{d\theta}G(\theta)$. Furthermore, if $\theta^* \in (0, 1)$, then:

$$\theta^* - \gamma = \frac{1}{G(\theta^*)}\int_0^{\theta^*} g(\theta)\theta d\theta. \tag{17}$$

Proof. To prove the proposition, it should first be noted that the choice of adopting IR is independent of μ_i, as it is a constant that equivalently affects all payoffs and does not influence the distribution of θ. Second, since θ is independently distributed across firms, the fact that a company finds it optimal to disclose its type does not allow making an inference about the others' types. Hence, the focus can be on the disclosure problem of each firm in isolation, which can be represented equivalently as follows:

$$\max_{IR=\{0, 1\}} \begin{cases} (\theta - \gamma), & IR = 1 \\ \mathbb{E}(\theta|IR = 0), & IR = 0 \end{cases}. \tag{18}$$

The remainder of the proof is similar to that of Stocken (2013), except that θ is allowed to be arbitrarily distributed to the support [0, 1], and corner solutions are explicitly discussed. Suppose that the "indifference" condition:

$$\theta^* - \gamma = \mathbb{E}(\theta|\theta\text{: } IR = 0), \tag{19}$$

is satisfied for $0 < \theta^* < 1$. Firms with $\theta = \theta^*$ are indifferent to adopting IR, while those with $\theta > \theta^*$ will find it beneficial to adopt it as $\theta - \gamma > \mathbb{E}(\theta|\theta\text{: } IR = 0)$. For firms with $\theta < \theta^*$, managers will instead find it more convenient to avoid disclosing their firms' types as $\mathbb{E}(\theta|\theta\text{: } IR = 0) > \theta - \gamma$. Hence, IR is adopted if $\theta > \theta^*$, provided that Equation (19) admits a solution on the open interval (0, 1). To this extent, the hypothesis of rational expectations in turn requires that investors' expectations be consistent with managers' disclosure policy, that is, $\mathbb{E}(\theta|\theta\text{: } IR = 0) = \mathbb{E}(\theta|\theta \leqslant \theta^*) = \int_0^{\theta^*} g(\theta)\theta d\theta / G(\theta^*)$ (Bayes' rule). Therefore, Equation (19) becomes in equilibrium:

$$\theta^* - \gamma = \frac{1}{G(\theta^*)}\int_0^{\theta^*} g(\theta)\theta d\theta. \tag{20}$$

Finally, if Equation (20) does not admit a solution on the open interval (0, 1), then either all firms adopt IR or no firm does; either $P_i = \theta_i\mu_i$ or $P_i = \int_0^1 g(\theta)\theta\mu_i d\theta$ for every firm. This is equivalent to letting $\theta^* = 0$ and 1, respectively. The former case occurs if $\gamma = 0$, while the latter holds true whenever Equation (20) implies $\theta^* \geqslant 1$. ■

3.5 Theoretical results

According to *P1*, the equilibrium pricing kernel of the economy can be written as:

$$p = \mathbb{E}(y|IR) = \begin{cases} \theta\mu, & IR = 1\left(\theta^* < \theta < 1\right) \\ \frac{\int_0^{\theta^*} g(\theta)\theta d\theta}{G(\theta^*)}\mu, & IR = 0\left(\theta \leqslant \theta^* < 1\right). \end{cases} \tag{21}$$

In words, managers find it beneficial to adopt IR only when IC (θ) is sufficiently large, as distinguishing from other firms provide a benefit greater than the private detriment induced by the additional efforts of undertaking a more demanding reporting standard. Consistent with managers' incentives, Equation (21) states that companies adopting IR enjoy higher market multiples (p/f), the higher IC (θ) is:

$$\frac{p}{f}\Big|(IR = 1) = \theta > \frac{p}{f}\Big|(IR = 0) = \mathbb{E}\left(\theta|\theta \leqslant \theta^*\right). \tag{22}$$

Conversely, firms without sufficient IC to reach θ^* are valued identically, as investors can only infer that IC is insufficient to motivate the adoption of IR. Consequently, investors are, *ceteris paribus*, overpaying low IC companies and underpaying those with a higher IC but still inadequate to motivate managers to disclose more information. This effect should be negligible whenever IC has a limited impact on a firm's business, while it might be appreciable in sectors (e.g. the pharmaceutical industry) where factors such as innovation and quality of research play a crucial role.

3.6 Preliminary empirical considerations

The price of a generic company's shares can be equivalently represented as:

$$p_i = \mathbb{E}\left(y_i\middle|IR_i\right) = \mathbb{E}\left(\theta|\theta \leqslant \theta^*\right)f_i\mathbb{I}(IR_i = 0) + \theta_i f_i \mathbb{I}(IR_i = 1), \tag{23}$$

because in equilibrium, $f_i = \mu_i$. Equations (22) and (23) contain the results that this study intends to test by using actual financial data, that is, whether companies adopting IR are "valued more" as a result of disclosing "high" IC. An empirical version of the theoretical model presented is of immediate derivation, as stock prices are linear in f, with different "slopes", depending on whether or not IR is adopted. Proving this claim starts with rewriting Equation (23) equivalently as:

$$p_i = \mathbb{E}\left(\theta|\theta \leqslant \theta^*\right)(1 - D_i)f_i + \mathbb{E}\left(\theta|\theta > \theta^*\right)D_i f_i + Z_i, \tag{24}$$

where $D_i := \mathbb{I}(IR_i = 1)$, and Z_i: $\theta_i f_i D_i - \mathbb{E}(\theta|\theta > \theta^*)D_i f_i$. Since θ is independently distributed from μ, and $f = \mu$, it follows that:

$$\mathbb{E}\left[z_i|f_i, D_i\right] = D_i f_i\left[\mathbb{E}(\theta|D_i) - \mathbb{E}\left(\theta|\theta > \theta^*\right)\right] = 0, \tag{25}$$

as $D_i = 1 \Leftrightarrow \theta > \theta^*$. Therefore, this study's model is formulated equivalently as:

$$p_i = \mathbb{E}(\theta|D_i = 0)f_i + [\mathbb{E}(\theta|D_i = 1) - \mathbb{E}(\theta|D_i = 0)]D_i f_i + Z_i, \tag{26}$$

where Z_i denotes a residual component satisfying the exogeneity condition $\mathbb{E}[Z_i|f_i, D_i] = 0$.

Equation (26) is a convenient formulation[9] of the model because it does not require observing θ and still allows testing this study's theory. However, an empirical counterpart of the project's returns should first be considered because the model is intentionally abstract in this sense. A first obvious choice consists of employing earnings-per-share (*eps*) as an empirical substitute for y, which is based on the evidence that prices tend to follow the

expectations for current unreported (FY1) earnings (Table II, Section 5). In this respect, a consensus earnings estimate ($f(eps_1^{(i)})$) could be used as a straight empirical counterpart of f.

In reality, companies operate (hopefully) for many years; thus, the returns generated by their projects are spread over time. Therefore, to reconcile the model with actual data, it is assumed more generally that y is proportional to current unreported *eps*, that is, $f = k \cdot f(eps_{1,t}^{(i)}), k > 1$. Hence, this study's theoretical model can be represented as:

$$p_i = \beta_2 f\left(eps_1^{(i)}\right) + \beta_3 f\left(eps_1^{(i)}\right) D_i + z_i, \tag{27}$$

where $z_i := k \cdot Z_i$, while $\beta_2 = k \cdot \mathbb{E}(\theta | D_i = 0)$, and $\beta_3 = k \cdot [\mathbb{E}(\theta | D_i = 1) - \mathbb{E}(\theta | D_i = 0)] > 0$ are parameters to be estimated. Specifically, the term $\beta_2 f(eps_1^{(i)}) + \beta_3 f(eps_1^{(i)}) D_i$ can be defined as a systematic component, while z is a theoretical residual[10]. It should be noted that z satisfies the ordinary least squares (OLS) exogeneity condition for unbiasedness and consistency, that is, $\mathbb{E}[z_i | f_i, D_i] = 0$.

A necessary condition to support the claim that IR is value-relevant is that the estimate for β_3 appears to be significantly positive. While this study's theoretical model could be easily implemented through a linear regression, the strategic nature of IR's adoption could introduce a self-selection bias in the related OLS estimates.

4. Research methodology

The validity of this study's theory is tested by considering the pharmaceutical sector, where IC largely contributes to the development of drugs that are able to pass clinical tests and be approved by regulatory authorities. Thus, IC can be considered the key value-relevant information disclosed with IR.

4.1 Data set

This study's data set considers the major health technology stocks listed on developed markets and classified as Pharmaceuticals: Major, Pharmaceuticals: Generic, or Pharmaceuticals: Other according to Factset's industry field (FA_FACTSET_INDUSTRY). Since earnings estimates are only periodically revised, the quarterly data are obtained by considering the last business day of each calendar quarter. Analysts' estimates are obtained from the Factset Estimates database[11], and when more than one analyst covers a company, the median of available forecasts is considered to define a consensus.

The adoption of the IR framework is identified by using the list published on the IIRC website (http://examples.integratedreporting.org/all_reporters). According to the IIRC website, the IR framework was launched in December 2013, which is therefore considered the natural starting observation date; the last observation date is the end of December 2017.

Firms without either a current positive book-value-per-share (*bps*) or a positive *eps* forecast for FY1 are excluded because their equity value probably does not fit a simple regression model. Alternatively, a specific dummy variable may have been included in the model, but this solution is not considered in this study because the previously mentioned condition occurs in a limited number of cases. Small-caps are also excluded, considering a minimum requirement of €3.5bn market capitalisation. In particular, companies included in the analysis are required to satisfy this condition at least once in the sample.

After excluding missing data observations, this study's estimation sample is ultimately composed of 792 observations for 49 companies, of which 11 are integrated reporters, according to the IIRC. The interquartile ranges for market capitalisation, price-to-book ratio and return on equity are (€6.1–7.3bn), (2.1x–5.4x) and (8.6–24.7 per cent), respectively. In the following subsections, the superscript (i) identifies the company, while the subscript t refers to the observation date.

4.2 Econometric methodology

To estimate Equation (27) on the data set, this study considers a simple pooled regression model, including the current *bps* ($bps_{0,t}^{(i)}$) as the control variable. Furthermore, this study allows the presence of a constant term, that is, an intercept common to all companies. This requires converting all data to euros, using the historical exchange rate, and multiplying per-share data by the number of outstanding shares ($N_t^{(i)}$)[12]. Therefore, the regression model is formulated as:

$$p_t^{(i)}N_t^{(i)} = \underbrace{\beta_0 + \beta_1 bps_{0,t}^{(i)}N_t^{(i)}}_{Control\ variables} + \underbrace{\left[\beta_2 f\left(eps_{1,t}^{(i)}\right) + \beta_3 D_i f\left(eps_{1,t}^{(i)}\right)\right]}_{Equation(27):\ systematic\ component} \cdot N_t^{(i)} + \underbrace{\varepsilon_t^{(i)}}_{Residual}, \tag{28}$$

where ε represents a generic residual component.

Consistent with Equation (26), ε shall include the theoretical residual z, which satisfies the exogeneity condition $\mathbb{E}[z_i | f(eps_{1,t}^{(i)}), bps_{0,t}^{(i)}, D_i] = 0$[13]. However, other sources of disturbance (e.g. omitted variables) could be present in the actual data, potentially correlated to IC and therefore to D. For this reason, this study only requires that $\mathbb{E}[\varepsilon_t^{(i)} | f(eps_{1,t}^{(i)}), bps_{0,t}^{(i)}] = 0$ and acknowledges that ε could be potentially correlated to IC (endogeneity).

The regression of the equity market value is not new as a statistical testing device used to assess the value relevance of corporate disclosure, and it is also specified in terms of expected equity returns (i.e. the cost of equity), such as in Botosan's (1997) seminal work. Similarly, Orens *et al.* (2009) and Boujelbene and Affes (2013) tested the value relevance of IC on a broad set of companies, while Baboukardos and Rimmel (2016) tested the value relevance of IR in South Africa, following the introduction of the King III reform. Dealing with a broader reference, the authors of these studies often included specific control variables (e.g. size, industry and leverage). Having considered large caps operating in the same sector, the inclusion of additional regressors probably increases the chances of over-fitting, especially given the already high explicative power of the simple regression, formulated as follows:

$$p_t^{(i)}N_t^{(i)} = \alpha_0 + \alpha_1 bps_{0,t}^{(i)}N_t^{(i)} + \alpha_2 f\left(eps_{1,t}^{(i)}\right)N_t^{(i)} + \epsilon_t^{(i)}, \tag{29}$$

whose estimates are presented in Table II (Section 5).

With the exception of Orens *et al.*'s (2009) study, previous empirical work paid limited attention to the equilibrium nature of IC disclosure, which probably induces a self-selection bias in the model. This phenomenon can be observed in Heckman's (1978) seminal work and, with specific reference to corporate voluntary disclosure, in Leuz and Verrecchia's (2000) study. A simple examination of Equation (28) suggests that self-selection might be a serious concern in the present study's case because the error term (ε) might be correlated to IC and thus to θ. Since IR is adopted, provided that $\theta \geqslant \theta^*$, if ε and θ are correlated to each other, it could no longer be claimed that ε is exogenous to the whole set of regressors $(bps_{0,t}^{(i)}, f(eps_{1,t}^{(i)}), D_i)$, namely, $\mathbb{E}[\varepsilon_t^{(i)} | bps_{0,t}^{(i)}, f(eps_{1,t}^{(i)}), D_i]$, could be a function of D. Consequently, the OLS estimator's direct application to Equation (28) would provide biased and inconsistent estimates for the parameters involved, preventing a fair assessment of the value relevance of IR and IC disclosure.

Nevertheless, this study's theory provides a concrete backup to the OLS estimation of Equation (28). Proceeding with order, it is assumed that the residual $\varepsilon_t^{(i)}$ can be represented as $\varepsilon_t^{(i)} = N_t^{(i)} \cdot z_t^{(i)} + v_t^{(i)}$, where $v_t^{(i)}$ denotes an independent and identically distributed (i.i.d.)[14] error with zero expected value and stochastically independent from $\mathbf{x}_t^{(i)}$. Despite IR being endogenous to price determination, this present study shows that in equilibrium, the former

depends only on a firm's IC endowment, which should not be correlated to $\mathbf{x}_t^{(i)}$: $(bps_{0,t}^{(i)}, f(eps_{1,t}^{(i)}))$. Thus, recalling that $\mathbb{E}[z_i|\mathbf{x}_t^{(i)}, D_i] = 0$, this equation can be formulated:

$$\begin{aligned}\mathbb{E}\left[\varepsilon_t^{(i)}\middle|D_i = 1,\ \mathbf{x}_t^{(i)}\right] &= \mathbb{E}\left[v_t^{(i)}\middle|\theta_i \geqslant \theta^*,\ \mathbf{x}_t^{(i)}\right] = \mathbb{E}\left[v_t^{(i)}\middle|\theta_i > \theta^*\right] = \mathbb{E}\left(v|\theta > \theta^*\right)\\ \mathbb{E}\left[\varepsilon_t^{(i)}\middle|D_i = 0,\ \mathbf{x}_t^{(i)}\right] &= \mathbb{E}\left[v_t^{(i)}\middle|\theta_i < \theta^*,\ \mathbf{x}_t^{(i)}\right] = \mathbb{E}\left(v|\theta \leqslant \theta^*\right).\end{aligned} \tag{30}$$

An immediate consequence is that ε can be ultimately represented as:

$$\varepsilon = \mathbb{E}\left(v|\theta \leqslant \theta^*\right) + \left[\mathbb{E}\left(v|\theta > \theta^*\right) - \mathbb{E}\left(v|\theta \leqslant \theta^*\right)\right]D + u, \tag{31}$$

where u satisfies the exogeneity condition $\mathbb{E}[u_t^{(i)}|D_i = 0,\ \mathbf{x}_t^{(i)}] = 0$. Substituting the former representation of the error term in Equation (28), an equivalent representation of this study's regression model that can be estimated with OLS is obtained:

$$P_t^{(i)}N_t^{(i)} = \alpha_0 + \alpha_1 D_i + \beta_1 bps_{0,t}^{(i)}N_t^{(i)} + \beta_2 f\left(eps_{1,t}^{(i)}\right)N_t^{(i)} + \beta_3 D_i f\left(eps_{1,t}^{(i)}\right)N_t^{(i)} + u_t^{(i)}, \tag{32}$$

where $\alpha_0 = \beta_0 + \mathbb{E}(v|\theta \leqslant \theta^*)$, and $\alpha_1 = \mathbb{E}(v|\theta > \theta^*) - \mathbb{E}(v|\theta \leqslant \theta^*)$.

Despite a potential self-selection problem, the theoretical model presented in this paper can still be estimated with OLS, as long as a specific dummy variable is included in the regression. As illustrated, the role of this additional regressor is to correct the self-selection bias resulting from a potential correlation between the regression's residual and IC.

5. Results

5.1 Preliminary findings

Estimates for Equation (32) suggest that adopting the IR framework increases the sensitivity to *eps* forecasts (Table I), consistent with this study's theory, and the results are robust to the inclusion of time-fixed effects that are significant although their exclusion does not affect the results. Furthermore, the residual valuation component (ε) appears to be significantly higher for companies adopting the integrated report. Similar results are obtained, allowing for heteroscedasticity in the error term.

Although unbiased and consistent, the OLS estimator might be inefficient in the present context. The regression's residual includes the term z_i: $[\theta_i D_i - \mathbb{E}(\theta|\theta > \theta^*)]kD_i f(eps_{1,t}^{(i)})$, with

Coef.: variable	Coeff.	SE	*t*-stat	*p*-value (%)	[2.5%	97.5%]
OLS estimates for Equation (32) ($R^2 = 95\%$, p-value(F) = 0.0%)						
α_0: *Intercept*	2.268	0.643	3.525	0.0	1.005	3.531
α_1: D_i	5.754	1.371	4.197	0.0	3.062	8.445
β_1: $bps_{0,t}^{(i)}N_t^{(i)}$	−0.230	0.046	−4.956	0.0	−0.321	−0.139
β_2: $f(eps_{1,t}^{(i)})N_t^{(i)}$	16.680	0.219	76.170	0.0	16.250	17.109
β_3: $D_i f(eps_{1,t}^{(i)})N_t^{(i)}$	0.782	0.314	2.494	1.3	0.167	1.398
Including time-fixed effects ($R^2 = 96\%$, p-value(F) = 0.0%)						
α_0: *Intercept*	2.194	0.635	3.453	0.0	0.947	3.441
α_1: D_i	5.798	1.352	4.289	0.0	3.144	8.451
β_1: $bps_{0,t}^{(i)}N_t^{(i)}$	−0.217	0.046	−4.741	0.0	−0.307	−0.127
β_2: $f(eps_{1,t}^{(i)})N_t^{(i)}$	16.650	0.216	77.017	0.0	16.227	17.076
β_3: $D_i f(eps_{1,t}^{(i)})N_t^{(i)}$	0.751	0.301	2.429	1.5	0.144	1.358

Notes: *F*-test for poolability: 2.429, *p*-value: 0.0 per cent. Confidence intervals for hypothesis testing were obtained under the hypothesis of homoscedasticity

Table I. Estimates for Equation (32)

the consequence that the variance of the error term (u) might be a function of consensus *eps* forecasts. As long as the variance of the "additional disturbances" (v) is predominant, standard confidence intervals could be saved, as errors could be presumed as approximately homoscedastic. Otherwise, specific forms of corrections should be considered. In this respect, by introducing HC3 robust standard errors (Davidson and MacKinnon, 1993), the 95% confidence interval for $\widehat{\beta}_3$ remains strictly positive and equal to [0.016−1.548]. In other words, after controlling for heteroscedasticity, the estimate for β_3 remains statistically significant, with a 5 per cent confidence level (p-value: 4.5 per cent).

5.2 Robustness checks

Due to the small number of integrated reporters, this study then assesses whether the results are robust to small sample modifications. Table II shows the output of estimating Equation (32) without including the top integrated reporter by the combined ranking of the price-to-book value ratio and the return on equity (Novo Nordisk). The omission of this company shifts down the point estimate for β_3, which is no longer statistically significant, considering both regular and robust standard errors. Due to the small sample size in terms of the companies considered, the confidence intervals for regression parameters are quite large, with the consequence that omitting the most expensive and capital-efficient integrated reporter reduces the statistical significance of $\widehat{\beta}_3$.

Finally, estimates are obtained considering *bps* as an IR-affected variable (see Baboukardos and Rimmel, 2016). This requires modifying Equation (32) as follows:

$$p_t^{(i)}N_t^{(i)} = \alpha_0 + \alpha_1 D_i + \left[\beta_1 bps_{0,t}^{(i)} + \beta_2 f\left(eps_{1,t}^{(i)}\right) + \beta_3 D_i f\left(eps_{1,t}^{(i)}\right) + \underbrace{\beta_4 D_i bps_{0,t}^{(i)}}_{Impact\ of\ IR\ on\ bps}\right] \cdot N_t^{(i)} + u_{t.}^{(i)} \quad (33)$$

As shown in Table II, the inclusion of the term $D_i bps_{0,t}^{(i)}$ makes the estimates for both β_3 and β_4 jointly insignificant although α_1 remains significantly positive. Besides, if the top integrated reporter is excluded by the combined ranking of the price-to-book value ratio and the return on equity (Novo Nordisk), the estimate for β_4 becomes significantly positive; in contrast, those for β_3 and α_1 are significantly negative and insignificant, respectively. This set of contradictory results might be related to a potential over-fitting, as the original model already has high explicative power. Nevertheless, this study confirms the mixed evidence to support (refute) the value relevance of IR as a device to strategically disclose price-relevant information related to IC.

Coef.: variable	Equation (29)	Equation (32)	Equation (33)	Equation (32, × top PB/ROE)	Equation (33, × top PB/ROE)
α_0: *Intercept*	3.59***	2.27***	2.25***	2.10***	2.25***
α_1: D_i		5.75***	5.87***	4.46***	2.06**
β_1: $bps_{0,t}^{(i)}N_t^{(i)}$	−0.17***	−0.23***	−0.22***	−0.14**	−0.22***
β_2: $f(eps_{1,t}^{(i)})N_t^{(i)}$	16.58***	16.68***	16.64***	16.35***	16.64***
β_3: $D_i f(eps_{1,t}^{(i)})N_t^{(i)}$		0.78**	1.03	0.39	−3.40***
β_4: $D_i bps_{0,t}^{(i)}N_t^{(i)}$			−0.05		0.77***
R^2 (%)	95	96	96	96	96
p-value(F) (%)	0.0	0.0	0.0	0.0	0.0

Notes: Confidence intervals for hypothesis testing are heteroscedasticity robust (HC3). *$p \leqslant 10$ per cent; **$p \leqslant 5$ per cent; ***$p \leqslant 1$ per cent

Table II. Comparison of estimates for Equations (29), (32) and (33)

6. Conclusions

6.1 Results and contributions to the literature

This study has shown how to build a consistent link between the choice of adopting an IR framework and IC by investigating the effect of disclosing the latter through the former on equity valuations (*RQ1*). In doing so, this study has also explicitly modelled the behaviour of equity research firms and financial analysts who might be reluctant to include information related to IC in their estimates.

This study has derived the empirical counterpart of its theoretical model and has provided adequate conditions to test it by estimating a simple linear regression without incurring a self-selection bias (*RQ2*). Using the same methodology, this study has tested for the value relevance of IR as a device to strategically disclose IC in the pharmaceutical sector and has found mixed evidence (*RQ3*). In particular, if the whole set of integrated reporters are considered, this study finds that IR positively affects valuations, with a large degree of confidence. However, a small sample set of modifications, such as the exclusion of the most expensive and capital-efficient integrated reporters, results in the low significance of the coefficient associated with the IR. Similarly, if IR should also affect the role of book value in market valuations, this study finds even more contradictory results. However, this might be due to a potential over-fitting.

6.2 Research limitations

One of the principal limitations of this empirical analysis is the small amount of data available, as the IIRC was established only in 2012, and the list of integrated reporters is dated December 2013. In this sense, the specific treatment of self-selection is also supported by the limited sample variety, and several of the assumptions made could be more flexible when dealing with a broader reference universe. On the theoretical side, this paper assumes that IR, when compliant with IIRC standards, provides a certified and verifiable signal to external stakeholders (e.g. investors). This could be a major limitation, in light of the mixed evidence obtained, and it allows critical thinking about policy and research implications.

6.3 Implications for research

The regression model is based on an equilibrium theory that in turn rests on the critical assumption that IR, when compliant with IIRC standards, provides credible, precise and truthful information related to IC. As long as this assumption can be considered valid, the framework also provides the necessary theoretical elements to support prior results. Nevertheless, this study has shown how the strategic nature of IR adoption and IC disclosure possibly introduces an endogeneity problem in empirical strategies. Consequently, prior results should be considered with some scepticism whenever OLS estimates are obtained without the proper treatment of self-selection.

Nevertheless, this work is not exempt from potential critics. As stated, one of the major limitations is the assumption of perfect verifiability of IR non-financial contents. However, it might be possible that despite the IIRC's effort, integrated reports often lack the required conciseness and completeness to provide an informative message to shareholders, as noted by Melloni *et al.* (2017). In particular, if the IR contents are not verifiable, truthful IC disclosure could become impossible whenever managers have the incentive to inflate the market value of their companies. A similar setting could be modelled as "cheap talk", as shown in Crawford and Sobel's (1982) seminal work. Thus, in light of this study's mixed evidence, future research should be more critical about the verifiability of IR contents. While this could require introducing further complexity in research methodologies, the results would benefit from a more general approach.

6.4 Implications for policy

Policy implications are slightly more difficult to establish at this point. Besides, this work has focussed more on the methodological aspects of connecting IR to IC disclosure, as well as the related empirical consequences. However, if this study had definite evidence supporting the claim about value-relevant IR, different supportive policies could be discussed. Examples could be introducing IR as a factor affecting managers' remuneration policies or tax benefits for increased non-financial disclosure.

Instead, if IR is far from being considered value-relevant, the path is long before "IR-friendly" policies can be discussed. First, regulators and policy makers should be concerned with the quality of the additional information disclosed through IR, and this result might be achieved by introducing specific auditing forms. While this could increase IR costs, investors would definitely benefit from a better non-financial disclosure, especially for what concerns IC. Second, where possible, IC contents should be stated according to common quantitative metrics, easing the tasks of both auditors and investors. In this way, investors could allocate capital systematically to companies with better growth perspectives or lower business risks, increasing the overall quality of their portfolios.

Notes

1. Nevertheless, there are also examples of involuntary disclosure (Dumay and Guthrie, 2017), although they are not the subject of the present work.
2. Holmstrom and Tirole (1997) adopted a similar approach to model a borrower's incentive to make her risky project successful.
3. Consumptions goods per share.
4. To this extent, it is worth noting that in $t = 2$, aggregate consumption will be equal to the real income generated by the corporate sector.
5. Technically, the interaction between managers and investors is modelled as a sequential game with imperfect information.
6. $\mathbb{I}(IR = 1)$ is an indicator function equal to 1 when companies adopt IR.
7. This is a general and modern definition of equilibrium in economics (Fernández-Villaverde *et al.*, 2008). Here, the relevant assumptions are optimising behaviour and rational expectations (consistent beliefs).
8. From a game-theoretical perspective, the equilibrium (solution) concept involved is perfect Bayesian equilibrium.
9. From a microeconometrics perspective, this is a linear mixed model with (partially) random coefficients. Hence, heteroscedasticity might be an issue.
10. For ease of reading, the words residual and error term are used interchangeably. However, this paper always refers to the non-systematic component of a linear model.
11. Fundamental data, stock market prices and exchange rates are also obtained from Factset.
12. Imagine two identical companies, differing only in the number of shares issued; if the model with an intercept is correct, the ratio between the two companies' intercepts must be equal to the ratio of the number of shares issued, contradicting the hypothesis about a common intercept.
13. This results from the general assumption that θ is independent of a firm's economic size.
14. This assumption is consistent with the studies of Heckman (1978) and Leuz and Verrecchia (2000), where a single source of error is present.

References

Abdolmohammadi, M.J. (2005), "Intellectual capital disclosure and market capitalization", *Journal of Intellectual Capital*, Vol. 6 No. 3, pp. 397-416.

Abeysekera, I. (2013), "A template for integrated reporting", *Journal of Intellectual Capital*, Vol. 14 No. 2, pp. 227-245.

Abhayawansa, S. (2013), "A review of guidelines and frameworks on external reporting of intellectual capital", *Journal of Intellectual Capital*, Vol. 15 No. 1, pp. 100-141.

Abhayawansa, S. and Guthrie, J. (2010), "Intellectual capital and the capital market: a review and synthesis", *Journal of Intellectual Capital*, Vol. 14 No. 3, pp. 196-226.

Alwert, K., Bornemann, M. and Will, M. (2009), "Does intellectual capital reporting matter to financial analysts?", *Journal of Intellectual Capital*, Vol. 10 No. 3, pp. 354-368.

Baboukardos, D. and Rimmel, G. (2016), "Value relevance of accounting information under an integrated reporting approach: a research note", *Journal of Accounting and Public Policy*, Vol. 35 No. 4, pp. 437-452.

Barth, M.E. and Clinch, G. (1998), "Revalued financial, tangible, and intangible assets: associations with share prices and non-market-based value estimates", *Journal of Accounting Research*, Vol. 36, pp. 199-233.

Barth, M.E., Cahan, S.F., Chen, L. and Venter, E.R. (2017), "The economic consequences associated with integrated report quality: capital market and real effects", *Accounting, Organizations and Society*, Vol. 62, pp. 43-64.

Beattie, V. and Smith, S.J. (2013), "Value creation and business models: refocusing the intellectual capital debate", *The British Accounting Review*, Vol. 45 No. 4, pp. 243-254.

Beattie, V. and Thomson, S.J. (2007), "Lifting the lid on the use of content analysis to investigate intellectual capital disclosures", *Accounting Forum*, Vol. 31 No. 2, pp. 129-163.

Bernardi, C. and Stark, A. (2018), "Environmental, social and governance disclosure, integrated reporting, and the accuracy of analyst forecasts", *The British Accounting Review*, Vol. 50 No. 1, pp. 16-31.

Bini, L., Dainelli, F. and Giunta, F. (2016), "Business model disclosure in the strategic report", *Journal of Intellectual Capital*, Vol. 17 No. 1, pp. 83-102.

Boekestein, B. (2006), "The relation between intellectual capital and intangible assets of pharmaceutical companies", *Journal of Intellectual Capital*, Vol. 7 No. 2, pp. 241-252.

Botosan, C.A. (1997), "Disclosure level and the cost of equity capital", *Accounting Review*, Vol. 72 No. 3, pp. 323-349.

Boujelbene, M.A. and Affes, H. (2013), "The impact of intellectual capital disclosure on cost of equity capital: a case of French firms", *Journal of Economics, Finance and Administrative Science*, Vol. 18 No. 34, pp. 45-53.

Bozzolan, S., Favotto, F. and Ricceri, F. (2003), "Italian annual intellectual capital disclosure: an empirical analysis", *Journal of Intellectual Capital*, Vol. 4 No. 4, pp. 543-558.

Brennan, N. and Connel, B. (2001), "Intellectual capital: current issues and policy implications", *Journal of Intellectual Capital*, Vol. 1 No. 3, pp. 206-240.

Breton, G. and Taffler, R.J. (2001), "Accounting information and analyst stock recommendation decision: a content analysis approach", *Accounting and Business Research*, Vol. 31 No. 2, pp. 91-101.

Brown, S., Lo, K. and Lys, T. (1999), "Use of R2 in accounting research: measuring changes in value relevance over the last four decades", *Journal of Accounting and Economics*, Vol. 20 No. 2, pp. 83-115.

Bukh, P.N. (2003), "The relevance of intellectual capital disclosure: a paradox?", *Accounting, Auditing & Accountability Journal*, Vol. 16 No. 1, pp. 49-56.

Camodeca, R. and Almici, A. (2017a), "Implementing integrated reporting: case studies from the Italian listed companies", *Accounting and Finance Research*, Vol. 6 No. 2, pp. 121-135.

Camodeca, R. and Almici, A. (2017b), "From the corporate social responsibility reporting to the integrated reporting: the case of Sabaf S.p.a.", *Problems and Perspectives in Management*, Vol. 15 No. 1, pp. 150-157.

Chen, C.M., Cheng, S.J. and Hwang, Y. (2005), "An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance", *Journal of Intellectual Capital*, Vol. 6 No. 2, pp. 159-176.

Collins, D.W., Maydew, E.L. and Weiss, I.S. (1997), "Changes in the value-relevance of earnings and book values over the past forty years", *Journal of Accounting and Economics*, Vol. 24 No. 1, pp. 39-67.

Crawford, V.P. and Sobel, J. (1982), "Strategic information transmission", *Econometrica*, Vol. 50 No. 6, pp. 1431-1451.

Cuganesan, S. and Dumay, J.H. (2009), "Reflecting on the production of intellectual capital visualisations", *Accounting, Auditing & Accountability Journal*, Vol. 22 No. 8, pp. 1161-1186.

Cumby, J. and Conrod, J. (2001), "Non-financial performance measures in the Canadian biotechnology industry", *Journal of Intellectual Capital*, Vol. 2 No. 2, pp. 261-272.

Davidson, R. and MacKinnon, J.G. (1993), *Estimation and Inference in Econometrics*, Oxford University Press, New York, NY.

Dumay, J. (2012), "Grand theories as barriers to using IC concepts", *Journal of Intellectual Capital*, Vol. 13 No. 1, pp. 4-15.

Dumay, J. (2016), "A critical reflection on the future of intellectual capital: from reporting to disclosure", *Journal of Intellectual Capital*, Vol. 17 No. 1, pp. 168-184.

Dumay, J. and Guthrie, J. (2017), "Involuntary disclosure of intellectual capital: is it relevant?", *Journal of Intellectual Capital*, Vol. 18 No. 1, pp. 29-44.

Dumay, J. and Tull, J. (2007), "Intellectual capital disclosure and price sensitive Australian stock exchange announcements", *Journal of Intellectual Capital*, Vol. 8 No. 2, pp. 236-255.

Dye, R.A. (1985), "Disclosure of nonproprietary information", *Journal of Accounting Research*, Vol. 23 No. 1, pp. 123-145.

Eccles, R. and Krzus, M. (2010), *One Report – Integrated Reporting for a Sustainable Strategy*, Wiley & Sons, New York, NY.

Eccles, R. and Krzus, M. (2014), *Integrated Reporting Movement. Meaning, Momentum, Motives and Materiality*, Wiley, New York, NY.

Eccles, R., Beiting, C. and Saltzman, D. (2010), *The Landscape of Integrated Reporting*, Harvard Business School, Boston, MA.

Eccles, R.G., Herz, R.H., Keegan, E.M. and Phillips, D.M. (2001), *The Value Reporting Revolution: Moving Beyond the Earnings Game*, John Willey & Sons, New York, NY.

Edvisson, L. and Malone, M.S. (1997), *Intellectual Capital*, Harper Business, New York, NY.

Ellis, H. and Seng, D. (2015), "The value relevance of voluntary intellectual capital disclosure: New Zealand evidence", *Corporate Ownership and Control*, Vol. 13 No. 1, pp. 1071-1087.

Fernández-Villaverde, J., Guerrón-Quintana, P. and Rubio-Ramírez, J. (2008), "The new macroeconometrics: a Bayesian approach", in O'Hagan, A. and West, M. (Eds), *Handbook of Applied Bayesian Analysis*, Oxford University Press, New York, NY, pp. 366-396.

Francis, J. and Shipper, K. (1999), "Have financial statements lost their relevance?", *Journal of Accounting Research*, Vol. 37 No. 2, pp. 319-352.

Gamerschlag, R. (2013), "Value relevance of human capital information", *Journal of Intellectual Capital*, Vol. 14 No. 2, pp. 325-345.

Garanina, T. and Dumay, J. (2017), "Forward-looking intellectual capital disclosure in IPOs", *Journal of Intellectual Capital*, Vol. 18 No. 1, pp. 128-148.

Ghosh, S. and Mondal, A. (2009), "Indian software and pharmaceutical sector IC and financial performance", *Journal of Intellectual Capital*, Vol. 10 No. 3, pp. 369-388.

Ghosh, S. and Wu, A. (2007), "Intellectual capital and capital markets: additional evidence", *Journal of Intellectual Capital*, Vol. 8 No. 2, pp. 216-235.

Givoly, D., Hayn, C. and Katz, S.P. (2016), "The changing relevance of accounting information to debt holders over time", *Review of Accounting Studies*, Vol. 22 No. 1, pp. 64-108.

Hansson, B. (1997), "Personnel investments and abnormal return: knowledge-based firms and human resource accounting", *Journal of Human Resource Costing and Accounting*, Vol. 2 No. 2, pp. 9-29.

Heckman, J. (1978), "Dummy endogenous variables in a simultaneous equation system", *Econometrica*, Vol. 46 No. 4, pp. 931-959.

Holland, J. and Johanson, U. (2003), "Value-relevant information on corporate intangibles – creation, use, and barriers in capital markets – between a rock and a hard place", *Journal of Intellectual Capital*, Vol. 4 No. 4, pp. 465-486.

Holmstrom, B. and Tirole, J. (1997), "Financial intermediation, loanable funds, and the real sector", *The Quarterly Journal of Economics*, Vol. 112 No. 3, pp. 663-691.

Kamath, G.B. (2008), "Intellectual capital and corporate performance in Indian pharmaceutical industry", *Journal of Intellectual Capital*, Vol. 9 No. 4, pp. 684-704.

Kim, D.-Y. and Kumar, V. (2009), "A framework for prioritization of intellectual capital indicators in R&D", *Journal of Intellectual Capital*, Vol. 10 No. 2, pp. 277-293.

Lee, K.W. and Yeo, G.H.H. (2016), "The association between integrated reporting and firm valuation", *Review of Quantitative Finance and Accounting*, Vol. 47 No. 4, pp. 1221-1250.

Leuz, C. and Verrecchia, R. (2000), "The economic consequences of increased disclosure", *Journal of Accounting Research*, Vol. 38, Supplement, pp. 91-124.

Lev, B. and Zarowin, P. (1999), "The boundaries of financial reporting and how to extend them", *Journal of Accounting Research*, Vol. 37 No. 2, pp. 353-385.

Li, J., Pike, R. and Haniffa, R. (2008), "Intellectual capital disclosure and corporate governance structure in UK firms", *Accounting and Business Research*, Vol. 38 No. 2, pp. 137-159.

Melloni, G. (2015), "Intellectual capital disclosure in integrated reporting: an impression management analysis", *Journal of Intellectual Capital*, Vol. 16 No. 3, pp. 661-680.

Melloni, G., Caglio, A. and Perego, P. (2017), "Saying more with less? Disclosure conciseness, completeness and balance in integrated reports", *Journal of Accounting and Public Policy*, Vol. 36 No. 3, pp. 220-238.

Nielsen, C., Roslender, R. and Shaper, S. (2017), "Explaining the demise of the intellectual capital statement in Denmark", *Accounting, Auditing & Accountability Journal*, Vol. 30 No. 1, pp. 38-64.

Orens, R., Aerts, W. and Lybaert, N. (2009), "Intellectual capital disclosure, cost of finance and firm value", *Management Decision*, Vol. 47 No. 10, pp. 1536-1554.

Previs, G.J., Bricker, R.J., Robinson, T.R. and Young, S.J. (1994), "A content analysis of sell-side financial analysts company reports", *Accounting Horizons*, Vol. 8 No. 2, pp. 55-70.

Stocken, P. (2013), "Strategic accounting disclosure", *Foundations and Trends® in Accounting*, Vol. 7 No. 4, pp. 197-291.

Swartz, G.E., Swartz, N.P. and Firer, S. (2006), "An empirical examination of the value relevance of intellectual capital using the Ohlson (1995) valuation model", *Meditari Accountancy Research*, Vol. 14 No. 2, pp. 67-81.

Vafaei, A., Taylor, D. and Ahmed, K. (2011), "The value relevance of intellectual capital disclosures", *Journal of Intellectual Capital*, Vol. 12 No. 3, pp. 407-429.

Van der Meer-Kooistra, J. and Zijlstra, S.M. (2001), "Reporting on intellectual capital", *Accounting, Auditing & Accountability Journal*, Vol. 14 No. 4, pp. 456-476.

Verrecchia, R.E. (1983), "Discretionary disclosure", *Journal of Accounting and Economics*, Vol. 5, pp. 179-194.

Wallman, S.M. (1995), "The future of accounting and disclosure in an evolving world: the need for dramatic change", *Accounting Horizons*, Vol. 9 No. 3, pp. 81-91.

Yongvanich, K. and Guthrie, J. (2005), "Extended performance reporting: an examination of the Australian mining industry", *Accounting Forum*, Vol. 29 No. 1, pp. 103-119.

Zambon, S. and Marzo, G. (2007), *Visualising Intangibles: Measuring and Reporting in the Knowledge Economy*, Ashgate, Farnham.

Zhou, S., Simnett, R. and Green, W. (2017), "Does integrated reporting matter to the capital market?", *Abacus*, Vol. 53 No. 1, pp. 94-132.

Zucker, L.G., Darby, M.R. and Brewer, M.B. (1994), "Intellectual capital and the birth of US biotechnology enterprise", Working Paper Series No. 4653, National Bureau of Economic Research, Cambridge, MA.

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