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Real effects of financial reporting and disclosure on innovation

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This paper reviews the literature on the real effects of financial reporting and disclosure on corporate innovation, highlighting both the possible channels of influence and the potential challenges that researchers face when attributing causal effects. We discuss the concept of innovation, emphasising the specific characteristics that make investments in innovation difficult to report. We then provide a review of the nascent work relating disclosure to innovation, which we organise around three channels: financing, compensation and learning. Finally, we discuss recent efforts aimed at increasing the quality of corporate disclosures, including disclosures of firms' innovative activities. Throughout the paper, we highlight the trade-offs of disclosure (reduced information asymmetry and increased proprietary costs), which are particularly exacerbated in the context of corporate innovation.

Keywords: Financial reporting; disclosure; innovation; real effects

1. Introduction

Technological innovation plays a pivotal role in a country's economic growth and development (Schumpeter 1911, 1934, Solow 1957, Romer 1986). According to a report by the OECD (2015), innovation can account for a substantial share of economic growth, often around 50% of total GDP growth, depending on the country's level of economic development and the phase of the economic cycle.¹ This growth stems from interrelated factors such as: (i) investments in knowledge based assets (e.g. software, databases, research and development, firm-specific skills and organisational capital); (ii) technological progress embodied in physical capital (e.g. through investment in information and communications technology); (iii) increased efficiency in the use of labour and capital (driven by, for example, process and organisational innovations) and (iv) the creative destruction that results from new innovative firms entering the market and displacing firms with low productivity (Schumpeter 1943).

At the corporation level, innovation is a main driver of firm value and, ultimately firm survival. Innovation often results in a long-term competitive advantage (Porter 1992), which possibly

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¹<http://www.oecd.org/sti/OECD-Innovation-Strategy-2015-CMIN2015-7.pdf>

explains why many firms invest as much in knowledge-based assets that drive innovation as in physical capital (OECD 2015).

Given the importance of innovation for economic growth and firm performance, academics, especially over the two last decades, have started to study the country-, market- and firm-level determinants of corporate innovation.² One potential determinant that remains largely unexplored, however, is the extent to which the provision of information to external parties (via voluntary corporate disclosures or mandated financial reporting) hinders or boosts a firm's innovative activities and, by aggregation, the 'innovative stock' of a country.

Within an agency framework, (mandated or voluntary) corporate disclosures may boost innovation by reducing information asymmetry between the firm/management and the providers of capital, thereby mitigating the severe adverse selection and moral hazard problems inherent in the uncertain, long-horizon investments that innovative activities often entail. This reduction in information asymmetry may, however, lead to managerial myopia and hinder investments. Even in the absence of agency problems, disclosure may affect innovation through the revelation of know-how. Such revelation may lead to (positive) spillover effects that could encourage further innovation by other firms or deter innovation if the proprietary cost of (mandated) disclosure offsets the benefits. Thus, the ultimate effect of disclosure on firms' innovative activities and the 'innovative stock' of a country is unclear.

Academic research on this topic is scarce, perhaps due to the difficulty in measuring innovation and the challenges in attributing changes in innovation to changes in disclosure practices and/or regulation. As such, much of the accounting literature has focused on how R&D expenditures map into firm valuation and on the incremental informativeness of R&D disclosures, without exploring the *real effects* of such disclosures. However, as pointed out by Kanodia and Sapra (2016, p. 624): 'The presence of real effects has far-reaching implications for standard setting and for future accounting research. If how accountants measure and disclose a firm's economic transactions changes those transactions, then it is not necessarily true that any disclosure that is incrementally informative to the capital markets improves resource allocation.' We extend this statement by emphasising the allocation of resources to factors that drive innovation.

Given the limited empirical evidence on the real effects of financial reporting and disclosure on innovation, the aim of our paper is twofold: (i) to provide a general framework for thinking about issues related to (mandated and voluntary) disclosure and innovation; and (ii) to highlight how academic research has contributed, and can continue to contribute, to the debate.

We start the paper by providing a definition of innovation and highlighting the specific characteristics that make investments in innovation difficult to report. Understanding the characteristics of innovative activities is important for understanding why financial reporting may impact innovation.

Next, we discuss the role of financial reporting and disclosure in boosting (or hampering) innovation by reviewing the relevant academic literature in accounting, finance and economics. We start by emphasising the challenges that we face as academics in drawing inferences from our studies and acknowledging the limitations of our research. Among the challenges, we highlight model specification issues, measurement problems and endogeneity concerns. After this caveat, we provide a non-exhaustive review of the nascent, mostly empirical, work relating disclosure to innovation. To do so, we adapt the framework proposed by Roychowdhury et al. (2019) linking financial reporting to investments to the setting of innovation.³ Within this framework, financial reporting can impact innovation in two ways: (i) by reducing information asymmetry between the manager and the

²For a comprehensive review of recent research on the determinants of country-, market- and firm-level innovation, see He and Tian (2018). Our paper complements their review by focusing on disclosure issues.

³The literature linking financial reporting to investments in general is extensive. For excellent reviews, see Roychowdhury et al. (2019) and the paper by Shakespeare (2020) in this issue.

providers of capital, which can facilitate financing or can exacerbate managerial myopia; and (ii) by revealing proprietary know-how, which can result in spillover effects and/or proprietary costs. Several conclusions emerge from this literature. First, while increased disclosure and better financial reporting can foster innovation in external financing-dependent industries, the dissemination of proprietary knowledge curtails innovation among private firms due to lower expected (quasi)rents from innovation. The ownership structure of innovative firms and their form of financing is indeed consistent with firms balancing their external financing needs with proprietary costs. Second, spillover effects resulting from the dissemination of knowledge do not seem to fully compensate for the loss of innovative activities among private firms. Third, the use of accounting numbers in compensation contracts can induce managerial myopia, leading firms to forego ex-ante positive, albeit risky, innovative activities. Hence, if the aim is to boost exploration and innovation, incentive schemes should encourage risk-taking behaviour by allowing for early failure and rewarding managers for long term success. Fourth, disclosure seems to affect the way in which companies protect their intellectual property (i.e. through patenting or trade secrets).

Finally, we conclude the paper by briefly discussing the current reporting regime of innovative activities and highlighting some possible avenues for reporting those activities in the future.

The remainder of this paper proceeds as follows. In section 2, we define the notion of innovation and describe its main features. In Section 3, we discuss how academic research can inform the debate on the role of financial reporting and disclosure on innovation and highlight the limitations of academic research. In Section 4, we review the literature on the real effects of financial reporting and disclosure on innovation. The paper concludes in Section 5 with a comment on the current reporting options that firms have when it comes to conveying their innovative activities to external parties and with a discussion of how the future of reporting may (or may not) unfold.

2. Innovation: definition and distinguishing features

2.1. Definition

Innovation is an elusive and broad concept, encompassing a wide range of activities and outcomes. A widely accepted definition of innovation is provided in the Oslo Manual (2018, p. 20) published by the OECD and the EU:⁴

‘An innovation is a new or improved product or process (or a combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)’.⁵

The Oslo Manual modifies this generic definition for the business sector. It states that a *business innovation* consists of a new or improved *product* that has been introduced to the market or a *business process* that has been brought into use by the firm.⁶ Product includes both goods and services, while business process includes the core activities of the firm (production and sale of products) and functions supporting the firm’s operations (e.g. marketing,

⁴The Oslo Manual provides guidelines for conceptualising and measuring innovation, with the aim of facilitating international comparability and providing a platform for research on innovation measurement. It was first published in 1992 to reflect the agreement reached by a global community of practitioners of the OECD Working Party of National Parties of Science and Technology Indicators in Oslo and was also endorsed by the European Union. The 4th and latest edition was published in 2018.

⁵The term ‘unit’ is used to describe the actor responsible for the innovation, which includes businesses, organisations, households etc.

⁶While the 2005 the Oslo Manual (3rd edition) contemplated four different types of business innovations (product, process, organisational and marketing), the revised 2018 manual proposes only two types of business innovations: product and business process.

information and communication technology services to the firm, administrative and management functions, engineering and technical services to the firm).

While the above definition emphasises the outcome of an innovative process/activity, the Oslo Manual acknowledges that innovation can also refer to the process/activity itself and includes as innovative activities ‘*all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm*’ (2018, p. 20).

The broad nature of these definitions highlights the challenge faced by practitioners (including accountants) and academics when it comes to the conceptualisation of innovation. In other words, what constitutes an innovative activity or outcome? What are the distinguishing features of innovation? How do investments in innovation differ from other types of investments? Why should financial reporting have a distinct effect on innovation?

2.2. Distinguishing features of innovation

Innovation derives from knowledge-based activities and involves novel products, technologies, etc., whose potential use determines the value of the innovation. As such, it consists of four dimensions: knowledge, novelty, implementation, and value creation (Smith 2006; OECD/Eurostat 2018). Collectively, these four attributes make investments in innovation distinct from other investments (such as investments in physical capital or human capital, which often do not involve a factor of novelty) or inventions (which do not necessarily involve a practical implementation).

Unlike routine tasks that follow existing technologies, innovative activities are rarely linear, sequential processes; rather they often involve many interactions and feedback in knowledge creation and use (e.g. Kline and Rosenberg 1986, Lundvall 1992, Nelson 1992), and require patience and a willingness to experiment with new unexplored methods (Holmstrom 1989). Ultimately, the goal of such activities is to create value, as is the case for any investment, but this value is usually much more uncertain *ex-ante*. Also, the ability to realise value from innovative activities can be easily curtailed by the revelation of proprietary information. As a result, firms protect proprietary information and, hence, their rents, through secrecy or by legal means, such as patenting. In sum, innovative activities are commonly idiosyncratic, highly uncertain and long processes, whose potential payoffs materialise only at later stages, once the innovative outcomes are implemented.

These characteristics are likely to influence the way in which financial reporting affects innovation. For example, given the uncertain, delayed payoffs that innovative activities often entail, a reporting system that emphasises past and current performance may hinder innovation, unless it is accompanied by an incentive scheme that exhibits tolerance for early failure and rewards managers for long term success (Manso 2011, Ederer and Manso 2013, Baranchuk et al. 2014), encourages risk-taking behaviour (Mao and Zhang 2018) and rewards team and group performance for internalising informational spillovers (Ederer 2016). Likewise, a reporting system that results in opaque disclosures may lead to undervaluation and discourage financing, which may, in turn, impede innovation. Alternatively, such a system may be welcomed by firms given the proprietary costs of know-how, thereby fostering innovation.

While these predictions are also valid for traditional investments, they are likely to be more relevant in the case of innovative activities, given the characteristics described above. However, whether this is indeed the case is ultimately an empirical question. In the next two sections, we discuss what we know (and what we do not know) from academic research so far.

3. How can academic research contribute? Challenges and limitations

Notwithstanding the importance of descriptive evidence, the main way in which academics can contribute to the *real effects literature* is by providing *rigorous evidence on the causal relation*

between financial reporting and the variable of interest, in this case innovation. However, as discussed below, the study of the economic consequences of disclosure is challenging due to model specification issues, measurement problems and endogeneity concerns (Leuz and Wysocki 2016, Roychowdhury et al. 2019).

3.1. Model specification: channels through which financial reporting may impact innovation

In order to determine if disclosure encourages or discourages innovation, it is pivotal to understand the channels through which this effect may take place. Disentangling these channels is not easy, however; it requires careful thought. Breuer et al. (2019) is a good example of this: by exploiting EU regulation that mandates all limited liability firms, including private ones, to disclose their financial statements, they are able to focus on the proprietary costs of financial reporting while offsetting the capital-market effects.

As suggested by Roychowdhury et al. (2019), the effect of financial reporting and disclosure on corporate investment can be analysed under two different frameworks: (i) within an *agency framework* that results from *information asymmetry between the management and outside investors and creditors*, and (ii) *within a learning framework* that results from *information uncertainty*. We adapt their framework to innovative investments and highlight the proprietary costs and spillover effects that result from a reduction in *information asymmetry between the innovative firm and other firms* (see Figure 1).

Within the agency framework, financial reporting can affect innovation by reducing information asymmetry between managers and the providers of capital, thereby mitigating adverse selection and moral hazard problems. The literature has identified two main channels linking financial reporting and investments/innovation: the financing and compensation channels. First, more transparent disclosures can lower adverse selection costs and, consequently, the cost of raising external capital to finance (innovative) investments (e.g. Diamond and Verrecchia 1991, Botosan 1997, Healy et al. 1999, Leuz and Verrecchia 2000). Second, more transparent disclosures can reduce moral hazard problems by facilitating the monitoring of managers' investment decisions via the use of accounting numbers in compensation contracts. However, the use of accounting numbers can exacerbate managers' motivation to achieve financial reporting benchmarks (Stein 1989, Graham et al. 2005), which can in turn decrease corporate innovation.

Within the learning channel, financial reporting may affect innovation even in the absence of agency frictions through its impact on learning about firms' innovative activities. Such learning

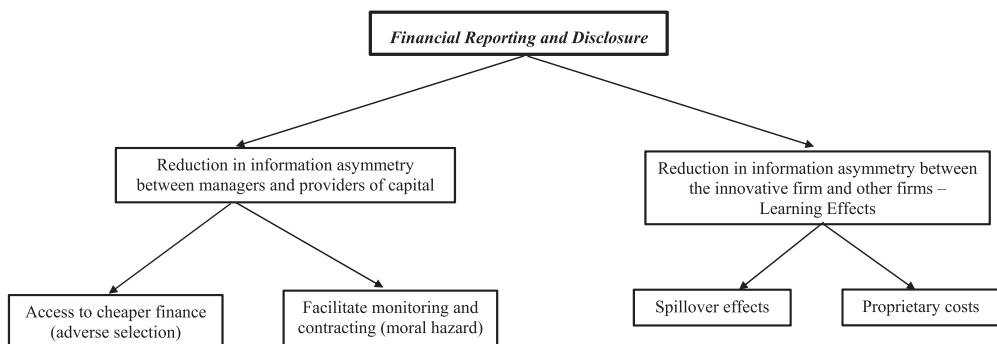


Figure 1. Channels through which disclosure may affect innovation.

can lead to spillovers effects via, for example, follow-on exploration of ideas, which increase aggregate innovation. However, by disseminating proprietary knowledge, financial reporting may reduce firms' ex-ante incentives to engage in innovation since (mandatory) disclosure increases the likelihood that some of the rents from innovation get redistributed ex-post among peers, suppliers and customers (Breuer et al. 2019).

The importance of each channel is likely to depend on the type of firm – for some firms the proprietary costs may be so high that they may prefer to remain private (assuming that the reporting requirements are lower for such firms). For other firms, the lack of internal financing may be the binding constraint and, as such, they may prefer to provide enhanced disclosures to ensure access to cheaper finance.⁷ These differences suggest that cross-sectional analyses may help in disentangling the different channels.

3.2. Measurement of innovation

Once we have identified the potential channels through which disclosure may impact innovation, the next challenge is to measure disclosure and innovation. This is not an easy task, which partly explains why researchers struggle with the (econometric) identification of the real effects of disclosure (Leuz and Wysocki 2016). In this section we focus on the measurement of innovation but we note that measuring disclosure itself is also difficult. There are many metrics aimed at capturing disclosure quality (and quantity), ranging from specific measures (e.g. accrual quality or a specific disclosure) to broader measures (e.g. a firm's overall disclosure policy based on aggregate indices). Both types of measures have advantages and disadvantages. Specific measures are usually easier to construct and enable consistency. However, they fail to provide a complete picture of a firm's disclosure quality because other disclosure activities can serve as substitutes or complements. Broader measures do not suffer from this problem but they usually capture the quantity of disclosure rather than the quality (since they are generally computed by aggregating binary indicators showing whether firms provide certain types of information or not). For a comprehensive discussion on the challenges associated with the measurement of disclosure and financial reporting quality, we refer the reader to Leuz and Wysocki (2016).

Turning to the measurement of innovation, the challenge derives from the multidimensional nature of innovation and the difficulty in quantifying most of these dimensions. The first challenge is to determine what we want to measure: is the focus on innovative activities or on innovative outcomes? As pointed out in Section 2, these are two interrelated but different aspects of innovation, which roughly translate into inputs and outputs. Furthermore, these two aspects of innovation are multidimensional.⁸ Thus, an encompassing metric for innovation is hard (or impossible) to come by. The second challenge is the measurement itself. Most innovative activities and outcomes cannot be reliably quantified due to their intangible nature, the lack of verifiable market prices and, more generally, their novelty, which makes their ex-ante payoffs uncertain.

As a result of these difficulties, practitioners, policy makers and academics have mostly relied on input measures of R&D expenditures, or output metrics based on patents. The reliance on these traditional metrics to examine the real effects of disclosure and, particularly of financial reporting, on innovation is problematic, however.

⁷We discuss the relation between innovation and firms' ownership structures and financing in Section 4.

⁸*Innovative activities* include, among others, R&D activities; intellectual property (IP) related activities; engineering, design and creative work; marketing activities, employee training; innovation in management activities etc. *Innovative outcomes* range from product (goods and services) innovations to business process innovation, which include innovations in the production, distribution and sale of goods and services; innovations in information and communication systems; and innovations in administration and management.

The first measure, R&D expenditures, is the most widely available proxy for innovation. However, using R&D expenditures is subject to endogeneity concerns. The interdependency derives from measuring the dependent variable of the causal relation (i.e. innovation) by using a feature of the explanatory variable (R&D expenditures as an outcome of the financial reporting environment of the firm). This endogeneity concern is further aggravated by the fact that a substantial number of firms that engage in innovative activities choose not to separately disclose R&D expenditures in their financial statements. Koh and Reeb (2015), for example, document that 10.5% of the firms with missing R&D expenditures in the Compustat file receive patents at a much higher rate (14 times higher) than firms that report zero R&D expenditures.⁹ Therefore, reported R&D expenditures do not capture the entire scope of innovative activities within the firm (Manso et al. 2017). Also, in many countries R&D expenditures are only publicly available for listed firms whereas much of the innovative activities occur in private firms (e.g. Rothwell 1978; Acs and Audretsch 1990; Vossen 1998; Schneider and Veugelers 2010).

Using patent-based measures to capture firms' innovative outcomes is not subject to the above endogeneity problem as patents are not an accounting-based measure. Patenting data allows researchers to estimate not only quantitative measures of innovation (e.g. number of patents granted, number of patent citations, etc.) but also assess the quality and attributes of the patents (generality, number of patent citations, originality, etc.) (He and Tian 2018). Furthermore, patents are available for both private and public firms. However, patent-based measures also have a number of limitations (e.g. Gittelman 2008). They, too, do not capture the entire extent of a company's innovative activities. Depending on the firm's innovative strategy, certain firms do not pursue the filing of patents but develop trade secrets instead (Koh and Reeb 2015), particularly in the case of process innovations (as opposed to product innovations, Lerner 2002). Managers' horizons, and investors' beliefs about those horizons, also affect firms' patenting decisions; managers patent more per dollar of R&D spending when their horizons are short because investors discount the value of non-patenting firms in such cases (Glaeser et al. 2019). Furthermore, as Lerner and Seru (2017) point out, the use of patenting data, if unadjusted for truncation issues related to time differences in the patent filing and patent granted dates, could introduce biases and, as a result, lead to erroneous conclusions.¹⁰

Recently, academic papers have started using alternative innovation proxies. For instance, Bellstam et al. (2017) compute a text-based innovation measure by analysing analyst reports and capturing the intensity with which analysts write about innovation. The advantage of this measure is that it is not influenced by firms' choices to disclose R&D expenditures or to file for patents. The obvious disadvantage, however, is that it can only be estimated for firms with analyst coverage and that it relies on analysts being knowledgeable of the firm's innovative activities. An alternative metric is proposed by Mukherjee et al. (2017) who focus on the stock price response to new product announcements. If markets are efficient, this metric should capture the value of the innovative product (assuming that no information is leaked prior to the announcement). Relatedly, Kogan et al. (2017) also measure innovation based on the market-perceived value of innovative outcomes, but instead of focusing on product announcements, they focus on abnormal returns around patent granting dates.

⁹The Compustat database, which is commonly used in accounting and finance research and is based on firms' financial statements, shows no R&D expenditures for 50% of firms. Of course, many of these firms do not actually engage in R&D activities, but at least 5% (10.5% of 50%) of them do, according to Koh and Reeb (2015).

¹⁰Researchers usually focus on patent filing dates while databases usually include patents once they have been granted. Thus, recently filed patents are often missing from the databases, which makes the most recent data incomplete.

At the aggregate level, researchers have turned to survey-based data from government and international organisations. For example, Brown and Martinsson (2019) use survey data from the OECD to construct a measure of country-level industry innovation, computed as the ratio of industry R&D investment to industry value added. They point out that an advantage of their measure, in the context of a cross-country study, is that it is not affected by cross-country differences in the propensity of firms to separately report R&D expenditures in their financial statements. Breuer et al. (2019) use industry-level information on innovation across Europe from Eurostat, which is based on aggregated responses to the Community Innovation Survey. Aggregated data allows them to measure spillover effects within industries.

Finally, the digitalisation of economic activities has brought new and complementary sources of data, such as data from electronic platforms (e.g. Kickstarter) where individual or organisations post proposals for innovative projects, media-analyses for product launches and collaborations, barcode data signalling product launches and recalls etc. (Oslo Manual 2018). Researchers have only recently started to explore these new sources of data (e.g. Cascino et al. 2019) but we believe that exploring new datasets may be a worthwhile exercise.

3.3. *Drawing inferences: correlation or causality?*

A final challenge that we face as researchers is being able to draw causal inferences given that a correlation between two variables may be due to omitted variables or reverse causality. Changes in firms' reporting practices are often driven by changes in the underlying economics of the firm, which can also affect innovation. In addition, changes in a firm's innovative activities may lead to changes in its disclosure practices.¹¹ As such, a correlation between disclosure and innovation is not necessarily indicative of a causal relation.

To address causality, ideally we would like to exploit a shock *exogenous* to the firm that changes financial reporting and impacts innovation solely through its effect on financial reporting. Examples of such shocks include the mandatory requirement to capitalise development expenditures after IFRS adoption if firms meet certain capitalisation criteria (e.g. Oswald et al. 2019), or the EU requirement that all limited liability firms publicly disclose their financial statements, including a management report discussing business risks, R&D activities and the firms' strategy (Breuer et al. 2019). From the perspective of an individual firm, mandatory regulatory changes are exogenous, which allows us to draw causal inferences by comparing the response of firms affected by the change (treated firms) and those not affected (control group) through a differences-in-differences estimation. An interesting extension is to examine the channels through which financial reporting may affect innovation, which can be done by, for example, conducting cross-sectional analyses of the impact.

However, as pointed out by Leuz and Wysocki (2016) and Gow et al. (2016) regulatory settings pose identification challenges themselves. Notably, (i) regulatory changes do not occur in a vacuum; rather they are imposed for economic and political reasons, which limits the generalisability of the findings (to other countries, periods and settings); (ii) these changes are often accompanied with other institutional changes, macroeconomics events etc., which makes it difficult to disentangle the impact of changes in financial reporting per se on innovation; and (iii) firms can sometimes (depending on the regulatory framework) avoid the regulation by for example

¹¹For example, there is evidence suggesting that innovative firms choose more opaque financial-reporting practices due to concerns about proprietary costs (e.g., Dambra et al. 2015, Barth et al. 2017, Chaplinsky et al. 2017).

going private, which is related with corporate innovation, or they can change their innovative activities in anticipation of the regulatory change.¹²

In sum, while academic research can be informative of the economic consequences of financial reporting on innovation, we need to carefully consider if the research design allows us to attribute causality. Furthermore, we need to exercise some caution when generalising the findings to other contexts (countries, regulatory regimes and periods) and to further disclosures.

4. Empirical evidence on the real effects of financial reporting on innovation

In this section, we provide a non-exhaustive review of the nascent academic literature exploring the effects of financial reporting and disclosure on innovation. Our discussion is organised following the framework discussed in 3.1 and focuses on the three most common channels: the financing channel, the compensation channel and the learning channel. However, before reviewing the literature that directly links financial reporting and disclosure to innovation, we comment on how a firm's ownership structure and form of financing can affect its innovative activities; and vice versa, how a firm's innovative activities can determine its ownership structure and form of financing. Discussing this relation is important because the demand for and supply of information, as well as firms' financial reporting requirements, depend on firms' ownership structures and form of financing. As such, the effect of financial reporting on innovation is related to the ownership structure of firms and the form of financing.

4.1. Ownership structure, financing form and firm innovation

One of the main determinants of firm innovation is ownership structure and the form of financing, which tend to evolve over a firm's life cycle.¹³

Young entrepreneurial firms often resort to angel and venture capital (VC) financing since they lack the track record and the collateral necessary to obtain debt and public equity financing. This form of financing eliminates the agency conflicts of disperse ownership while enabling the protection of confidential knowledge and business secrets. As such, firms have stronger incentives to engage in long-term, risky, innovative projects (Kortum and Lerner 2000). A related form of financing is through Corporate Venture Capital (CVC), which serves as a vehicle for established companies to explore innovative activities through subsidiaries. CVC-backed firms tend to be young and risky, and engage in very innovative activities (Chemmanur et al. 2014).

The optimal ownership structure changes as firms mature and seems to depend on whether the firm explores new ideas or exploits existing ones. Ferreira et al. (2014) illustrate this point by proposing a model in which private ownership is more suited to exploration, due to the higher tolerance for early failure in private firms, while public ownership is more suited to exploitation, due to the myopic behaviour of public firms that rewards early success. Private firms are less transparent than public firms and can pursue an early exit strategy when they receive bad news.¹⁴ This option is generally not available to public firms because their cash flows are observable and bad news get penalised by market. Gao

¹²See Leuz and Wysocki (2016) and Gow et al. (2016) for a detailed description of the identification challenges that regulatory settings pose for studies examining the economic consequences of disclosure regulation.

¹³See He and Tian (2018) for a more extensive description of the relation between ownership structure, financing and innovation.

¹⁴We note, however, that in the EU limited liability private firms have to disclose financial reports, just like public firms, although exceptions apply. Hence, the benefits of remaining private are likely to vary across countries.

et al. (2018) provide empirical evidence consistent with this idea. They find that private firms tend to explore new ideas while public firms tend to exploit existing ideas, which they attribute to the short investment horizon associated with public equity markets. Of course, an implicit assumption in these studies, and in other studies that we discuss later, is that the market is not fully efficient because it suffers from short-termism and applies an excessive discount rate to long term projects. More generally, the market fails to appreciate the long run value implications of corporate innovation. Whether this is indeed the case is in itself an empirical matter.¹⁵

The superior ability of private firms in generating high quality innovation (measured by patent citations) has been widely documented. Aggarwal and Hsu (2014) examine how entrepreneurial exit choices (via IPOs or acquisitions) affect patenting outcomes and find that innovation quality is higher under private ownership and lower under public ownership, with acquisition exits being in the middle. They credit their results to the proprietary cost of disclosure: going public entails a large amount of information disclosure and, hence, reduces the marginal benefit of conducting innovation. Bernstein (2015) also examines the impact of going public via an IPO on firm innovation. By comparing the innovation outcomes of firms that go public with the outcomes of a matched sample of firms that withdraw their IPO for exogenous reasons, he can draw causal inferences. He finds that the quality of innovation declines substantially after the IPO even if the number of patents does not. Bernstein (2015) attributes this finding to the severe agency conflicts (managerial career concerns in particular) that managers of public firms often face, which induces them to divert resources away from the most innovative activities. A similar conclusion is drawn by Lerner et al. (2011) using a sample of leveraged buyouts transactions.

Recent work has suggested that these results are dependent on firms' reliance on external financing. Acharya and Xu (2017), for example, show that public firms in external financing-dependent industries are as successful innovators as private firms. In internal financing-dependent industries, however, private firms seem to have the edge due to the short-termism imposed by the stock market on public firms.

Interestingly, the imposition of organisational structures mismatched to the pursuit of explorative innovation seems to have negative effects on innovation. Allen et al. (2018), for example, show that firms in their early life cycle experienced a reduction in both R&D spending and innovation outputs after the Sarbanes-Oxley Act (SOX) increased external monitoring and imposed more centralised decision-making. Furthermore, they find no evidence that innovation declines were offset by other ensuing benefits, such as improved financial reporting quality. These findings suggest that regulation can place a heavy net burden on some of the most innovative firms.

In sum, a firm's innovative activities and outcomes are determined by (and determine) the ownership structure of the firm and its form financing. Private firms seem to engage in more (exploratory) innovation than public firms due to lower agency conflicts, higher secrecy, more tolerance for early failure and less short-termism. This relation, however, depends on firms' external financing needs, suggesting that there is a trade-off between meeting those needs and the revelation of proprietary knowledge. The ownership structure of innovative firms and their form of financing is consistent with firms balancing these two factors and provides insights on the potential effects of disclosure on innovation.

¹⁵A series of papers (e.g., Lev and Sougiannis 1996, Lin and Wang 2016, Cohen et al. 2013, Hirshleifer et al. 2018) have shown that a firm's innovative activities can predict future returns. Whether this return predictability is due to risk (Berk et al. 2004, Eberhart et al. 2004, Hsu 2009) or mispricing (e.g. Bushee 1998, Hirshleifer et al. 2018) is unclear. The mispricing explanation implies either that investors pay limited attention to corporate innovation related information, or that firms provide inadequate disclosure of such information, which may ultimately lead to managerial myopia and underinvestment in innovation (see section 4.3).

4.2. Evidence on the Financing Channel

More transparent disclosures can foster innovation by reducing the information asymmetry between insiders/managers and the external providers of capital, increasing thereby the availability of external financing and reducing its cost. An implicit assumption is that the providers of capital understand the valuation implications of such disclosures, which contrasts with the market inefficiency assumption of some of the studies discussed in Sections 4.1 and 4.3 of this review.

The literature focusing exclusively on the causal relation between financial reporting quality and innovation via the financing channel is scarce, particularly at the aggregate level. A notable exception is Brown and Martinsson (2019), who show that better disclosure and transparency can facilitate higher levels of R&D investment, particularly in industry sectors with greater reliance on external financing.¹⁶ They argue that R&D investment is more information-sensitive and more dependent on external financing than other (fixed) capital investments. As a result, a country's information environment is likely an important determinant of its aggregate innovative stock. Their results suggest that the level of R&D investment is indeed higher in countries with richer information environments, even after controlling for institutional factors known to affect innovative investments (e.g. country legal origin and the level of development). To address causality, they use the initiation of insider trading enforcement as a quasi-experimental shock to the disclosure environment. They document substantial increases in R&D investment around the insider trading event, which allows them to conclude that the effect of financial reporting is indeed causal. Furthermore, difference-in-difference tests examining the differential effects of transparency conditional on an industry's reliance on external financing also allows them to infer causality.

Other studies have also documented the effect of financial reporting on innovative inputs (R&D expenditures) via the financing channel even if their focus is not on innovation per se. For example, Dou, Wong and Xin (2018) examine how the improvement of information provision on employee stock options brought about by SFAS 123R affected firms' investment efficiency. They show that the new rule led to a reduction in underinvestment, with the effect being more pronounced among financially constrained firms. Balakrishnan et al. (2014) use an exogenous change in a firm's financing capacity, proxied by the value of a firm's real estate assets, to examine (i) the relation between reporting quality and financing and investment, and (ii) the firm's reporting quality response to a change in financing capacity. They show that changes in firms' financing capacity affect the financing and investment activities of firms with higher reporting quality less than those of firms with lower reporting quality. In response to decreases in financing capacity, firms increase reporting quality.

We note, however, that even though higher transparency may boost innovation via the financing channel, imposing regulations seeking to improve corporate transparency may have unintended consequences that harm innovation. For example, in contrast to Dou et al. (2018), Mao and Zhang (2018) find that the introduction of SFAS 123R led to a decrease in managerial risk-taking incentives and innovation due to a reduction in the use of stock option compensation (Hayes et al. 2012), which is frequently employed in high technology and innovative firms. Thus,

¹⁶They capture disclosure quality using a variety of country-level variables: (i) Francis et al. (2009) measure, which accounts for financial disclosures, auditing activity, the enforcement of insider trading laws, and media development; (ii) the Center for International Financial Analysis and Research (CIFAR) measure of the comprehensiveness of corporate annual reports; (iii) the measure of disclosures related specifically to investments (including R&D), segments, and accounting methods; and (iv) the measure of earnings management. To capture R&D investments, they rely on data from the OECD STAN database, which is based national accounts and business surveys/censuses (maintained, among others by the OECD and Eurostat).

the final impact of disclosure on innovation is a fine balance between the financing channel, the compensation channel and the learning channel that we discuss next.

4.3. Evidence on the Compensation Channel

In the context of innovation, two common moral hazard problems are the so-called effort aversion and risk aversion.¹⁷ Effort aversion refers to managers' preference for a 'quiet life' (Bertrand and Mullainathan 2003) while risk-aversion refers to a lower-than-optimal (from shareholders' perspective) managerial preference for risk (e.g. Gormley and Matsa 2016). Financial reporting can mitigate these moral hazard problems by facilitating monitoring and contracting. For example, performance-based compensation contracts can improve investment efficiency by encouraging risk taking behaviour and longer horizons, aligning thereby managers' interest with those of shareholders.

However, linking accounting numbers to compensation (either directly via bonuses or indirectly through stock-based compensation) can also induce managerial myopia, particularly if the market is fixated on short-term earnings or on certain earnings benchmarks. In Stein's (1989) model of managerial myopia, managers forego ex-ante positive NPV projects in order to increase current earnings. According to survey evidence by Graham et al. (2005), this behaviour is condoned by CEOs, who state that they would pass up profitable investments in order to boost earnings. This type of managerial myopia is potentially more pronounced for hard-to-measure assets with delayed payoffs, such as innovation (Stein, 2003). Furthermore, managerial career concerns may also aggravate the suboptimal investment problem, inducing managers to divert resources away from the most innovative activities (Lerner et al. 2011, Bernstein 2015).

There is abundant empirical evidence consistent with investment-related managerial myopia in the presence of managerial incentives to report higher income (due to compensation contracts and/or managerial career concerns). For example, Bushee (1998) shows that when earnings before R&D and taxes fall short of the earnings in the previous period, the probability of firms making discretionary cuts to their R&D expenditures is unusually high. In a similar vein, Roychowdhury (2006) documents that firms with incentives to meet zero or positive earnings benchmarks use cuts in R&D expenditures, among other earnings management dials –such as reduction in SG&A, accelerated sales or overproduction–, to boost current reported income. Bens et al. (2002) find that R&D expenditures are unexpectedly lower in years when stock options are exercised while Edmans et al. (2016) show that firms in which managers have vesting equity are characterized by lower growth rates of R&D (and capital expenditures). Cohen and Zarowin (2010) provide evidence of managerial myopia through R&D cuts around seasoned equity offerings (SEOs).

Prior literature has also shown that the extent of investment-related managerial myopia increases when the relative cost of cutting R&D expenditures decreases. For example, Cohen et al. (2007) show that real earnings management, including discretionary R&D cuts, increased significantly after the passage of the Sarbanes-Oxley Act (SOX) because of higher cost of detection of accruals-based earnings management in the post-SOX period. Zang (2012) analyses the trade-off between accruals-based and real earnings management and concludes that decisions to engage in real earnings management precede decisions to engage in accruals-based earnings management.

¹⁷Managers' tendency to over-invest, i.e., the so-called empire building, is less pronounced in this setting, particularly in the case of younger, innovative firms.

Current R&D accounting rules are also likely to exacerbate investment-related managerial myopia. US GAAP and IFRS require the expensing of research-related expenditures while development-related expenditures are expensed under US GAAP and only capitalised under IFRS if certain criteria are met. As long as the R&D expenditures are growing, expensing results in greater R&D expense in the income statement than capitalisation (and amortisation). Therefore, growing firms may reduce their R&D expenditures in order to increase their income, thereby adversely affecting innovation in the economy. Consistent with this argument, Oswald et al. (2019) show that when UK firms that had chosen to expense their R&D expenditures before the adoption of IFRS switched to mandatory capitalisation, they increased their R&D expenditures more than firms that continued to capitalise. In a similar spirit, when SFAS 2 required a mandatory switch to R&D expensing for US firms in 1974, Horowitz and Kolodny (1980) found a significant decline in the R&D/Sales ratio of the affected firms.

More generally, attributes of the financial reporting system, such as conditional conservatism, seem to have a significant impact on managerial myopia and, hence, on innovative investments. By requiring the timely recognition of losses, conditional conservatism may induce managers to engage in 'real' earnings management when they are under the pressure to achieve short-term accounting goals. Chang et al. (2015) provide evidence showing that this is indeed the case: conditional conservatism leads managers to cut R&D expenditures and this adverse effect is more pronounced when CEO compensation strongly depends on the firm's accounting performance.

The frequency of financial reporting may also affect innovation. Using the transition of US firms from annual to semi-annual and quarterly reporting over the period 1950–1970 as an exogenous shock to firm reporting choices, Fu et al. (2019) show that higher reporting frequency leads to a significant decrease in innovative output, which they attribute to increases in short-term pressure on managers.¹⁸

Given the adverse impact that managerial short-termism can have on innovation, are there any factors that can curtail this myopic behaviour? The literature has explored among others: the design of optimal compensation contracts, the role of financial reporting transparency and the presence of active monitoring investors.

Manso (2011), among others, has examined the optimal incentive schemes that would stimulate innovation.¹⁹ He shows that such schemes should exhibit substantial tolerance for early failure and reward for long-term success. Specifically, he concludes that commitment to a long-term compensation plan, job security, and timely feedback on performance are essential to motivate innovation. In the context of managerial compensation, the optimal innovation-motivating incentive scheme can be achieved via a combination of stock options with long vesting periods, option repricing, golden parachutes, and managerial entrenchment.

Financial reporting transparency can also boost innovative effort by reducing managerial career concerns and facilitating monitoring (Zhong 2018).²⁰ The underlying mechanism is

¹⁸Prior literature has also documented a number of other, non-accounting related, factors that can exacerbate managerial short-termism and lead to lower innovation and less engagement in explorative innovative activities. These factors include the presence of transient and quasi-indexer institutional investors (Chang et al., 2015); higher presence of institutional investors who fail to monitor firm fundamentals (Fang et al. 2014); and increased risk of hostile takeovers (Fang et al. 2014).

¹⁹See also Ederer and Manso (2013). For empirical evidence on the features of innovation-inducing compensation contracts, see Baranchuk et al. (2014) and Mao and Zhang (2018).

²⁰Park (2018) also documents a positive association between financial reporting quality and future innovation, which is particularly strong for firms with intensive internal research and development activities and for firms in competitive industries. However, she does not explore the specific channel through which financial reporting boosts innovation.

transparency's implicit contracting role: it reduces the sensitivity of management turnover to poor innovative output. Zhong (2018) shows that transparency also increases innovative efficiency through its governance role, facilitating thereby the efficient allocation of R&D capital. Nonetheless, the benefit of transparency is fully offset in environments with greater proprietary cost, which explains why the most innovative firms are generally opaque (e.g. Lobo et al. 2018).

There are also external factors that can moderate managers' myopic behaviour. Aghion et al. (2013) document a positive relation between institutional ownership and innovation outputs, which they attribute to increased monitoring by institutional investors. The effect of the increased monitoring is twofold: it forces managers out of the 'quiet life' (Bertrand and Mullainathan, 2003) and reduces managers' reputational damage if the innovation fails. Luong et al. (2017) provide further evidence on the monitoring role of institutional investors but they focus on foreign investors. They show that foreign institutional ownership not only provides an active monitoring but also facilitates knowledge spillovers from high-innovation economies, leading to higher levels of innovation.

Overall, the effect of accounting-based compensation contracts on innovation seems adverse, unless they are structured in such a way that risk-taking is rewarded and effective monitoring is in place.

4.4. *Learning channel*

In this last section, we explore the so-called spillovers or learning effects, i.e. the benefits that other firms (usually competitors but also suppliers and customers) accrue from observing the disclosures of innovative firms. Given that the research focusing on financial reporting per se is scarce, we extend our review to other forms of disclosure, such as mandated patent disclosure.

As we have previously discussed, disclosure lowers the cost of capital and facilitates financing by reducing the information asymmetry between managers and investors. However, it also increases the costs associated with revealing proprietary information to competitors. The 'feedback effect equilibrium' model of Bhattacharya and Ritter (1983) illustrates this point. In their model, a firm is engaged in research and development and holds private information about the timing and likelihood of success of an innovation. The firm is motivated to communicate this information (for example to access cheaper financing) but can only do so through channels or signals that convey useful information to competing firms. The revelation of information to competitors reduces the value of the innovation and, consequently, the incentives to engage in innovative activities to start with.

Recent empirical work provides evidence consistent with Bhattacharya and Ritter's (1983) model. A number of studies examine the consequences of a change in mandated disclosure brought by the 1999 America Inventors' Act (AIPA). The AIPA patent application disclosure regulation significantly reduced the informational advantage of the firm/individual seeking to obtain a patent by mandating the disclosure of patent application materials before the USPTO (U.S. Patent and Trademark Office) grants the patent. Since this regulatory change was exogenous to the individual firms, we can draw causal inferences from the research exploiting this change. Using difference-in-differences analyses, Hussinger et al. (2018) find that the AIPA disclosure regulation reduces patenting activity among publicly listed firms. However, this effect is not driven by a reduction in R&D investments but rather by a switch from patenting to secrecy, which in turn affects the transparency of R&D intensive firms. Using a similar setting, Kim and Valentine (2019) show that the effect is asymmetric: while there is an increase in innovation for firms whose rivals reveal more information after the AIPA, there is a decrease in innovation for firms whose own disclosures are divulged to competitors. These results highlight the presence of both spillover benefits and proprietary costs. Kim and Valentine (2019) also find that, in order to

mitigate proprietary costs, firms respond by using strategic disclosure choices allowed by the patent law although such choices do not fully offset the disclosing firm's costs.

Further evidence on spillover effects is provided by Murray et al. (2016), who show that openness, by lowering costs to access existing research, can enhance both early and late stage innovation through greater exploration of novel research. Disclosures of innovative activities can also be found to improve innovation through increased price discovery, promotion of knowledge diffusion and reduction in the risk of duplicative R&D efforts (Hedge et al. 2018).

The benefits that competitor firms gain from observing the disclosures of innovative firms and becoming informed about peer forms' growth opportunities are referred to as 'learning effects' (Roychowdhury et al. 2019). It is not clear, however, whether these benefits offset the proprietary costs imposed on the disclosing innovative firms and what, on balance, the *aggregate* effect of innovation on the economy is.

Breuer et al. (2019) investigate these aggregate effects by exploiting EU regulation that mandates all limited liability firms, including private ones, to disclose their financial statements. They provide evidence that mandating disclosure of innovative activities (through public disclosure of financial statements) reduces firms' incentives to engage in innovative activities. Importantly, they find that this decline in innovative activity is not fully compensated by positive information spillovers (e.g. to competitors, suppliers, and customers) within industries. Furthermore, increased disclosure leads firms to shift to patenting (as opposed to trade secrets) as a way to protect their intellectual property, which suggests that focusing on patents alone can yield erroneous conclusions. Similarly, Fu et al. (2019) show that the reduction in innovative output as a result of increasing the frequency of financial reporting is not accompanied by a significant net externality effect on industry peers.

Relatedly, Dambra et al. (2015) show that after the JOBS (Jumpstart Our Business Start-ups) Act was passed in 2012 the number of IPOs increased by 25% annually relative to the pre-JOBS levels. The JOBS Act de-burdens small firms from certain accounting and disclosure requirements and allows them to disclose information exclusively to investors, but not competitors until the IPO is likely to succeed. They show that firms with high proprietary disclosure costs, such as biotechnology and pharmaceutical firms, increase IPO activity most.

In conclusion, while revealing innovation related information is clearly costly for the disclosing firm because it redistributes gains from proprietary information, whether this redistribution encourages or discourages aggregate innovation is still unclear.

5. Concluding Remarks: The Boundaries of Financial Reporting

Prior work has shown that while better financial reporting can lead to higher innovation in industries that rely on external financing, it may curtail innovation among private firms due to proprietary costs. In the latter case, spillover effects do not seem to fully compensate for the loss of innovative activities among private firms. In addition, the use of accounting numbers in compensation contracts can induce managerial myopia and reduce innovation. The ultimate effect of financial reporting depends on which of these channels prevails, which, in turn, depends on the type of firm, institutional setting and market characteristics.

An important aspect to consider is the way in which firms communicate their innovative activities. The continued growth in intangible investments has led to a decrease in the value relevance of traditional financial statements for investors' valuation decisions (e.g. Collins et al. 1997, Lev and Gu 2016, Lev 2018). Furthermore, some studies suggest that investors pay limited attention to corporate innovation-related information or that firms provide inadequate disclosures of such information (e.g. Bushee 1998, Hirshleifer et al. 2018). As such, a relevant question is:

How can firms communicate the value of their innovative activities in their financial reports and beyond?

When accounting data is less useful in assessing firm value, firms increase disclosures in response to investor demand for information (Grossman 1981, Dye 1985). One way in which managers have catered to investor demand against the backdrop of reduced financial statement relevance is through voluntary disclosures of non-GAAP performance measures. The practice of non-GAAP reporting has not only increased over time but also varies cross-sectionally with the degree of firms' financial statement usefulness. For example, Gu and Li (2003) show that firms in high-technology industries disclose non-GAAP measures of innovation when their current earnings are less informative and when their future earnings are more uncertain. They also document that for these firms non-GAAP disclosures are value relevant and predictive of the firm's future performance. However, prior literature has shown that, in the absence of explicit guidance on how to define non-GAAP measures and when to disclose them, a lot of variation in both managers' motives for disclosing such measures and the content of non-GAAP measures across companies emerges. While some managers report these adjusted numbers to reflect better core earnings, others may disclose them strategically, depending on the direction (positive/negative) of GAAP earnings surprises.²¹ Investors find non-GAAP measures to be most useful when the informativeness of GAAP earnings is low and when strategic considerations are absent. In addition, prior literature shows that non-GAAP measures are more value relevant when they are disclosed in a consistent and transparent way (Clinch et al. 2018).

The IASB has published an exposure draft proposing to improve the disclosure of non-GAAP measures. The proposed requirements would allow managers to continue to exercise flexibility in portraying aspects of their companies' performance that are not captured in the financial statements while improving the comparability of these measures across companies and over time (IASB 2019). While there are no specific constraints on the calculation of management performance measures (MPMs), companies that choose to disclose them will be required to provide a reconciliation in the notes between the MPMs and the most directly comparable IFRS measure of performance. For instance, if companies choose to report 'adjusted operating profit', in a separate reconciliation they will have to show the adjustment items that account for the difference with operating profit included in the income statement.²²

Even with the proposed amendments to the disclosure of MPMs, traditional financial reporting (i.e. financial statements and the notes to the financial statements) may still provide limited information on the company's business model, the environment it operates in, or the intangible assets and processes that underlie firms' innovative activities. In order to keep abreast with the wider financial information needs of investors, the IASB is currently working on a major revision of the Management Commentary Practice Statement, issued originally in 2010, as a non-mandatory guide for the narrative section of the annual report where companies can disclose forward-looking information about the business and its future prospects.²³ The current proposal is intended to encourage firms to disclose information on the company's business model with reference to its elements (inputs, processes and outputs), value creation, indirect wider consequences of the operation of the business model, etc.

Another avenue which innovative firms may embrace in order to convey more successfully the value of their business is integrated reporting. The International Integrated Reporting

²¹See Black et al. (2018) for a review of the literature on non-GAAP performance measures.

²²Operating profit is a required subtotal on the income statement in the proposed Exposure Draft on General Presentation and Disclosures.

²³<https://www.ifrs.org/projects/work-plan/management-commentary/>

Council (IIRC)'s Framework defines integrated reporting as periodic disclosure by companies of 'material information about an organisation's strategy, governance, performance and prospects in a way that reflects the commercial, social and environmental context within which it operates'.²⁴ Since the release of IIRC in 2013, an increasing number of companies have started issuing integrated reports, with currently over 1,750 participants in IR networks worldwide. A number of professional accounting bodies and standard setters in countries such as Japan, India, South Africa and the UK, have shown strong support for the idea of integrated reporting.

Integrated reporting may alleviate the incentive problem that some publicly listed innovative firms are face. Serafeim (2015) shows that firms that engage in integrated reporting respond to long term, dedicated investor demand for information. Given the early stages of integrated reporting adoption, it is difficult to assess its effectiveness, however. Integrated reporting can be used to inform but also to mislead. For instance, studying a sample of early integrated reporting adopters, Melloni et al. (2017) document that when companies' financial performance is weak, their integrated reports tend to be longer, less readable and more optimistic. However, the general conclusion from studies examining the relation between IR adoption, IR quality and market reactions so far is that integrated reporting has informational value.²⁵

Despite these avenues aimed at providing better disclosures and increasing the quality of financial reporting, it remains unclear whether highly innovative firms, especially the ones conducting exploratory innovative activities, will choose to reveal more information voluntarily. The evidence discussed in this review suggests that this may not be the case given the proprietary costs that such disclosures may entail.

We conclude this review by pointing that while we have discussed the effect of financial reporting on innovation, a fascinating topic is the study of the reverse relation: how does innovation impact financial reporting? We leave the answer to this question to future research.

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²⁴<https://integratedreporting.org>

²⁵For example, Baboukardos and Rimmel (2016), Bernardi and Stark (2018) and Barth et al. (2017) examine integrated reporting in South Africa, the first country to mandate integrated reporting. Baboukardos and Rimmel (2016) find evidence of an increase in the earnings response coefficient although they document a decrease in the value relevance of net assets. Bernardi and Stark (2018) document a positive association between environmental, social and governance disclosures and analyst forecast accuracy in the mandatory period. Barth et al. (2017) investigate the channels through which high quality integrated reports affect firm value and show evidence consistent with integrated reporting achieving the two goals identified by the IIRC of improved information for outside providers of financial capital and better internal decision making. The positive association between the disclosure of environmental, social and governance information and firm value has also been documented in a wider context of mandatory reporting in China, Denmark, Malaysia and China (Ioannou and Serafeim 2019) and in voluntary disclosure settings (Arguelles et al. 2015; Mervelskemper and Streit 2017). For a comprehensive review of the literature on integrated reporting, see Soderstrom and Potter (2014).

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