Financing Disruption

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Abstract

'Disruptive' innovations are powerful forces for reshaping activities and generating growth. Yet by definition, the properties (what they can do) and consequences (whether they disrupt) of innovations are not widely understood when they are first explored. This aggravates agency problems in financing innovative projects, increasing the cost of capital. Policymakers, keen to stimulate innovation, are exploring a number of ways of facilitating capital-raising by innovative firms. These range from modifications to securities laws to facilitate 'crowdfunding', through the toleration of entrenchment by founders of tech companies that go public, to outright subsidies for investment in innovative firms. We argue that to the extent the source of the problem lies in lack of understanding—a knowledge gap—it is desirable to raise finance from persons with comparative advantage at understanding the innovation in question. Whilst this obviously describes a stylised venture capitalist, we argue that it also helps explain financial contracts between innovative firms and capital markets (dual-class structures), consumers (crowdfunding), and employees (restricted stock). We develop this claim by reviewing contracting practices in relation to both nascent and established firms engaged in innovation, and use it to evaluate various policy initiatives.

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'Any sufficiently advanced technology is indistinguishable from magic'

Arthur C. Clarke.[1]

I. Introduction

Ten years ago, nobody had an iPhone. Who then would have been able to predict the technological capabilities of smartphones, and the extent of the impact they have had on so many industries, such as communications, media and computing? Today autonomous cars, which are just starting to be tested on public roads, are widely expected to disrupt automotive and transport industries, not to mention commuting.[2] And in the near future—perhaps sooner than we might imagine—direct neural communication technology may make current conceptions of 'connectedness' seem as clunky as semaphore.[3] Who now can predict the capabilities of the prototypes under development, and the extent of the impact they will have on industry, society and knowledge formation?

Disruptive innovations pitch novel technological capabilities into a market or social context in which those capabilities engineer a decisive change. The very novelty makes the capabilities, and potential consequences, of innovations hard to assess at the outset. This tends to make innovation an activity well-suited to individuals or firms that combine technical capabilities with an understanding of potential markets, and high levels of risk tolerance.

[1] Arthur C. Clarke, Hazards of Prophecy: The Failure of Imagination (1973).

[2] See eg, Burkhard Bilger, Auto Correct: Has the Self-Driving Car at Last Arrived?, The New Yorker, Nov 25, 2013; Sandor M. Veres, Autonomous Cars Start their Driving Lessons, The Guardian (UK), May 21, 2015.

[3] See eg Peter Watts, Hive Consciousness: Do We Really Want to Fuse our Minds Together?, Aeon, May 27, 2015 (http://aeon.co/magazine/psychology/do-we-really-want-to-fuse-our-minds-together/).

However, where outside finance is needed to fund innovative projects, the uncertainty over outcomes creates particularly intense contracting challenges.

Innovation generally proceeds as an experimental process involving a high degree of optionality: in a series of steps that can go through multiple iterations, capabilities are explored and tested, then a decision is made whether to continue or to pursue an alternative angle. Deciding how best to exercise these (real) options requires an understanding of their significance, and an interpretation of how they are affected by new information revealed during the testing process. Agents engaged in innovation are generally likely to have a better appreciation of their projects' technological capabilities than are outsiders. However, this creates agency costs when finance to fund the project is raised from outside investors. Investors asked to part with funds in return for a share in payoffs from an uncertain innovation that may take considerable time to materialise will discount or even forego the opportunity, because of the concern that agents will either have a bias in favour of continuation in the face of poor indicators, or more fundamentally will abuse discretion in order to further their own interests.

Much emphasis has been placed in the literature on financial contracting techniques calculated to reduce agency costs under such circumstances. For example, breaking the input of finance down into a series of staged rounds permits investors to make decisions about funding on the basis of realisations of interim outcomes. Similarly, compensating agents with stock in their firms aligns their interests with those of outside investors.

Unfortunately, if investors lack the understanding necessary to assess whether the agent has taken appropriate actions, techniques calculated to reduce the costs of self-serving

behaviour by agents may themselves introduce significant costs in the form of financiers' errors in decisions about the pursuit of innovative projects—poor *judgment*. If an outside investor in a start-up firm does not understand the firm's innovations, then giving that investor strong control rights may result in premature termination of projects. Similarly, if stock prices do not capture fully the value of an innovative public firm's projects, then tightly linking managers' compensation to stock price performance may distort managers' decision-making in favour of activities that are ultimately less valuable but have more impact on the stock price. On the other hand, giving unconstrained discretion to corporate agents, is not likely to be attractive to investors either. These combined problems of agent *discretion* and lack of investor *judgment* may be expected to raise innovative firms' cost of capital.

Innovative firms are disproportionately associated with job creation and economic growth.[4] Policymakers on both sides of the Atlantic, keen to foster the good things that innovation is said to bring, are concerned to reduce capital-raising costs for such firms. This, combined with the particularly intense contracting challenges over the financing of such firms, motivates a widespread perception that innovative firms are 'exceptional' and as such it is desirable to accord them special regulatory treatment in order to facilitate their activities.

For example, in the US, the JOBS (Jumpstart Our Business Start-ups) Act of 2012 was introduced with the goal of reducing the costs for innovative firms of accessing outside equity. In essence the JOBS Act seeks to do this by reducing the extent of registration and prospectus disclosure obligations for smaller firms. Similarly, the EU's recently-announced Capital Markets

[4] See eg Bronwyn H. Hall, Innovation and Productivity, NBER WPR 17178 (2011); Leonid Kogan, Dimitris Papanikolaou, Amit Seru and Noah Stoffman, Technological Innovation, Resource Allocation, and Growth, NBER WPR 17769 (2012).

Union proposals include measures aiming to reduce the fixed costs for small firms of complying with capital market prospectus requirements, and suggest the introduction of subsidies to encourage venture capital investment in start-ups. At the same time, listing authorities and stock exchanges have struggled with whether to permit innovative firms to go public with dual-class structures.

Each of these initiatives is liable to give greater discretion to entrepreneurs than they would otherwise enjoy. Lowering the costs of raising outside equity—as the JOBS Act and its EU equivalents would do, means a small firm may raise finance from dispersed investors rather than going to a venture capitalist who would demand control rights in the first instance. And permitting dual-class IPOs means entrepreneurs can ensure that their control is entrenched, meaning they need not concern themselves about short-term stock price movements. The problem is that whilst each mitigates the effect of poor investor judgment about technology by giving greater *discretion* to entrepreneurs, they thereby leave investors more exposed to self-serving actions by the latter.[5]

A way forward is to link finance not just to the supply of capital, but also to knowledge or information relevant to the project. This helps to ensure that controls designed to check agent misbehaviour do not themselves impede decision-making as regards the project. The more innovative the project, the greater the difficulty of making such judgments, and so the greater the potential benefits to linking capital provision with relevant information and expertise. This paper is concerned with ways in which financial contracts for firms pursuing

[5] To be sure, established entrepreneurs may develop a reputation for treating investors well, but this requires that they be able to raise finance in the first place.

innovation are structured so as to facilitate *judgment* about appropriate interpretation of project payoffs.

We develop a framework for considering the relationship between the structure of the investment contract and the judgment or 'wisdom' of the investor. A *wise* investor or class of investors has, or is able to generate, some relevant insight about whether a project is worth pursuing. It is sensible for a wise investor to constrain agents' *discretion*, and introduce optionality into funding. However, it is costly for such control rights to be granted to an investor who is not wise: this may result in distortion of the firm's investment policy. But investment by investors who are not 'wise' in this sense, under contracts that give agents discretion, will leave such investors exposed to agency costs. In short, measures that give agents more discretion only make sense where investors know what they are doing.

The paper's analysis proceeds as follows. Section II considers the base case of public equity market financing. Capital markets facilitate diversification and hence the lowering of risk-bearing costs. Whilst individual investors are typically ill-informed about firms' actual activities, the capital markets famously have the propensity to aggregate information about a firm's future prospects in the stock price. Where the stock price is used as a guide for firms' investment strategy—as is encouraged by executive compensation and shareholder activism—then the ability of analysts in the market to assess and understand innovative projects becomes crucial for success, because it will influence project selection.

However, there are good reasons for thinking that the 'wisdom of capital markets' may not be so useful as regards innovation. Understanding of new technology is by definition limited, and consequently market analysts will struggle to distinguish projects. This will result

either in higher costs of capital or controls that impede useful innovation. Consistently with this claim, a growing empirical literature suggests that tight linkages between managerial incentives and stock prices are associated with reductions in innovation by public firms.

Section III considers the archetypal financial contract between an entrepreneurial firm and a *wise* investor: a venture capitalist. Venture capitalists typically take significant control rights for the duration of their investment, and stage the provision of finance. This means that the entrepreneur must meet performance hurdles in early stages in order to obtain later financing. It also builds optionality into the financing, allowing for information to be revealed relevant to the value of the project at each stage and this to then be factored into the decision whether to invest further funding. However, for this contract to work, the VC must have a comparative advantage in understanding the innovation. If they do not, their exercise of control rights may impede the process of innovation. By definition, individuals who understand cutting-edge innovations will be in short supply. Consequently, there will be a finite number of VCs who have the relevant 'wisdom' in relation to any particular project. If the risk exists that the VCs do not commit further funds at a later stage, or they are not sufficiently proximate to the entrepreneur, then the latter will find the prospect of giving up control rights to a VC who does not understand their project to be unappealing.

The picture emerging from Sections II and III is one of imperfections in the supply of capital because of investors' lack of understanding of innovative projects. Tight accountability—either to a private investor or to a stock price—is counterproductive if this does not track the maximisation of value of underlying projects. This suggests a way of understanding the common complaint of innovative firms about financing constraints.

Section IV then turns to the raising of arm's length finance from dispersed investors through 'crowdfunding'. The 'wisdom of crowds' is thought by some to assist in selecting projects. If true, then this could provide a useful way to sidestep the limitations of markets and specialists. However, issuing equity to private investors generally does not seem a promising way to aggregate information. Indeed, the absence of a secondary market is likely to lead to herding, rather than useful information aggregation, in many cases. This is likely to result in *unwise* investment decisions and funds being used to pursue poor projects.

However, there are a subset of cases in which crowdfunding can be used to harness useful information, where the 'crowd' consists of people who know something about the technology in question. Most notable is the case of so-called 'reward' crowdfunding. Here the investors do not purchase equity, but front money in return for the firm's 'best efforts' commitment to supply them with its not-yet-completed product. Here the investors do know something relevant to the products' success: they know whether they want the product or not. The funding is made conditional on the firm being able to generate a sufficient level of investment to fund a product run. This introduces an element of optionality: the firm only proceeds with the project if there is sufficient demand to fund a run. But control rights remain in the hands of the entrepreneur, not the investors. 'Equity' crowdfunding is more problematic, because here investors are being asked to predict the behaviour of others, about which they may lack information. Yet, a number of mechanisms exist to make the crowds wiser, including limiting investment to individuals who have specialist expertise in the field, for example crowdfunding platforms for medical tech that are open only to qualified MDs. Devising mechanisms that will also allow non-expert investors to profit from equity crowdfunding

investments is a daunting task both for well-intentioned crowdfunding platforms and for policymakers.

Section V shifts the focus to innovative firms that do go public, but seek to preserve control rights for their founders through the use of dual-class stock. This can readily be rationalised in light of the foregoing, as a way of insulating those managing the firm from capital markets' tendency to undervalue innovation. At the same time, it exacerbates concerns about controller discretion. We argue that such firms co-opt the wisdom of another group who do understand the technology in question: their R&D employees. If such employees are paid in stock, then this bonds them to the firm's long-run financial performance. Common rationalisations of broad-based equity compensation schemes emphasize incentives: encouraging employees to act in accordance with the interests of shareholders. Yet such schemes are costly, as compared to cash compensation, because of the risk loaded onto employees, and the typical employee has little ability to influence the stock price in any event. Our analysis suggests an alternative explanation for this practice. The founder bonds himself not to abuse his discretion by committing to pay key employees returns that vary with those paid to outside stockholders. The employees, better than outsiders, are *wise* as to the way the firm is proceeding with its innovations, and as to whether the founder is or is not abusing their position. This commitment device is strongest where the equity compensation takes the form of restricted stock, rather than options, because the value of stock is more sensitive to downside, which would be realised by founder misappropriation. Consistently with this conjecture, we observe a higher ratio of restricted stock to options in broad based equity compensation at tech companies that have dual class capital structure than at those that do

not. This suggests that the NYSE was wise to permit dual-class IPOs, and that analysts could usefully focus on the structure of employee compensation at these firms.

Section VI concludes.

II. The Wisdom of Capital Markets

A. Why do Managers care about the stock price?

We begin by considering the pursuit of innovative projects by publicly-traded companies. In the absence of entrenchment mechanisms such as a staggered board or dual-class stock, CEOs of publicly-traded companies are exposed to strong incentives to maximise their firm's stock price.[6] First, CEO compensation packages link their payoffs to the performance of the stock using a combination of stock option grants and restricted stock awards.[7] Second, activist investors are likely to target a firm with a stock price they consider to be underperforming and use a combination of threats and proxy fights to influence the board to reorient corporate strategy towards unlocking more returns for shareholders.[8] Amongst other things, proxy fights have an adverse effect of the career prospects of targeted managers.[9] Third, and relatedly, a

[6] The extent of this pressure has increased considerably in recent years: see Marcel Kahan and Edward B. Rock, Embattled CEOs, 88 Tex L Rev 987 (2010).

[7] Kaplan, NBER WP 18395 (2012).

[8] Marcel Kahan and Edward B. Rock, Hedge Funds in Corporate Governance and Corporate Control, 155 U Pa L Rev 1021 (2007); Lucian Bebchuk, Alon Brav and Wei Jiang, The Long-Term Effects of Hedge Fund Activism, 115 Colum L Rev (2015).

[9] Vyacheslav Fos and Margarita Tsoutsoura, Shareholder Democracy in Play: Career Consequences of Proxy Contests, 114 J Fin Econ 316 (2014).

firm with an underperforming stock price may become a takeover target, unless the board have entrenched themselves.[10] A corporate investment policy which boosts the stock price will thus both increase the value of the CEO's compensation package and reduce the prospect of hostile intervention from activists.

In an informationally efficient capital market, the stock price (almost) instantaneously reflects all publicly-available information about the firm's activities. When coupled with the extensive initial and continuing disclosure regime under effective securities laws,[11] this means that the stock price offers a kind of running commentary on the firm's expected financial performance under its current investment policy. This provides a guide for investors, and even independent directors, as to how well the executives are running the firm.[12]

B. How does the stock price get determined?

At the core of how equity markets are thought to value stocks is fundamental value analysis.[13] This means the valuation of securities in terms of their future expected cash flows. A share

[10] This is more of an issue in jurisdictions in which takeover law imposes restrictions on target boards' ability to entrench themselves. See generally John Armour and David A. Skeel, Jr, Who Writes the Rules for Hostile Takeovers, and Why? The Peculiar Divergence of US and UK Takeover Regulation, 95 Geo LJ 1727, 1734-38 (2007).

[11] On the role of disclosure in enhancing the accuracy of stock prices, see Merrit B. Fox, Randall Morck, Bernard Yeung and Artyom Durnev, Law, Share Price Accuracy, and Economic Performance: The New Evidence, 102 Mich L Rev 331 (2003).

[12] Jeffrey N. Gordon, 'The Rise of Independent directors in the United States, 1950-2005: Of Shareholder Value and Stock Market Prices' 59 Stan L Rev 1465 (2007).

[13] Ronald J. Gilson and Reinier H. Kraakman, the Mechanisms of Market Efficiency, 70 Va L Rev 549 (1984); Zohar Goshen and Gideon Parchomovsky, The Essential Role of Securities Regulation, 55 Duke LJ 711 (2006); Ronald J. Gilson and Reinier H. Kraakman, Market Efficiency After the Financial Crisis: It's Still a Matter of Information Costs, ECGI WP 242/2014 (2014).

entitles the holder to the stream of future payouts. Its present value is therefore the sum of the future expected payouts, discounted to present value. Estimating future dividends requires *analysis* of the firm's expected future profitability—that is, its revenues minus its costs. It is to investors seeking to perform this analysis, or something approximating to it, to which we refer when we speak of fundamental value analysis, or 'FVA'.

The release of new information about a firm's prospects will cause investors engaged in FVA to update their valuations. This in turn will lead to rapid adjustment of the stock price, as these investors buy or sell almost instantaneously in light of their revised estimates. In an informationally efficient capital market, the information will be incorporated into the stock price so rapidly that investors cannot expect to make a profit trading on the information.

To be sure, not all investors engage in FVA. It is costly to acquire the information and expertise necessary to do so. And trading on such information reveals its quality to others, because the price movement is generally observable. Many investors choose simply to free-ride on others' analysis, by watching and rapidly following sudden price movements. These 'momentum' traders, having no model of the security's fundamental value, are apt to continue to follow price movements too far—that is, past the point when the impact of new information on fundamental value has been taken into account. This then yields an opportunity for FVA investors to trade against the trend, which will tend to correct mis-pricing.

Other investors trade on the basis of factors unrelated to the stock price. 'Liquidity' investors trade, regardless of the current price, because they need to convert their savings into cash, and 'noise' traders trade on the basis of matters they believe to be relevant to the stock price, but which are not. Such investors' trading behaviour is not usually correlated, and

consequently they have the effect of providing liquidity for trading by FVA and momentum traders.

In summary, the position in relation to secondary markets is that, despite the existence of other types of trader, the behaviour of investors engaged in FVA is ultimately expected to drive price movements.[14]

C. How 'wise' are markets?

Well-functioning equity markets aggregate all publicly available information, whether it has come from the firm, its competitors, or another source. It follows from this that the accuracy of the stock price' estimate of the firm's value will be a function of how much of the total set of what is known about the firm's activities is *publicly* known; that is, to persons who are not insiders. This encompasses information made public through the firm's securities filings, through other channels, but also assessments made by outside investors based on their knowledge and analysis. Of course, information need not be disclosed to become reflected in the stock price—it can do this through the process of trading. But information known only to insiders cannot be used for trading, and can only be disseminated by public disclosures.[15]

Publicly-traded firms are obliged to make extensive disclosures about their activities. Where the firm's activities are readily comprehensible to analysts in the marketplace, then the

[14] This also holds for primary markets—that is, for IPOs. A firm undergoing an IPO has no existing market for its securities, and so it is the job of its underwriters to estimate what the appropriate price will be. This is done by a combination of in-house analysis by the underwriter, coupled with conversations with the clients who will be participating in the IPO and who themselves will have engaged in such analysis.

[15] In contrast, the assessments and discoveries of outside analysts can of course be traded upon, provided their source was not an insider.

stock price may provide a superior indicator of the firm's expected performance to the managers' own assessments. This is because the price will, through trading, come to aggregate not only the information the firm discloses, but also the analysis of all investors engaged in FVA—their synthesis of the implications for valuation of the firm's disclosures coupled with their knowledge of other similar firms' performances and information about the business environment in general.[16] The collective output of these investors' analysis may well be more informative than the analysis of the CEO and her board. Hence encouraging managers to use stock price reactions as a guide for corporate strategy can under these circumstances enhance the efficiency of the allocation of corporate assets.[17]

If the firm's projects are not readily comprehensible to analysts in the marketplace, then the stock price becomes less useful as a guide to expected performance. In relation to innovation, a disconnect might stem simply from scarcity of cutting-edge technical expertise necessary to assess the properties or implications of a technological advance. Or it could be grounded in the firm's unwillingness to share details about proprietary innovations, to avoid giving away advantages to its competitors.[18] The more novel the firm's activities, and the better the quality of its people's expertise, the greater the possibility of such a gap. Another source of

[16] Goshen and Parchomovsky, *supra* note 13.

[17] James Dow and Gary Gorton, Stock Market Efficiency and Economic Efficiency: Is There a Connection?, 52 J Fin 1087 (1997).

[18] Of course, mandatory disclosure imposes a minimum floor on what must be made public, but beyond this there is still a great deal of room for manoeuvre. See James R. Brown and Gustav Martinsson, The Real Consequences of Corporate Transparency: Evidence from R&D Activity, Working Paper, Iowa State University / Swedish Institute for Financial Research (2015).

disconnect may be the inability to convey in a public securities filing the kinds of 'soft' factors that form inputs to a heuristic assessment of progress in an innovative project.

A disconnect between what insiders know and what the stock price reflects can make it counterproductive to tie managers' payoffs too closely to the stock price. If the stock price responds not to the (poorly-understood) *actual* activities of the firm, but to imperfect (but readily comprehensible) signals about the firm's future performance, then managers who care—or are made to care—about the stock price may have incentives to substitute the firm's projects away from those which will yield the highest long-term payoffs, in favour of those that maximise the indicators to which the stock price responds.[19] Because such a disconnect is likely to be present in relation to cutting-edge innovation, we might expect this to introduce a bias in managerial decision-making against exploratory innovations, in favour of more conservative—but better-understood—projects.

D. Capital markets and innovation

Theorists of innovation distinguish 'exploratory' innovation, consisting of those changes to business processes or products that mark a distinct break from their predecessors, from 'exploitative' innovation, consisting of steps building on pre-existing processes and practices.[20] It is intuitive that the more exploratory the innovation, the bigger the potential disconnect between the actual value of a firm's activities and its (stock) market valuation. This prediction

[19] Jeremy C. Stein, Takeover Threats and Managerial Myopia, 69 J Pol Econ 61 (1988).

[20] See eg Ufuk Akcigit and William R. Kerr, Growth Through Heterogeneous Innovations, NBER WP 16443 (2010). The terminology is due to James G. March, Exploration and Exploitation in Organizational Learning, 2 Organization Science 71 (1991).

seems to be borne out by a recent, but quite robust, body of research into innovation by public firms.[21] These studies utilise patent data as a dependent variable capturing firm-level innovation. Patent data have the attractive feature of yielding both measures of overall innovative outputs (aggregate patents) and also a measure of the *novelty* or *significance* of innovation, as measured by the number of citations received by patents. These capture the extent to which a particular innovation is used, or built upon, by subsequent patent applications.[22] High-citation patents can be interpreted as more exploratory innovations.

The studies find that exposure to equity market valuations, measured in a variety of ways, has a negative impact on innovation, especially exploratory innovation. Bernstein compares a group of firms that undertake IPOs with an observationally identical group that

[21] For a review, see Ramana Nanda and Matthew Rhodes-Kropf, Financing Risk and Innovation, Harvard Business School Working Paper 11-013 (2014). The prediction also has an obvious resonance with the stylised fact that exploratory innovation often takes place at small, start-up firms, which do not undertake IPOs unless and until they are well-established. We should be careful about interpreting this stylised fact, however, because firm size may be related both to innovation and capital structure. IPOs entail high fixed costs, making them not worthwhile unless a significant amount of capital is being raised. So small firms tend to eschew public equity. At the same time, small firms may also be more likely to engage in exploratory, rather than exploitative, innovation (see Akgcigit and Kerr, *supra* note 20). This is because there are less returns to scale for more exploratory innovation, meaning such innovations are more likely to be undertaken by new firms that are in a start-up phase. There is thus a distinct life-cycle effect explaining the intuition of start-ups engaging in exploratory innovation. The studies discussed in the text focus on firms that are already public, or plan to become so, thereby abstracting from any life-cycle effects.

[22] Patents are an output measure of innovation, and to that extent studies using this as a dependent variable are a significant enhancement on an earlier body of work that relied largely on R&D expenditure, an input measure. Nevertheless, patents represent only a fraction of total innovative activity. They capture scientific or technological innovation, particularly in relation to manufacturing industries. They do not however capture innovation in services, or processes. Whilst some of these might be reflected in other types of intellectual property—copyright and trademarks, for example—others receive no such protection. A large research and policy agenda is geared towards the development of more satisfactory metrics of innovation outputs. For now, patents have the virtue of offering the most comprehensive data, and readily comparable, data. Moreover, there is no reason to believe that the SEMM's impact on innovation should be any different depending on the nature of the innovation pursued. Patent data, in other words, provide a credible proxy for total innovative activity in these studies.

were preparing to do IPOs—as indicated by filing a registration statement with the SEC—but withdrew for reasons beyond their control.[23] He finds that whilst the post-IPO firms still engage in innovation, they do so in a way that is less exploratory: their focus, in other words, shifts toward more exploitative innovations. Thus patents generated by the IPO firms in the post-IPO period attract less citations than those firms' pre-IPO patents; there is no comparable difference for the non-IPO firms. This seems to happen because the IPO firms do less foundational research: they experience significant reductions in the employment of scientists post-IPO, compared with the non-IPO firms.

As amongst those firms which are already public, Fang, Tian and Tice find that increases in liquidity (stock trading activity) exogenously triggered by decimalisation of stock prices are associated with subsequent declines in innovation, as measured both by total patent grants and by citations.[24] Greater liquidity can be interpreted as exposing a firm's stock more intensively to the price effects of new publicly available information.

A plausible mechanism underpinning these results relates to the *nature* of the analysis that is done by outsiders in relation to the firm's activities. The role of general equity analysts is thought to be one of contextualisation of a public firm's activities against the background of other firms in its industry, and movements in the economy more generally.[25] However, for a

[23] Shai Bernstein, Does Going Public Affect Innovation?, forthcoming, J Fin (2015). By focusing on firms preparing for IPOs, the study abstracts from life-cycle effects both within firms that go public and between firms that choose to go public and those that do not. To avoid a potential bias introduced by firms' decisions not to complete their IPOs, he uses short-run drops in NASDAQ indices, which strongly predicts IPO cancellation, as an instrument for IPO non-completion.

[24] Vivian W. Fang, Xuan Tian and Sheri Tice, Does Stock Liquidity Enhance or Impede Firm Innovation?, 69 J Fin 2085 (2014).

[25] See sources cited *supra*, note 13.

firm pursuing activities that are, by definition, very different to others—as is plausibly the case with exploratory innovation, at least—such broad, comparative analysis is likely to be less useful. Consistently with this, He and Tian report that a reduction in general analyst coverage through an exogenous shock (merger or closure of an analyst firm specialising in the industry) is associated with an increase in innovation, as measured both by patent grants and citations.[26] In contrast, exploratory innovation is likely to be better understood by an analyst who invests greater time in understanding *this firm's* activities. Because the fixed costs of this sort of specialisation by definition could not be spread across investments in multiple firms, they would only be rational to incur for an investor taking a large stake in the innovative firm. Consistently with this, several studies report that firms whose stockholders include 'dedicated' institutional investors are more engaged in exploratory innovation, as measured by citation-weighted patents.[27] Dedicated investors take concentrated stakes in firms, and trade relatively infrequently.[28] This is consistent with a pattern of specialising in understanding the idiosyncratic activities of those firms, which would complement exploratory innovation. The limit case of this strategy is, of course, venture capital investment, to which we turn in Section II.

[26] Jie He and Xuan Tian, The Dark Side of Analyst Coverage: The Case of Innovation, 109 J Fin Econ 856 (2013).

[27] See Philippe Aghion, John Van Reenen and Luigi Zingales, Innovation and Institutional Ownership, 103 Am Ec Rev 277 (2013); Fang et al, *supra* note 24, at 2121-22; He and Tian, *supra* note 26, 872-3.

[28] The categorisation is due to Bushee: Brian J. Bushee, The Influence of Institutional Investors on Myopic R&D Investment Behaviour, 73 Acct Rev 305 (1998).

E. Reforms facilitating IPOs

Policymakers in the US and the EU are seeking to facilitate access to capital markets for emerging, high-growth firms by lowering the fixed costs of IPOs. In particular, Title I of the US JOBS ('Jumpstart Our Business Startups') Act of 2012 relaxed a number of provisions relating to disclosure surrounding an IPO for 'emerging growth companies'—defined as having gross revenues less than $1 billion.[29] And Title IV of the JOBS Act will from June 2015 further extend this policy by exempting from registration requirements entirely so-called 'Regulation A+' IPOs of up to $50 million annually.[30] Similarly, the European Commission's Capital Markets Union Green Paper floats proposals to make prospectus obligations less onerous, especially for small firms.[31]

Early evidence suggests that the JOBS Act has facilitated IPO activity, consistent with fixed IPO costs falling disproportionately on smaller firms.[32] However, the analysis in this section suggests policymakers would be unwise to view facilitating IPOs, without more, as a way to stimulate innovation. The obvious drawback of lowering costs through reducing

[29] See SEC Division of Corporation Finance, Financial Reporting Manual (updated Jan 12, 2015), ¶ 10110 (available at http://www.sec.gov/divisions/corpfin/cffinancialreportingmanual.shtml, last accessed May 28, 2015).

[30] SEC, Amendments for Small and Additional Issues Exemptions Under the Securities Act (Regulation A), 80 Fed. Reg. 21806, Apr 20, 2015.

[31] European Commission, Green Paper: Building a Capital Markets Union, COM (2015) 63 final, 10.

[32] Michael Dambra, Laura Casares Field and Matthew T. Gustafson, The JOBS Act and IPO Volume: Evidence that Disclosure Costs Affect the IPO Decision, 116 J Fin Econ 121 (2015).

disclosure is that it is likely, if anything, to make the disconnect between market valuation and firm activity greater for these firms.[33]

An obvious policy alternative (or complement) is to focus on facilitating (private) capital-raising from investors with specialist knowledge. We consider versions of this in Sections II and III. Yet as we shall see, there are limits to the total amount of capital which can be raised through these channels. And for innovative firms in capital-intensive industries, the benefits of accessing diversified investors via capital markets may outweigh the costs associated with a disconnect between market valuation and the firm's activities.[34] The other implication of this section's analysis is therefore that in addition simply to facilitating IPOs, it is desirable also to facilitate mechanisms that help innovative public firms manage the impact on investment policy of their relatively inaccurate stock prices. We return to one such mechanism in Section IV.

III. The Wisdom of Specialist Investors

We have seen that where equity market analysts do not understand an innovative firm's projects, this drives a wedge between the stock price and insiders' assessment of the value of the firm's projects. Where managers' returns are tightly linked to the stock price, this has the potential to distort the firm's investment choices. This problem can be ameliorated by seeking finance from a specialist investor who has comparative advantage in understanding the firm's

[33] Consistently with this, JOBS Act Title I IPOs are reported to experience systematically greater IPO underpricing: See Mary E. Barth, Wayne R. Landsman and Daniel J. Taylor, The JOBS Act and Information Uncertainty in IPO Firms, Stanford University GSB Research Paper 14-26 (2014).

[34] See Viral V. Acharya and Zhaoxia Xu, Financial Dependence and Innovation: The Case of Public Versus Private Firms, NBER Working Paper 19708 (2013) (public firms in external finance-dependent industries are more innovative, as measured by total and citation-weighted patents, than private firms).

projects: a venture capitalist. The advantages of venture capital ('VC') financing for start-ups are well-known, and for this reason we review them only briefly in this section. Instead, we focus on a less well-analysed limitation on the VC financing market. We argue that the scarcity of understanding of new technology also limits the scale of VC finance.

A. Venture Capitalists as Specialist Investors

Venture capital is a subset of private equity investment, distinguished by the fact that funds are advanced to businesses that are starting up or at an early stage in their development—generally, before a profit has been earned.[35] VCs are financial intermediaries, generally raising their investment funds from institutional investors. VCs typically hold their investments for a period of between 3-7 years, after which successful investments are exited either by listing the company through an initial public offering ('IPO'), or by selling the company to a competitor (a 'trade sale').[36] Unsuccessful investments are liquidated. One good investment can earn enough to outweigh several write-offs and thereby generate a healthy overall portfolio return.[37]

[35] VC finance typically is sought at the point the entrepreneur can show that his business model can turn a profit. Generally, very early, 'seed' finance—used in order to explore the viability of a project—is supplied by the entrepreneurs themselves. The entrepreneurs may exploit their personal credit capacity, particularly if they are a homeowner, in order to provide such capital. See Alicia M. Robb and David T. Robinson, The Capital Structure Decisions of New Firms, RFS (2012) (most new firms are founded using personal loans raised by the founder). So-called 'business angels'—wealthy individuals with prior entrepreneurial experience who now invest in other projects—may also be able to offer funds at a very early stage: see eg Stephen Prowse, Angel Investors and the Market for Angel Investments, 22 J Bank & Fin 785 (1998).

[36] A trade sale can itself be viewed as a sale to a specialist investor: a competitor engaged in similar activity. Trade sales have become the most common form of VC exit: see Pierre Giot and Armin Schwienbacher, IPOs, Trade Sales and Liquidations: Modelling Venture Capital Exists Using Survival Analysis, 31 J Bank & Fin 679 (2007).

[37] See Douglas J. Cumming and Jeffrey G. MacIntosh, A Cross-Country Comparison of Full and Partial Venture Capital Exits, 27 J Bank & Fin 511 (2003); Giot and Schwienbacher, *supra* note 36.

Venture capital is a particularly useful source of external finance for small firms pursuing innovative projects.[38] 'Start-up' firms developing new technologies commonly do not generate steady cash flows that can be used to make interest payments, and lack liquid assets that could be used as collateral. Instead, the value (if any) of a start-up firm will inhere in the ideas and 'human capital' of the entrepreneur and opportunities for growth. This makes such firms unsuitable candidates for debt investment.[39]

B. VCs' Expertise and Monitoring

VCs recruit and develop specialist technology and industry expertise. This not only helps them to evaluate potential investments more effectively, but also to participate in the ongoing process of deciding whether, and in what way, to pursue the project based on the revelation over time of results.[40] The VC's expertise is put to effective use through sophisticated contract terms that give them a significant role in the governance of portfolio companies.[41] A common

[38] Samuel Kortum and Josh Lerner, Assessing the Contribution of Venture Capital to Innovation, 31 RAND J Econ 674 (2000).

[39] Allen N. Berger and Gregory F. Udell, The Economics of Small Business Finance: The Roles of Private Equity and Debt Markets in the Financial Growth Cycle, 22 J Bank & Fin 613 (1998). Empirical findings confirm that equity financing in the form of venture capital, and not debt, predominates in privately-held firms in technology-intensive industries: Robert E. Carpenter and Bruce C. Petersen, Capital Market Imperfections, High-Tech Investment and New Equity Financing, 112 Econ J F54 (2002); Philippe Aghion, Stephen Bond, Alexander Klemm and Ioana Martinescu, Technology and Financial Structure: Are Innovative Firms Different?, 2 J Eur Econ Assoc 277 (2004). However, at the stage before approaching a VC, most entrepreneurs fund their businesses entirely by *personal* indebtedness: see John Armour and Douglas Cumming, The Legislative Road to Silicon Valley, 58 Ox Econ Pap 596 (2006); Robb and Robinson, *supra* note 35.

[40] See Yuk-Shee Chan, On the Positive Role of Financial Intermediation in Allocation of Venture Capital in a Market with Imperfect Information, 38 J Fin 1543 (1983).

[41] William A. Sahlman, The Structure and Governance of Venture Capital Organizations, 27 J Fin Econ 473 (1990); Paul A. Gompers and Josh Lerner, The Venture Capital Cycle (1999); Michael Klausner and Kate Litvak, What

feature of venture capital investments is that the finance is not advanced all at once, but rather is staged. Subsequent rounds of finance may not be available to the firm, or only on considerably more expensive terms, if performance targets are not met in the interim. A lower valuation of the shares will dilute the entrepreneur's holdings. Conversely, non-investment will bring about the end of the business, as the VC's decision not to continue to fund the project will signal to others that it is underperforming. Investment agreements also usually provide for a range of control rights to be given to the venture capitalist, though voting rights, entitlements to appoint directors to the board, and veto rights over a range of specified actions.[42]

At its best, therefore, VC investment combines both the supply of finance and of judgment regarding the development of the project. However, just as giving discretion to the entrepreneur creates agency costs for investors, the very features of the typical VC investment agreement that give control rights to the VC create the potential for (reverse) agency costs for the entrepreneur.

First, the entrepreneur will be concerned that the VC may lack sufficient expertise to understand the project properly, and so may make inappropriate decisions regarding subsequent funding. In particular, the use of staged financing requires performance 'hurdles' to be set, the meeting of which are conditions for the provision of subsequent rounds of finance. These performance targets must be observable to the VC. The greater the gap between the VC's understanding and the technology under development, the more likely it is that the signals

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Economists Have Taught Us About Venture Capital Contracting, in Michael J. Whincop (ed), Bridging the Entrepreneurial Financing Gap: Linking Governance with Regulatory Policy (2001); Steve N. Kaplan and Per Strömberg, Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts, 70 Rev. Fin. Stud. 281 (2003).

[42] Kaplan and Strömberg, *supra* note 41.

the VC can meaningfully observe will be biased indicators of the project's true value. This can lead to distortions in the entrepreneur's investment choices, similar in structure to the problem discussed in relation to capital markets. Consistently with this, a recent study by Mao et al reports that greater staging of VC finance—as measured by number of financing rounds—is associated with declines in innovation.[43] The size of the effect is inversely correlated with the VC's experience.[44]

Second, the entrepreneur will worry that the VC may opportunistically divert value to themselves at the entrepreneur's expense through the selection and timing of an exit from the investment.[45] The entrepreneur is likely to favour an IPO—which will allow the VC to exit and the entrepreneur to retain control as manager—to an acquisition by a competitor, in which case the acquiror will take control.[46] Conversely, the VC may prefer to take the immediate liquidity associated with a trade sale rather than continue to fund a firm to remain independent sufficiently long to make it attractive for the IPO market.[47] These two problems (insufficient understanding of the project and opportunism) are likely to be mutually reinforcing, in that a VC who does not understand the project is likelier to find early exit more appealing.

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[43] Yifei Mao, Xuan Tian and Xiaoyuan Yu, Unleashing Innovation, Working Paper Kelley School of Business, Indiana University (2014).

[44] *Ibid.*

[45] Jesse M. Fried and Mira Ganor, Agency Costs of Venture Capitalist Control in Startups, 81 NYU L Rev 967 (2006). The potential for opportunism arises from the fact that VCs typically take a position that is senior in priority terms in the firm's capital structure to that of the entrepreneur.

[46] Bernard S. Black and Ronald J. Gilson, Venture Capital and the Structure of Capital Markets: Banks Versus Stock Markets, 47 J Fin Econ 243 (1998).

[47] Thomas Hellman, IPOs, Acquisitions, and the Use of Convertible Securities in Venture Capital, 81 J Fin Econ 649 (2006).

C. Limits to the Supply of Good VCs

An entrepreneur's challenge at the funding stage is therefore not only to persuade a VC that their project is worth funding, but in so doing to match with a VC who really understands what is being done and who will not behave opportunistically.

Opportunism seems to be something that a VC firm's reputation can help to constrain.[48] However, developing a reputation requires the VC firm to have been established for some time, creating a constraint on supply of 'trustworthy' VCs. Relevant VC expertise can be understood as a combination of specialist technical or scientific expertise, which permits the VC to assess the feasibility, and progress of a technological innovation, and experience in assisting entrepreneurs in developing their projects, which may be more generic. VC experience, like reputation, takes time to acquire. And the more exploratory the innovation, the smaller the set of people who will have the technical expertise necessary to make good judgments about its development. These differences in VC human capital are most important at the level of the individual partner, as opposed to the partnerships in which they participate.[49] Thus the right combination of technical and generic capability may be very hard to find. And because of the 'hands-on' nature of VC investment, those VCs who do have relevant expertise cannot readily scale their exploitation of it: they cannot be in two places at once. Thus geographic proximity to

[48] Vladimir Atanasov, Vladimir Ivanov and Kate Litvak, Does Reputation Limit Opportunistic Behavior in the VC Industry? Evidence from Litigation against VCs, 67 J Fin 2215 (2012).

[49] Michael Ewens and Matthew Rhodes-Kropf, Is a VC Partnership Greater than the Sum of its Partners?, NBER Working Paper 19120 (2013). See also Morten Sørensen, How Smart is the Smart Money? A Two-Sided matching Model of Venture Capital, 62 J Fin 2725 (2007); Laura Bottazzi, Marco Da Rin and Thomas Hellmann, Who are the Active Investors? Evidence from Venture Capital, 89 J Fin Econ 488 (2008).

the VC's offices is a significant determinant of success in raising funds, and of outcomes conditional on funding being supplied.[50]

To summarise, VC finance offers the potential for a knowledgeable investor to supply finance and judgment in a way that will both help to realise the value of an innovative project and control agency costs on the part of the entrepreneur. However, the supply of 'good' VCs—those who combine the technical knowledge and financing experience necessary to make the most effective judgments on implementing a new technology—will be limited.

D. Policy Initiative: Subsidising investment in VC finance?

In order to stimulate the supply of VC finance, policymakers in Europe are considering a number of possibilities, including public investment and subsidies to private investors in this asset class.[51] Our analysis suggests this policy is unlikely to achieve its goal of increasing the use of VC finance. This is because it does not address the central problem—namely that of the strictly limited pool of expertise regarding a new technology. Because expertise cannot be scaled easily, subsidised funding is unlikely to bring much benefit for already-successful VCs with relevant expertise to increase their portfolio sizes. Rather, it is most likely to permit entry of VCs whose judgment is inferior and who, without such subsidy, would not be able to operate in the marketplace. Unfortunately, this will create more competition for established VCs and may in fact lead to established VCs being outbid for promising projects. This may have the

[50] Josh Lerner, Venture Capitalists and the Oversight of Private Firms, 50 J Fin 301 (1995). See also Andrew Metrick and Ayako Yasuda, The Economics of Private Equity Funds, 23 Rev Fin Stud 2303 (2010) (successful VCs have more difficulty scaling their businesses than do LBO fund managers).

[51] European Commission, *supra* note 31, 18.

contrarian result of 'crowding out' private investment in the sector. One of us previously investigated this question empirically, concluding that state subsidies for venture capital generally tended to have a negative impact on the overall supply of VC finance.[52]

IV. The Wisdom of Crowds?

Much has been written about the 'wisdom of crowds' as regards new investment projects.[53] And in the past few years, a new kid has indeed arrived on the block for financing start-ups, 'crowdfunding' ('CF'). In essence, this involves raising early stage funds from individuals in the general community. The ownership structure is the inverse of VC finance. Where a VC fund makes a significant investment and takes a concentrated control position, CF investors are numerous and each makes only a small contribution to a firm's capital requirements. This is attractive, from the standpoint of entrepreneurs, because it does not require any transfer of control rights to investors. The entrepreneur thus retains discretion over the direction of their projects. However, from the standpoint of investors, there is little to signal whether the founder's decisions regarding project continuation will be good ones, or *a fortiori* to control founder opportunism. The key question, in our view, is whether crowdfunding has the potential to aggregate information about the proposed projects in a way that facilitates good decisions.[54]

[52] Armour and Cumming, *supra* note 39, 619-620. See also, Ronald J. Gilson, Engineering a Venture Capital Market: Lessons from the American Experience, 55 Stanf L Rev 1067 (2003); Josh Lerner, Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed—and What to Do About It (2009).

[53] See eg James Surowiecki, The Wisdom of Crowds (2005); Jeff Howe, Crowdsourcing: How the Power of the Crowd is Driving the Future of Business (2009).

[54] This section draws on John Armour and Luca Enriques, The Promise and Perils of Crowdfunding, University of Oxford Working Paper (2015).

A. Varieties of crowdfunding contract

Crowdfunding typically involves the aggregation of many individuals' small direct investments in a project. There is of course nothing new about this in principle.[55] What is different today, however, is the scale of activity, which is driven by the use of technology to lower communication costs. Where in the past geography would have placed a significant constraint on the success of this kind of fundraising, the internet means that a great deal of information can be conveyed to investors nationally and internationally.[56] Precisely because CF investors do not contract for governance entitlements, internet-based communications have facilitated the scaling of investment activity through this channel.

There are a variety of different financial contracts used in CF. We restrict our focus here to two of these: 'equity' and 'reward' CF.[57] Equity CF, sometimes referred to as 'crowdinvesting', involves investors buying shares in start-up businesses via a CF platform. Although the JOBS (Jump-Start Our Business Startups) Act 2013 was intended to facilitate equity CF, it has not (yet) fully done so. Implementation of Title III of the JOBS Act, which would

[55] See e.g. Venkat Kuppuswamy and Barry L. Bayus, Crowdfunding creative ideas: The dynamics of project backers in Kickstarter, UNC Kenan-Flagler Research Paper 2013-15 (2014), 2 (reporting that 'Mozart and Beethoven financed concerts and new music compositions with money from interested patrons, [and] that the Statue of Liberty was funded by small donations from the American and French people').

[56] Ajay K. Agrawal, Christian Catalini and Avi Goldfarb, The Geography of Crowdfunding, NBER Working Paper No 16820 (2011). See also Franks, Julian, Colin Mayer and Stefano Rossi, Ownership: Evolution and Regulation, 22 Review of Financial Studies 4009 (2009) (geographic proximity was traditionally important in supporting trust for private investors in UK firms).

[57] The other well-known mode is peer-to-peer lending. We do not focus on this because, as discussed in Section III.B (*supra*, text to notes 38-39), debt finance is generally thought to be less important for innovative projects that cannot support collateral.

permit equity CF as we have described it—raising up to $1,000,000 by unregistered securities directly to unaccredited investors—has so far foundered amid objections to SEC Rulemaking.[58]

However, in other jurisdictions, including a number of EU member states,[59] the regulatory environment already permits equity CF. The EU Prospectus Directive does not apply to offerings of less than €5 million in a 12-month period,[60] thus allowing member states to leave smaller offerings unregulated if they see fit. The UK, for example, has made use of this ceiling to permit, since 2013, offers of up to €5 million in value without a prospectus, provided that retail investors do not invest (on a self-certified basis) more than 10% of their net assets in this class.[61] The UK-based equity crowdfunding market has grown exponentially, raising £28 million ($43 million) in 2013 and an estimated £84 million ($129 million) in 2014.[62] To put this in context, a total of only £143 million ($220 million) of early-stage venture capital investments were made in the UK in 2013.[63]

[58] See Michael Raneri, Who Needs Equity Crowdfunding? 3 Critical Questions About Title III of the JOBS Act, Forbes.com, Apr 16, 2015 (last accessed May 26, 2015). See SEC Proposed Rule: Crowdfunding, 78 Fed. Reg. 66428, 5 November 2013 ("Regulation Crowdfunding"). The deadline for comments on these proposed rules was 3 February 2014, and comments can be viewed at https://www.sec.gov/comments/jobs-title-iii/jobs-title-iii.shtml.

[59] For example, equity CF is permitted—and has growing markets—in New Zealand, Spain, the UK [...countries].

[60] Article 1(2)(h) Prospectus Directive [2003] O.J. L 345/64 (as amended) (the "Prospectus Directive").

[61] Financial Services and Markets Act 2000 ("FSMA"), Section 85(5)(a), Schedule 11A, para 9. *See* FCA, Policy Statement 14/4, The FCA's regulatory approach to crowdfunding over the internet, and the promotion of non-readily realisable securities by other media: Feedback to CP13/13 and final rules, March 2014.

[62] Peter Baeck, Liam Collins and Byan Zhang, Understanding Alternative Finance: The UK Alternative Finance Industry Report 2014 (2014), 52 (available at http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf, last accessed 26 May 2015).

[63] BVCA, Private Equity and Venture Capital Report on Investment Activity 2013 (Autumn 2014), 5 (Table 4).

'Reward' CF involves the promise of some type of tangible non-financial return on investment. In the technology sector, the most common reward promised is one or more units of the new product the start-up firm is planning to bring to market. Reward CF investors are in effect pre-paying for the product, although the firm's commitment to deliver is only 'best efforts', rather than absolute, meaning that the investors bear the risk that it may prove impossible to manufacture the product. Because reward CF does not involve any offer of securities, it is not subject to securities law at all. As a consequence, much of the crowdfunding action in the US to date has centred on reward CF. In contrast to equity crowdfunding, there are no regulatory restrictions on reward CF activity. And reward CF has boomed, as the success of websites such as Kickstarter and Indiegogo testifies. Since Kickstarter's launch in 2009, a total of $1.46 billion has been successfully pledged by funders, of which $239 million went to technology projects.[64] And according to worldwide data collected by Massolution, reward-based CF raised $1.33 billion in 2014, as opposed to $1.10 billion raised by equity CF.[65]

B. Equity crowdfunding: fools rush in?

As regards equity crowdfunding from retail investors in its simplest guise, we are sceptical that any meaningful 'wisdom' will be aggregated from such investment. This is because there is typically no secondary market for crowdfunded securities. Indeed, the SEC's Draft Regulation Crowdfunding for Title III of the JOBS Act would prohibit the re-sale of crowdfunded securities

[64] Data from Kickstarter. See https://www.kickstarter.com/help/stats?ref=footer (last visited on May 15, 2015).

[65] See Massolution, The Crowdfund Industry Report (2015), available at http://reports.crowdsourcing.org/index.php?route=product/product&product_id=54 (2015).

by their initial purchasers for a period of one year.[66] Instead of trading amongst one another on the basis of their interpretations of publicly-available information, equity CF investors simply make a one-time decision whether or not to purchase equity in a firm raising funds. In principle, their assessment of the value to them of the securities should be based on FVA, just as would investors in securities in public markets. However, disclosure required in relation to CF investments is less comprehensive than for publicly traded equity. And because there is no secondary trading, there is no opportunity for arbitrage profits as a return from investment in analysis.

Moreover, the process of equity CF fundraising gives rise to serious concerns about herding. The theoretical literature suggests that 'information cascades' occur where individuals arrive sequentially and all must make a choice among similar products about which they have limited information.[67] Once a small number have decided on a particular product, individuals arriving thereafter will draw a strong inference from this in favour of the product, even if their own assessment of its merits would otherwise be negative. Crowdfunding platforms appear to foster herding behaviour by design: pitches are open for a relatively long time,[68] with platforms encouraging fundraisers to 'generate momentum' early on and then more prominently displaying pitches that are close to the target amount.

The basic equity crowdfunding model, therefore, offers little prospect of improving investment outcomes as compared to VC finance or ordinary equity capital markets. Unlike VCs,

[66] Section 4(a)(3) of the Securities Act, proposed Rule 501 of Regulation Crowdfunding (*supra*, note 58).

[67] See eg Sushil Bikchandani, David Hirshleifer and Ivo Welch, A Theory of Fads, Fashion, Custom and Cultural Change as Information Cascades, 100 J Pol Econ 992 (1992).

[68] As Vismara (2015, p. 15) reports, campaigns on Crowdcube run for an average of approximately two months.

investors are neither expert nor concentrated, and unlike ordinary equity markets, the bookbuilding process at the IPO stage and, later, secondary trading do not operate to aggregate information. Concerns of this variety have underpinned the delay in implementing Title III of the JOBS Act in the US.

More promising may be measures that seek to match private placements with investors having some specialist knowledge. The classical securities-law characterisation of 'sophisticated' investors by reference to wealth (in the US) or prior investment experience (in the EU) does not seem sufficient by itself to distinguish relevant expertise, but crowdfunding platforms are experimenting with more granular criteria. For example, AngelMD is a US investment platform which allows only medical professionals (also meeting the 'accredited investor' wealth criterion) to invest in medical start-ups (although other accredited investors may join the platform on an invite only basis).[69]

C. Reward crowdfunding: raising finance from your consumers

Whilst reward CF similarly involves large numbers of passive investors funding a project, this time the funding process does have the ability to aggregate information relevant to the exercise of the real option that is the entrepreneur's business project. This is because the investors are also the would-be consumers of the product: reward crowdfunders are offered one or more units of the first product run in return for their investment. Here the funder has relevant information regarding the product market: their own subjective valuation of the product.

[69] *See* https://www.angelmd.co/investor_faqs (last accessed 3 March 2015). See also Armour and Enriques, *supra* note 54, at xx-xx.

Because crowdfunding rounds are usually made contingent on raising a 'target' amount of financing, reward CF can be used to generate information as to whether there is a viable market for a product. This is a meaningful sense of 'wisdom of crowds', in that each individual funder need only know whether she wishes to purchase the product, and the process of fundraising operates to aggregate this information in a way that is useful for the entrepreneur.

Entrepreneurs set their target funding level for a reward CF round at what they anticipate will be necessary to cover costs to bring the project to production. Funding is conditional on this target being met, such that if the target is not met, funders receive their money back. The reward CF funder still bears the risk that the firm is unable to deliver its product on time, within budget, or perhaps even at all. This risk is shared amongst a large number of CF funders each of whom contributes a small investment. In return, the reward CF investors are promised one of more units of the product. This is a type of pre-order, under which the investors get a right to receive the product from a 'vendor' whose obligation is not actually to deliver the product but rather to use their 'best efforts' to manufacture and deliver it. A reward CF investor will be willing to enter into this contract if her anticipated consumer surplus from the product is greater than the 'price' plus a risk premium according to the risk of non-delivery.

As the investor's decision to fund is based on her own preferences regarding the offered product, as opposed to her expectations about the preferences of others, herding is less of a concern for reward CF than for equity CF.[70] This operates through two complementary

[70] See Ajay K. Agrawal, Christian Catalini and Avi Goldfarb, Some Simple Economics of Crowdfunding, NBER Working Paper 19133 (2013).

channels. First, the fact that an investor has funded a reward CF round does not send any signal to others about her expectations about the project's likely profitability. Rather, it signals simply that her anticipated consumer surplus from the product would exceed the 'price' designated by the reward CF investment round plus a risk premium. Second, the nature of potential investors' preferences regarding a new tech product are likely to be heterogeneous, and each individual has private information about their own preferences. Thus the revelation of information about prior investors' preferences for the product should carry little informative value for subsequent investors, whose decision to invest is based mainly on their own preferences.[71]

On our analysis, reward CF has the capacity to deliver an informed judgment about one aspect of the project's viability: *whether there is a market for the product*. As compared with VC finance, it avoids the risk—for the entrepreneur—of being unable to match with a VC with relevant knowledge, and indeed may succeed in generating new knowledge. It leaves with the entrepreneur the decision whether the technology is sufficient to deliver the product—in effect, the investors give the entrepreneur a put option as respects production. This does leave investors open to agency costs, through the potential for opportunistic non-performance by the entrepreneur. This is reduced by the practice of only opening reward CF calls where a prototype has been produced, but clearly is not eliminated.

Needless to say, reward CF is not a silver bullet that overcomes all the problems of funding innovation. In particular, there are limits to the amount of capital which can be raised

[71] Herding is nevertheless still relevant when reward crowdfunders have to choose between two similar products: they may choose the one which others have chosen before them, because of the higher risk that the other, which may be better, will not achieve its target funding. See Agrawal et al, *supra* note 70.

in this way without distorting the firm's product market.[72] Yet on our analysis it provides a useful addition to the armoury of financial contracts. For projects for which the technological capability has credibly been established, reward CF provides a way of generating a high-quality judgment, untainted by the self-interest of the entrepreneur, as to the market impact of the product.

V. The Wisdom of Techies

A growing phenomenon in tech company IPOs has been the use of dual-class stock to secure control for the founder after the float. An early example was Google, which went public in August 2004. Google offered Class A shares, each carrying a single vote, to the public in its IPO, but its founders Sergey Brin and Larry Page retained Class B shares, which each carried ten votes. Their combined Class B holdings accounted for 56% of the overall voting rights, but only 17% of the cash-flow rights.[73] This approach, which had long been common among media companies—such as the New York Times or News Corporation—has since been followed in a number of recent tech company IPOs, the best-known of which include LinkedIn in 2011 and Facebook in 2012.[74]

[72] Paul Belleflamme, Thomas Lambert and Armin Schwienbacher, Crowdfunding: Tapping the Right Crowd, 29 J Bus Vent 585 (2014).

[73] Google Inc SEC filings: 10-K, March 30, 2005, 67 (outstanding shares); DEF14A, April 8, 2005, 26 (shares held by insiders and corresponding voting power).

[74] Stu Woo, Lynn Cowan and Pui-Wing Tam, LinkedIn IPO Soars, Feeding Web Boom, Wall Street Journal, May 20, 2011; Shayndi Rice, Anupreeta Das and John Letzing, Facebook Prices IPO at Record Value, Wall Street Journal, May 17, 2012.

A. The perils and promise of dual-class capital structures

A dual-class capital structure entrenches controllers, making it impossible for the company to be acquired or directors to be elected (whether in a proxy fight or otherwise) without the controller's consent. It is well-known that this leads to potentially significant agency costs as between the controller and outside investors.[75] Because the controller has only a minority of the cash-flow rights, the transfer of resources—'rent extraction' or 'tunnelling'—from the corporation to the controller or her affiliates becomes more attractive to her. If the controller has only some fraction of the cashflows θ (where $0 < \theta < 1$), then the transfer of corporate resources of value *v* to herself will net her $(1 - \theta)v$, taking into account the decline in value of her payouts from the firm. It will be apparent that as $\theta \rightarrow 0$, the temptation to use her control rights to engage in redistribution will, *ceteris paribus*, become stronger. Such redistribution leads to inefficiency if the controller expends corporate resources covering it up, or worse still, liquidates productive corporate investments in order to fund transfers to herself. For this reason, dual-class structures are highly controversial.[76]

Despite this, tech firms argue that such structures are necessary in order to provide a bulwark against the pressure for short-termism stock markets would otherwise create, which

[75] See eg, Lucian A. Bebchuk, Reinier Kraakman and George G. Triantis, Stock Pyramids, Cross-Ownership and Dual Class Equity: The Creation and Agency Costs of Separating Control from Cash Flow Rights, in Randall Morck (ed), Concentrated Corporate Ownership (2000), 295.

[76] See eg James Suroweicki, Unequal Shares, The New Yorker, May 28, 2012; Shareholder Rights—Out of Control, Economist, Sep 20, 2014.

would be harmful for their capacity to innovate.[77] Our analysis of the limitations of stock markets in guiding investment decisions in innovative projects suggests this claim has some merit.[78] Even so, dual-class structures put outside investors in an uncomfortable position: they are asked simply to trust the founders to use their control rights to make decisions about the use of the firm's resources. Whilst it is true that the founders likely have comparative advantage in understanding the implications of new technology, investors must seemingly expose themselves to the risk of expropriation in order to give the founders freedom to continue to make such decisions. To be sure, reputation may be used to foster such trust—whether through the founder's prior track record or the firm's track record in paying dividends[79]--but this has little relevance for a tech firm founded by a relatively unknown entrepreneur and which may not be in a position to make payouts for many years.

In this section we argue that tech founders can and do offer meaningful commitments to outside investors. These commitments take the form of paying key employees in their firm's Class A stock, the same as the outside shareholders.[80] Such 'broad-based' stock compensation

[77] See Zohar Goshen and Assaf Hamdani, Concentrated Ownership Revisited: The Idiosyncratic Value of Corporate Control, ECGI Law Working Paper 206/2013 (2013). Thus Facebook's 2012 Prospectus emphasised amongst its 'risk factors' for investors that '[o]ur culture emphasizes rapid innovation and prioritizes user engagement over short-term financial results.' (Facebook, Prospectus, May 18, 2012, 17).

[78] *Supra*, Section II.D.

[79] Dual-class firms that pay dividends generally make above average payouts, which can be interpreted as a commitment mechanism to outside investors. See eg Bradford D. Jordan, Mark H. Liu and Qun Wu, Corporate Payout Policy in Dual-Class Firms, 26 J Corp Fin 1 (2014) (dual-class firms generally make larger cash dividend and total payouts to shareholders than propensity-matched single-class firms).

[80] Other mechanisms by which qualitatively similar, but weaker, commitments can be made include management entrenchment through use of a classified board and/or incorporation in a jurisdiction favourable to entrenchment:

schemes are ubiquitous amongst tech firms. We argue that the employees, in contrast to outside investors, are likely to have comparative advantage in assessing the capabilities of the firm's innovative technologies, and so are well-placed to assess whether the founder is using their control rights in a productive way. Consequently, the employees' willingness to accept Class A stock sends a credible signal to outside investors that the founder is trustworthy. Making employees shareholders in the firm is costly, because of the risk they must bear. Our account helps explain the ubiquity of broad-based stock compensation at tech firms, and especially dual-class ones, which is otherwise something of a puzzle. The technical expertise—or 'wisdom'—that employees possess is leveraged to assist in committing the founders to making good choices.

B. The 'puzzle' of employee stock compensation in tech firms

A distinctive feature of technology companies' employment arrangements is their enthusiastic use of broad-based equity compensation. Whilst equity-based pay—which we take to mean compensation that includes grants of stock and/or options—has become ubiquitous for senior executives in public companies generally, what distinguishes technology firms is their use of equity compensation not just for senior executives, but for employees right across the firm. Hence the schemes are said to be 'broad-based'.[81] Employee grants are typically deferred, vesting over a three to five year period.[82]

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see Martin Cremers, Lubomir P. Litov, and Simone M. Sepe, Staggered Boards and Firm Value, Revisited, Working Paper (2014).

[81] Christopher D. Ittner, Richard A. Lambert and David F. Larcker, The Structure and Performance Consequences of Equity Grants to Employees of New Economy Firms, 34 J Acct & Econ 89, 105-6 (2003); Paul Oyer and Scott

However, the prevalence of broad-based equity compensation in the tech sector has lacked a complete explanation. Discussions of equity compensation traditionally focus on incentives, the idea being that linking an agent's pay to stock performance will align the agent's incentives with the interests of stockholders. But this analysis best fits CEO compensation, not that of employees generally. This is because of the classical trade-off in agency models between risk and incentives. As well as affecting incentives, equity compensation also loads risk onto the agent, meaning that the total expected value of compensation offered must be increased—relative to a cash award—in order to induce a risk-averse agent to participate. The incentive benefits of using equity pay increase with the extent of the employee's control over the firm—the more significant the impact of the employee's decisions, the more valuable aligning their incentives will be. If employees do not differ in their risk aversion, then the risk premium which would need to be paid to a rank-and-file employee would be the same as for a senior executive. Consequently, the less influential the employee, the more expensive equity pay becomes as a means of aligning incentives. In other words, incentive alignment may help explain the use of CEO equity compensation, but it is a poor explanation for broad-based equity compensation schemes.[83] On this analysis, the prevalence of broad-based equity compensation schemes

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Schaefer, Why do Some Firms Give Stock Options to All Employees? An Empirical Examination of Alternative Theories, 76 J Fin Econ 99, 104-6 (2005) (such practices far more common at 'new economy' firms than at firms generally).

[82] In the case of options, this is done by setting the exercise date. In the case of stock, the entitlement is 'restricted'—that is, the employee is not permitted to sell it—until the vesting period is over.

[83] The use of vesting periods is commonly rationalised as a retention device. Typically, employees forfeit unvested entitlements on termination of their employment. Consequently employees with unvested grants will incur costs if they leave the firm prior to their entitlements vesting. Whilst this helps explain the deferred vesting of these

amongst technology firms seems to present a puzzle, as innovative firms are typically more risky than the average public firm.[84] These would seem to be the *least* likely firms to use broad-based equity compensation to align incentives.[85]

C. Options and incentives to innovate

To be sure, not all varieties of equity compensation involve the same level of risk sharing. Paying agents with stock exposes them to downside risk—that is, the risk that the stock price might go down—whereas option compensation involves only upside risk. Options can thus be used to encourage agents to *take* risks, where this is in investors' interests. This seems potentially more promising in relation to technology firms. The exploration of new technologies is inherently risky for employees who invest in associated human capital; employees paid in options will be more willing to take such risks. An important recent study by Chang et al bears this out.[86] The authors distinguished between stock-based and option-based compensation, finding that broad-based option compensation—which gives upside rewards but no downside

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entitlements, it does not explain why relatively costly equity grants are used, as opposed simply to deferred performance-linked cash compensation: see Oyer & Schaefer, *supra* note 81, 110.

[84] Indeed, Oyer and Schaefer report that the use of broad-based equity compensation is more likely the *higher* a firm's stock price volatility: Oyer & Schaefer, *supra* note 81, 128.

[85] An explanation sometimes offered for tech companies' use of equity compensation is that it overcomes liquidity constraints, sparing the firm the need to use cashflows to pay employees. Whilst this may be plausible for start-ups, it is less so for more established companies, such as Apple, Facebook and Google, which are not cash-constrained but still use broad-based equity compensation schemes.

[86] Xin Chang, Kangkang Fu, Angie Low and Wenrui Zhang, Non-Executive Employee Stock Options and Corporate Innovation, 115 J Fin Econ 168, 182 (2015).

losses—is conducive to both the quantity and quality of a firm's innovation (measured by patent output and citations, respectively).[87]

Two aspects of Chang et al's results help to distinguish the options-for-innovation from the more traditional equity-for-incentives story. The first is that the sensitivity of the valuations of broad-based option compensation to corporate risk-taking ('vega') is strongly associated with corporate innovation, whereas their corresponding sensitivity to movements in the stock price ('delta') is not. That is to say, the utility of broad-based option compensation for technology firms likely lies in their propensity to encourage risky innovation, rather than in encouraging employees to take actions which are calculated to increase the stock price. This is consistent with the account we have developed above whereby the stock price does not fully reflect the future expected value to the firm of its current innovative projects.[88] The second is that the effect of options in encouraging innovation is dulled when used in combination with employee stock ownership, which makes employees more risk-averse.

The options-for-innovation story does a lot to explain the use of broad-based option compensation amongst technology firms. But the use of restricted stock is still a puzzle. Indeed, because employee stock ownership appears to dull incentives to innovate, the options-for-innovation story predicts that the broad-based equity compensation schemes used in technology companies should consist primarily of options. Yet leading technology companies in fact use a mixture of options and restricted stock.

[87] *Ibid*, at 182-5.

[88] *Supra*, Section II.D.

D. Stock compensation as a signal: harnessing the wisdom of techies

The explanations considered so far have focused on the incentive properties of equity compensation, arguing that the goal of such schemes is to align employees' payoffs with those of outside shareholders so as to incentivise the former to take actions that are in the latter's interests. As an explanation for the use of restricted stock, this seems unpersuasive.

An alternative account is that, rather than operating as a means of controlling agency costs between employees and shareholders, stock compensation serves as a way of managing agency costs between controllers and other shareholders.[89] The constraint imposed on tech firm controllers by broad-based stock compensation can be explained simply using our analytic framework. An emerging technology is by definition understood only by a finite number of people. Amongst those best-placed to understand it will be the firm's technical and scientific employees. These employees are likely to have comparative advantage in understanding and contextualising new information emerging about developing technologies or products in the firm's project pipeline. They will thus be well-placed to assess the quality of the controller's decisions—or the systems the controller implements for delegating decision-making—in relation to this new information. That is, the employees will likely be better placed than the market to judge *ex ante* whether the founder uses their control to make decisions which may be expected to be value-increasing.

[89] A related story is that a compensation package involving high levels of volatility will be relatively more attractive to employees who have low levels of risk aversion, and thus help the firm to select more 'entrepreneurial' staff (Oyer & Schaefer, *supra* note 81, at 109-10). On this analysis, restricted stock compensation serves to screen employees, overcoming asymmetric information about new recruits' risk preferences.

At the IPO stage, the fact that employees in a tech firm are willing to accept restricted stock as a significant component of their compensation package sends a signal to outside investors that these employees have confidence in the firm's project pipeline. If the firm has dual-class stock, and the employees are compensated in Class A stock, this also sends a signal that the employees, who have been with the firm since well before the IPO, have confidence in the founder's judgment. Paying employees in restricted stock is costly because of the need to include an element of risk premium. Consequently the use of such a signal would be expected to be focused on firms for which the benefits, in terms of overcoming information asymmetries, are most significant—namely dual class firms.

After the IPO stage, and during the life of a tech firm as a public company, employees paid in restricted stock have an incentive to monitor closely internal information about the success of the firm's projects. In a dual-class firm, this will include the founder's judgments about project investment and continuation. Exercises of control by the founder that employees view as harmful for the firm's long-run performance—*a fortiori*, rent-extraction activity—will devalue the employees' stock compensation. This will put the firm at risk of losing employees to competitors. The loss of key employees may therefore be expected to send a negative signal to outside investors about the quality of the founder's decision-making.

The fact that employee departures depress the stock price may not in itself be of great concern to an entrenched founder. Precisely because the founder is entrenched, they have little reason to care about the stock price, unless they plan to return to the stock market to raise further capital in the future. Yet the loss of key employees will hurt the firm, and through that, its founder, in other ways. First, the finite the supply of individuals who have the

necessary competences to work on the firm's innovative projects means that the firm may struggle to replace employees with people of similar calibre. Second, partially-executed technical innovations are at best incompletely protected by non-compete and non-disclosure agreements. So not only may the firm's capacity to execute its projects suffer from the loss of technical personnel, but competitors' capacity may be enhanced. Thus the founder will be at pains to avoid employees leaving.

To be sure, the fact that stock compensation is usually paid on a vesting schedule over a period of years puts a constraint on employees' willingness to exit. This deters employees from leaving at the first sign of trouble. But if a sustained pattern of poor decision-making emerges, employees are unlikely to want to wait around to be able to cash in compensation that may, by the time the vesting schedule is complete, be worthless. Moreover, vesting schedules are not the same for each employee—they will vary depending on tenure, meaning that there will likely always be a set of employees whose retention is more marginal.

Another tactic a founder might deploy to prevent employee departures would be to increase the cash component of employees' compensation if their equity component declines in value. However, this could be very counter-productive, as the founder might thereby send an adverse signal to employees about the founder's own assessment of the company's trajectory, in turn increasing the employees' reservation price.

In sum, therefore, the need to retain key employees means that offering them restricted Class A shares as part of their compensation package puts a significant constraint on founders' incentives to take actions that may harm returns to Class A shareholders. In short, this may be expected to constrain rent-seeking activity and to encourage consensus-based decision-making

(as between founder and employees) regarding project selection and execution. The employees' technical competence will thus credibly be fed into the firm's innovation decisions. And the conventional logic of employee share schemes—that employee payoffs are made to follow shareholders', so as to align employees' incentives, is reframed: outside shareholders' payoffs are made to follow employees, so as to align founders' incentives.

E. Case study: Facebook's Employee Incentive Plan

We can flesh this point out through a case-study of the broad-based employee compensation scheme at Facebook. Facebook has a dual-class stock structure, under which Mark Zuckerberg, the founder, has 10-vote-per share Class B stock giving him 60.1% of the voting rights but only 15.2% of the cash flow rights. Facebook also has in place a broad-based equity compensation scheme, known as its 'Equity Incentive Plan' (the 'EIP'). Facebook's Proxy Statement explains that its EIP is intended, amongst other things, to 'align the objectives of our stockholders and our employees'.[90] The EIP gives Facebook's Compensation Committee the power to make performance-related pay awards, including grants of stock options and restricted stock, to any of Facebook's employees.[91]

Since the EIP was adopted after Facebook's IPO in 2012, awards of just under 4 million one-vote-per-share Class A shares have been made to executives, whereas nearly 133 million

[90] Facebook DEF14A 2015, 46.

[91] *Ibid*, 47 (any of 10,042 employees as of March 31, 2015). As of December 31, 2014, Facebook had a total of 2,234 million Class A shares issued (Facebook 10K 2014, 56). The EIP awards therefore amount to 6% of the total Class A capitalisation, or 5% of the company's total cash flows (including 563 million Class B shares issued as of December 31, 2014).

have been awarded to non-executive employees.[92] Facebook's income statement shows that the use of EIP shares is focused in particular on employees involved in R&D. In 2014, the total awards were expensed at $1,837m, of which $1,328m, or 72%, related to R&D. This in turn comprised 50% of Facebook's total R&D expenses for the year. Moreover, the vast majority of the EIP shares issued take the form of restricted stock units, as opposed to options. As of the end of 2014, Facebook had 138 million restricted stock units outstanding, as opposed to only 13 million outstanding option awards.[93]

The picture that emerges is that employees working in R&D for Facebook, who are crucial for the firm's success, are the largest recipients of the firm's equity compensation. What is more, over 90% of the firm's equity compensation awards take the form of restricted stock. This is puzzling if we focus simply on incentives to innovate, which would be greater if the compensation took the form of options, and which the literature suggests are actually dulled by employee stock ownership. But it is consistent with a picture in which the employees, through their willingness to accept compensation the value of which varies with the stock price, and which is restricted for a period of several years, signal their belief in the firm's prospects. In the case of a firm with a dual-class stock structure such as Facebook, the employees' stock compensation signals their belief about the firm's prospects to outside investors. This gives the outside investors reassurance that Zuckerberg will use his control rights in accordance with their stated rationale—to foster long-term value—rather than to extract rents from outside investors.

[92] *Ibid,* 51. A further 96,000 have been awarded to non-executive directors.

[93] Facebook 2014 10K, 77-78.

F. The Constraining Effect of Restricted Stock: Zynga

A key step in our analysis of the way in which stock compensation makes tech company employees delegated monitors for outside investors is the assertion that employees will be likely to leave if the founder uses their control in a way that is extractive, or simply fails to maximise (in the employees' eyes) the value of the firm's innovative projects. We can illustrate this conjecture with the case of Zynga, which seems a textbook example of the costs of founder entrenchment.

Zynga produces web-based social games that piggyback on Facebook's social media platform. These are free for users to play, generating revenues through sales of performance-enhancing virtual goods. Zynga achieved considerable early success with the hit game 'Farmville', and went public in December 2011 with a market valuation of $9 billion.[94] Under the firm's capital structure, Zynga's founder and CEO, Marc Pincus, retained control of the voting rights but only 16% of the cashflows.[95] The firm encountered serious headwinds in 2012 when Facebook shifted emphasis from desktops to mobile media. Zynga struggled to adapt its games to the mobile format, and suffered a big writedown following a botched acquisition.[96] Pincus, who received the dubious accolade of being dubbed one of America's 'worst CEOs' in 2012 after the firm's stock price declined over 75% that year,[97] stepped aside in 2013 and

[94] See generally, Dean Takahashi, How Zynga Grew from Gaming Outcast to $9 Billion Social Game Powerhouse, Venturebeat (2011); Vanessa Grigoriadis, Ol' Mark Pincus Had a Farm…, Vanity Fair, June 2011.

[95] Zynga 10-K, Feb 28, 2012, 57; DEF 14A, April 27, 2012, 44.

[96] Evelyn M. Rusli, Behind Marc Pincus's Bid to Save Zynga, Wall Street Journal, Nov 15, 2012.

[97] See eg, Sean Williams, Our Second Nominee for Worst CEO of the Year: Marc Pincus, The Motley Fool, Sept 28, 2012; Sydney Finkelstein, The Five Worst CEOs of 2012, Washington Post, Dec 18, 2012.

appointed Microsoft veteran Don Mattrick as CEO.[98] Mattrick was however unable to turn the company around, and he departed in April 2015, with Pincus returning as CEO in a move that seems a clear example of the costs of founder entrenchment.[99] One commentator asked, '[i]f Marc Pincus was the wrong CEO before, what makes him right for the job now?'[100] Pincus' first significant action since re-taking the helm has been to cut costs by firing just under a quarter of its workforce.[101]

The poor judgment exhibited by Zynga's founder appears to have impacted negatively on employee morale and retention. According to a Wall Street Journal account, part of the reason Zynga was unable to adapt quickly enough to mobile media was because of defections of key programmers, who had lost confidence in the firm's direction.[102] In response, Pincus reportedly offered employees extra stock compensation and sought to foster greater openness to employee concerns.[103] These concerns also feature in Zynga's risk factors disclosed in its periodic reports. Zynga's May 2015 10-Q notes,[104]

> "[O]ur ability to execute our strategy depends on our continued ability to identify, hire, develop motivate and retain highly skilled employees, particularly game designers, product managers and engineers. These employees are in high demand, and we devote

[98] Shira Ovide, Zynga's Pincus Joins Tech Founders Who Yielded to Pro CEOs, Wall Street Journal, Jul 1, 2013.

[99] Tom Huddleston, Jr., Zynga Cofounder Pincus Returns as CEO Two Years After Stepping Down, Fortune, Apr 8, 2015.

[100] Richard Greenfield, Zynga Reminds Us to be Careful What We Wish For, Apr 10, 2015.

[101] Dan Gallagher, Zynga's Oldest Game, Wall Street Journal, May 6, 2015.

[102] Rusli, *supra* note 96.

[103] *Ibid.*

[104] Zynga 10-Q, May 7, 2015, 47.

> significant resources to identifying, recruiting, hiring, training, successfully integrating and retaining them. We have experienced significant turnover in our headcount over the last year, which has placed and will continue to place significant demands on our management and our operational, financial and technological infrastructure. As of March 31, 2015, approximately 33% of our employees had been with us for less than one year and approximately 51% for less than two years.
>
> … In addition, our recent operating results, the decline in our revenue and the current trading price of our Class A common stock may cause our employee base to be more vulnerable to be targeted for recruitment by competitors. Some of our employees may have been motivated to work for us by an expectation that our Class A common stock would be trading at a higher value and may be less motivated by the equity compensation they receive as a result. Competitors may leverage any resulting disappointment as a tool to recruit talented employees. Competition for highly skilled employees is intense, particularly in the San Francisco Bay Area, where our headquarters is located."

The point of this section is not to demonstrate that recruiting employees as monitors through the use of stock compensation serves to *prevent* entrenched founders from using their control rights to make bad or self-serving decisions. Rather, it is simply to show that such stock compensation serves—through the link to employee retention—to increase the costs to founders of such decisions, and thereby *helps* to commit the founder to avoid rent extraction and take on board employees' wisdom.

H. Dual-class vs Single-class tech firms

Our account suggests that broad-based stock compensation plans should be particularly attractive for tech firms with dual-class capital structures. Stock compensation is a relatively

costly way to pay employees for performance, as compared with options, because it loads downside risk onto employees and is not associated with beneficial incentives to innovate. If stock compensation has a beneficial effect as a way of reducing founder agency costs, then we might expect dual-class firms to be relatively more willing to incur this cost.

To investigate this conjecture, we explored the relative use of stock and option based equity compensation by leading technology firms. Table 1 presents data on the numbers of Class A shares outstanding in unvested grants of restricted stock units (RSUs) and stock options, as revealed by the 2014 annual reports and proxy filings of a sample of tech companies. This sample is non-random; it consists simply of the firms named as peers in Facebook's executive compensation statement plus tech firms known to have done IPOs with dual-class capital structures.[105] Of the 17 firms in the table, six have dual-class capital structures, and the rest do not. The mean ratio of stock options to RSUs outstanding under non-executive (broad-based) compensation schemes in the dual-class firms is 0.34; for the single-class firms it is 0.61. Thus on average twice as many RSUs, relative to stock options, are used in dual class firms.[106] Whilst little can be read into results based on a small, non-random sample, this difference is at least suggestive.

[105] Three firms were excluded: one (Microsoft) because its securities filings did not differentiate quantitatively between RSU and option grants, and two (Oracle and Yelp) because they were outliers. Oracle, a single-class firm, had 462 million Class A shares subject to outstanding stock options, but no RSUs, implying an infinite ratio of options to RSUs; Yelp, a dual-class firm had a ratio of options to RSUs of 7.63, more than two standard deviations above the mean value for all dual-class firms in the sample.

[106] Unsurprisingly given the small number of observations, a t-test of the difference in means is insignificant ($p = 0.186$)

Table 1: Outstanding broad-based equity compensation awards as of 2014 (000s of Class A shares)

Company	A. RSUs	B. Options	Ratio (B/A)	Dual class?
Adobe Systems	13,564	3,173	0.23	No
Amazon	17,400	400	0.02	No
Apple	103,822	6,600	0.06	No
Cisco Systems	149,000	187,000	1.26	No
eBay	36,000	10,000	0.28	No
EMC	53,000	40,000	0.75	No
Facebook	138,055	12,984	0.09	Yes
Google	24,620	7,240	0.29	Yes
Groupon	41,338	2,263	0.05	Yes
Hewlett Packard	40,808	57,853	1.42	No
Intel	119,400	75,900	0.64	No
LinkedIn	5,141	3,028	0.59	Yes
Qualcomm	28,550	42,113	1.48	No
Twitter	64,135	20,420	0.32	No
VMWare	12,585	5,869	0.47	Yes
Yahoo	40,677	9,225	0.23	No
Zynga	69,883	39,460	0.56	Yes

Source: SEC Filings.
Note: VMWare is a controlled subsidiary of EMC Corporation.

VI. Conclusion

In this paper, we have focused on the relationship between finance and knowledge in relation to exploratory innovations. Projects pursuing exploratory innovations are by definition understood only by a limited number of people, and entrepreneurs wish to keep it that way in order to maximise their proprietary returns. Where external finance is needed to execute such projects, this poses a challenge. Investors, fearing opportunism, are unwilling to advance funds without control. But investor control without understanding is liable to impede the successful execution of the innovative project.

We have considered the relative (dis)advantages of four modes of financing exploratory innovation. Public equity markets are very effective at aggregating information about firms using established technologies. But novel technologies appear to introduce a wedge between stock price, which responds to publicly-available indicators, and the judgments of insiders about the value of the firm's projects. This can impede the firm's ability to execute innovation if its management's incentives are too closely tied to the stock price. Specialist investors, such as venture capitalists, can lower the gap between entrepreneurs' and investors' understanding of the project. However, VCs generally take tight reins on control, which increases the costs of their *mis*understanding. And the more novel the innovation, the fewer such specialists capable of understanding it. This imposes high search costs, and limits the extent to which knowledgeable VC investment can scale to match entrepreneurial demand.

Crowdfunding involves raising finance from multiple private investors via the internet. Unlike VC finance, equity crowdfunders have no specialist knowledge and no control over their investee companies; unlike equity market investors they have no secondary market to assist in aggregating information relevant to price formation. This seems almost tailor-made to maximise the costs of investment without knowledge, which are likely to fall primarily on overly optimistic investors.

In contrast, we suggest that reward (or pre-order) crowdfunding does help to aggregate relevant information from investors—about their demand for the product. Because funding is conditional on a target being met, this creates an effective 'milestone' based on realised market demand. Yet this funding mode gives the entrepreneur discretion over that aspect of the

production decision she understands better than her consumers—the technical viability of production.

The other constituency with relevant expertise that may be harnessed in financing is a firm's employees. Technology firm employees are key to successful innovation, and have both technical knowledge and inside information relevant to assessing the expected viability of the firm's projects. Finance can be 'raised' from employees through stock compensation. This is costly for the firm, because of the risks the employees thereby bear. But in our analysis, employee share ownership helps sustain a greater allocation of discretion by outside investors to controlling founders. Because of the limited accuracy of stock price valuations, giving outside investors tight control rights is counterproductive, as we have discussed. On our view, employee stock ownership may help founders to commit to outside investors not to abuse such discretion. Knowledgeable employees are in short supply in the labour market. If they are paid in stock, they will leave if the firm's prospects do not—from the inside—look attractive. An exodus of employees in turn will hurt the founder's ability to continue to operate the firm. Linking the outside investors' returns to employees' returns means that the former are able to benefit from the founder's accountability to the latter.

Policymakers in both the US and the EU are keen to facilitate the financing of innovation. This is a central theme underlying the US JOBS Act of 2012 and the European Commission's proposed Capital Markets Union. However, the central plank of these reforms consists of reducing the costs to firms of accessing investors *by relaxing disclosure obligations*. This seems calculated only to increase the size of the wedge between market pricing and insiders' assessments of the value of innovative projects. Our analysis in contrast emphasises

the importance of investors' knowledge. None of the policy measures under consideration would directly enhance the stock of investors' knowledge.[107] Given this, progress can be made through the use of financial contracts that appropriately harness available knowledge. We have illustrated two examples whereby this can happen beyond traditional 'investors'—reward crowdfunding harnessing the knowledge of consumers and stock compensation harnessing the knowledge of employees. The implications are, however, likely too granular to be capable of informing broad policy prescriptions, save for one. This is that corporate governance rules imposing a mandatory allocation of control rights, as opposed to permitting contractual flexibility, are unlikely to be beneficial for stimulating innovation.

[107] Indeed, the only plausible way in which this might be done is through subsidising technical research and tertiary education, which is for most governments not a Treasury or Finance matter.