The Real Effects of Accounting on Innovation: Evidence from ASC 606

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Abstract

This study investigates the impact of the recent revenue recognition rule change, Accounting Standard Codification (ASC) 606, on drug development firms' investments in R&D alliances and innovation outcomes. ASC 606 allows managers to change revenue recognition timing and increases disclosure requirements. I first document that drug development firms dependent on R&D alliance revenues accelerate revenue recognition and concurrently disclose more about the recognition process following ASC 606 adoption. Consistent with the net result being a decrease in information asymmetry between managers and investors, these firms access more capital and increase investments in R&D. Importantly, they form more R&D alliances consistent with the information asymmetry between peer firms also decreasing upon adopting ASC 606. In particular, firms that primarily provide technology in return for payments before ASC 606 become more likely to pay and acquire technology after ASC 606. Thus, the structure of alliances within the industry significantly changes. Finally, I show that affected drug development firms exhibit higher innovation, proxied for by the number of drug candidates, number of patents, patent values, and citations. These findings suggest a specific and concrete mechanism of the real effects of a specific financial reporting standard on R&D alliances and innovation outcomes.

Keywords: Real effects, innovation, R&D Alliances, ASC 606, revenue recognition

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1 Introduction

A central issue in accounting research is the extent to which alternative accounting regulations affect managers' investment decisions. Despite the topic's importance, there is a paucity of research on the specific mechanisms through which accounting affects investment decisions and investment efficiency (see Roychowdhury, Shroff, and Verdi, 2019; Leuz and Wysocki, 2016; Kanodia and Sapra, 2016). In this study, I contribute to this line of research by examining the impact of the new revenue recognition standard, ASC 606, on R&D alliances and innovation, which are crucial investments and outcomes. To do so, I focus on drug development firms (or the "life sciences industry"), an economically and socially important industry in which R&D alliances are ubiquitous, and there are precise and timely innovation measures (number of drug candidates, patents, patent citations, and patent values).[1]

R&D alliances are a common type of R&D investment and critical for innovation, particularly in high-technology industries like drug development (e.g., Robinson, 2008; Lerner and Rajan, 2006). These alliances are the arrangements between a *principal* firm, which provides intellectual property (IP), and a *partner* firm, which pays the principal for access to the technology provided, to co-develop a technology or drug.[2] For principal firms, revenue recognition from alliances is complex because technology deliveries to and payments from partners occur across multiple reporting periods. ASC 606 has a pronounced effect on principal firms because it significantly changes the recognition of alliance revenues for such firms.

In fiscal years starting after December 15, 2017, public firms were required to adopt ASC 606. This principles-based standard allows managers to change the timing of revenue

[1]Specifically, my sample consists of pharmaceutical and biotechnology companies that have drugs in active development or in use. Due to federal reporting regulations, drug development firms have reduced ability to keep their intellectual property (IP) a secret. Thus, unlike other high-technology industries, patenting occurs at the beginning of the innovation process. A more detailed discussion of the industry is in Section 2.2.

[2]One of the most famous examples is BioNTech and Pfizer alliance to develop a COVID-19 vaccine. In this example, BioNTech provides mRNA based vaccine technology and Pfizer pays upfront, milestone, and royalty payments to BioNTech.

recognition (e.g., via the determination of performance obligations in a contract) and increases required disclosure about the revenue recognition process (e.g., specific performance obligations) (KPMG, 2018; Deloitte, 2017). Specifically, principal firms accelerate revenue recognition from alliance revenues and disclose more about the recognition after ASC 606 adoption.[3]

These changes potentially affect R&D alliances and subsequent innovation outcomes because of the change in information asymmetry between managers and investors, and between different firms. In the industry, a primary friction that interferes with innovation investments is agency costs due to information asymmetry between managers and investors (e.g., Krieger, Li, and Papanikolaou, 2021). High information asymmetry between managers and investors increases the cost of external capital. Thus, to avoid costly external financing, managers underinvest in innovative projects, which are inherently riskier than other investments like capital expenditures. Furthermore, information asymmetry between firms, in particular between potential principals and partners, is a major friction for R&D alliance formation (e.g., Lerner and Malmendier, 2010). Specifically, high information asymmetry between firms increases awareness/search costs for the potential principal-partner matching and hampers the contractability of R&D alliances after principal-partner matching. Thus, if ASC 606 changed information asymmetry, it potentially also affected alliances and innovation outcomes.

The effect of ASC 606 on the information content of the financial statements is not obvious. It depends on two offsetting effects on the credibility of financial statements under ASC 606 (Dye, Glover, and Sunder, 2014; Gao and Jiang, 2020). On the one hand, since the timing of revenue recognition under ASC 606 is more dependent on managements' discretion compared to the old standard, managers can use this extra discretion opportunistically in a way that reduces the credibility of their financial statements. On the other hand, ASC

[3]For example, Exelixis, a biotech company, explains one effect of ASC 606: "Collaboration revenues recognized for the three months ended March 31, 2018 in accordance with Topic 606 included $45.8 million in revenue relating to a $50.0 million milestone from Ipsen for the approval of cabozantinib for the first-line treatment of advanced RCC that would not have been recognized under Topic 605..." Importantly, the earlier recognition does not change the timing of firms' cash flows from the contracts. Firms increase revenue, i.e., stockholders' equity, by only decreasing deferred revenue, i.e., a liability.

606 requires enhanced disclosures of interim performance obligations that provide additional information to both investors and potential alliance participants, and clearly articulate when they have been met. The combination of the extra discretion afforded by ASC 606 and the expanded disclosures provides managers with the opportunity to credibly accelerate revenue recognition. I test whether the accelerated revenue recognition and accompanying disclosures that support this recognition are jointly incrementally informative and alleviate information asymmetry between managers and investors, and among different firms who are potential collaborators. Explicitly, I test whether principal firms exhibit (a) lower bid-ask spreads, (b) greater access to capital, (c) increased R&D alliances, and (d) more innovation after adopting ASC 606.

I use a sample of 7,615 firm-quarters over the period 2014-2019. Identification in my empirical analysis relies on life sciences firms having two distinct types of operating revenue, with the mix varying across different firms: direct sales (i.e., revenues from sales of products and services) and R&D-contracts-driven alliance revenue (in the form of upfront, milestone, and royalty payments). While ASC 606 does not materially affect revenue recognition from direct sales, it does significantly affect alliance revenues. Under the new standard, alliance revenues that were historically mostly deferred are now recognized as interim performance obligations are met. I use the firm's dependence on alliance revenues prior to ASC 606 adoption to identify the treatment, that is, the effect of the rule change on life sciences firms' alliance formation and innovation outcomes. I determine a firm's dependence on alliance revenue based on its median ratio of alliance revenue to total revenue between 2014-2016. This ratio serves as a continuous treatment variable in the difference-in-differences (DiD) design analysis.[4] For there to be an endogeneity concern with the research design, any correlated omitted variable must not only vary with alliance revenue dependence, but its effect must also vary across time. This concern can be mitigated by testing for if the parallel

[4]Note that higher alliance revenue dependence implies that corresponding firms have a greater net tendency to enter R&D contracts as principals. That is, such firms (typically smaller) provide the R&D technology and/or know-how that partners (typically much larger firms) gain access to through alliance payments.

trends assumption holds before ASC 606 adoption.

I first provide evidence showing that ASC 606 provides more information about revenues with more disclosures and acceleration in revenue recognition. I confirm a significant (a) increase in revenue recognition related disclosures, (b) increase in revenues, and (c) decrease in deferred revenues after ASC 606 adoption in more alliance revenue-dependent (ARD) firms (relative to firms that are less ARD).[5] Consistent with the net result of ASC 606 being a decrease in information asymmetry between managers and investors, I find that ARD firms have significantly lower bid-ask spreads after the ASC 606 adoption. Furthermore, I find that this result holds only if the acceleration in revenue recognition and increase in disclosure occur together. This is in line with the acceleration in revenue recognition and accompanying disclosure mutually reinforcing each other under ASC 606. Finally, I show that with decreased information asymmetry between managers and investors, ARD firms have more access to external capital proxied by more equity issuance after ASC 606 adoption.

Turning to innovation-related *real* outcomes, I find that ARD firms increase their R&D investments. One of my critical findings is that, after ASC 606, ARD firms are more likely to enter R&D alliances as partners (i.e., investors accessing the technology), consistent with the decrease in information asymmetry between peer firms. However, before ASC 606, ARD firms historically developed their technologies within the firm and gave R&D alliance partners access to these technologies. Consequently, the structure of alliances within the industry significantly changes because firms that primarily provide technology in return for payments before ASC 606 become more likely to pay and acquire technology after ASC 606. Importantly, the innovation outcomes for ARD firms can potentially change since alliances provide more successful technology development outcomes (Danzon, Nicholson, and Pereira, 2005). I next examine if this increase in R&D alliances yields greater innovation among ARD firms. My first finding is an increase in granted patent applications in ARD firms. Second, I

[5]Since alliance revenue-dependence is a continuous treatment variable, there is no ARD or non-ARD firm. However, for ease of readability, I refer to "more ARD firms" as "ARD firms" hereafter.

find the total value of these patents, both in terms of the equity market reaction and patent citations, is higher for the ARD firms.[6] Third, I find that ARD firms produce more drug candidates. These findings suggest economically significant changes. For instance, ARD firms produce 15.8% more drug candidates after ASC 606 adoption relative to the sample average before ASC 606. Furthermore, cross-sectional analysis shows that the increase in R&D alliances and innovation is stronger when information asymmetry between firms is expected to be higher in the pre-ASC 606 period, (a) when ARD firms are less central in the alliance network before ASC 606 adoption, that is, ARD firms have less private communication channels (Kepler, 2021), and (b) when alliances occur between ARD firms and private firms, that is, when alliance firms have limited resources to acquire information (Kim and Valentine, 2022). These findings suggest that ASC 606 significantly changes the R&D investment structure in the life sciences industry and facilitates more innovation by alleviating information asymmetry between managers and investors, and between peer firms.[7]

To strengthen my inferences, I conduct a battery of robustness tests. First, one potential concern is endogeneity due to correlated omitted variables. I show that the parallel trends assumption holds before ASC 606 adoption in the estimation of alliance formation and innovation outcomes since there is no significant change in the coefficients of interests before ASC 606 adoption. The significant increase in these coefficients starts after ASC 606 adoption. This mitigates concerns of correlated omitted variables. Second, one concern about increasing alliances is whether it is an opportunistic change. For instance, after ASC 606, it is possible that managers increase alliances opportunistically to exploit favorable revenue recognition treatment. Even though this would not explain an increase in innovation, I implement a falsification test to address this concern. Specifically, if the increase in R&D alliances reflects an opportunistic attempt to increase revenues, I expect to find ARD firms

[6]There are two caveats related to citation analysis. First, it can only be done for the granted patents. Second, recently published patents are less likely to receive citations than older ones. However, this issue biases against the findings and do not impose a threat to the findings.

[7]Naturally, these results raise the question of why firms couldn't achieve the same results via voluntary disclosures. I give three explanations based on proprietary costs, the credibility of disclosures, and specialization in Section 2.4.

significantly increasing R&D alliances as principals (i.e., receiving payments and recording alliance revenue). However, consistent with the increase in the R&D alliances being a strategic but not opportunistic response to declining information asymmetry, I find that ARD firms exhibit no change in their tendency to be principals in R&D alliances.

This study contributes to several streams of literature. My first contribution is to the literature on the real effects of accounting (e.g., Roychowdhury et al., 2019; Leuz and Wysocki, 2016). I study the role of accounting regulations in innovation, where the evidence is scant (Simpson and Tamayo, 2020; Leuz and Wysocki, 2016). I provide a specific and unique mechanism on how ASC 606 changes innovation activities and innovation outcomes, which are vital to economic growth. Particularly, this is the first paper that shows the facilitating role of accounting information in the formation of R&D alliances and subsequent innovation. There are prior and concurrent studies providing evidence of the effect of accounting standards and financial reporting on R&D investments (e.g., Biddle, Hilary, and Verdi, 2009; Shroff, 2017) and innovation (e.g., Allen, Lewis-Western, and Valentine, 2022; Williams and Williams, 2021; Breuer, Leuz, and Vanhaverbeke, 2021). However, except for Williams and Williams (2021), these studies focus on broad regulation changes, and none of them provide evidence on the effect of a financial reporting practice on *specific* investments in R&D and related outcomes. Thus, this study especially contributes to the recent call for more research on specific accounting regulations and specific mechanisms through which accounting information affects firm investment levels and efficiency (Roychowdhury et al., 2019; Kanodia and Sapra, 2016; Leuz and Wysocki, 2016).

Second, this study is related to the long-standing literature that discusses principles versus rules-based accounting standards (e.g., Schipper, 2003; Herz, 2003; Dye and Verrecchia, 1995). ASC 606 replaces rules-based revenue recognition with principles-based guidance and requires more disclosure. Thus, it is a well-suited setting to study the intended and unintended consequences of replacing stringent rules-based accounting standards with more flexible principles accompanied by enhanced supporting disclosures. Extant theory suggests

that more flexible standards are more informative (Gao and Jiang, 2020) and perform better when they are credible (Dye and Sridhar, 2008; Dye et al., 2014). I find ASC 606 improves the information content of revenues, especially for firms with complex revenue streams, consistent with concurrent work on ASC 606 (Choi, Kim, and Wang, 2022). Consequently, my study provides empirical evidence supporting these hypothesized capabilities of accounting standards on information asymmetry by showing the alleviation of information asymmetry between firm management and market participants with the adoption of ASC 606 in the US, a high enforcement regime where mandatory accounting disclosures are credible. Furthermore, I provide evidence on *real* effects of ASC 606, which is unique to the best of my knowledge.

My final contribution is to the innovation literature. This study sheds light on the conflicting results on whether large or small firms yield more innovation. Akcigit and Kerr (2018) find that small firms engage in more disruptive innovation since they have more incentives to do so compared to large incumbent firms. However, by considering costly external financing and the riskiness of radical innovation, Krieger et al. (2021) find that large drug development firms are more likely to develop novel products compared to small drug development firms. My study provides new insights into Krieger et al. (2021). Specifically, my study suggests that one potential reason that impedes innovation in small drug development firms is the information asymmetry arising from alliance revenue recognition. ARD firms, which are typically smaller firms, invest more in R&D alliances and exhibit more innovation when information asymmetry about their revenues decreases with accelerated revenue recognition and accompanying disclosures for alliance revenues.

Two caveats apply to my study. First, the generalizability of my results might be limited. I focus on the life sciences industry because of the ubiquity of R&D alliances and precise innovation measures, and I would expect the results to apply to any high technology industry because of widespread R&D alliances, but the results may not be fully generalizable to all industries. However, this industry is important in and of itself to understand R&D

investments and innovation as it constitutes 14% of aggregate R&D expenditure in the US, according to the National Science Foundation. Furthermore, even a small improvement in medical innovations can yield enormous welfare gains (Murphy and Topel, 2006; Filson and Oweis, 2010). Second, ASC 606 might not be an exogenous shock. The mix of revenues from direct sales versus alliances can be an endogenous strategic firm choice, and I use alliance revenue dependence as a continuous treatment variable to identify the average effect of ASC 606 on ARD firms. In this case, firms can act strategically in anticipation of the ASC 606 effect (i.e., "anticipation effect"). However, alliance revenue dependence is computed based on the median ratio of alliance revenue to total revenue using the subsample period ending two years before ASC 606 adoption. Thus, the anticipation effect concern is mitigated, and the effect of ASC 606 on the industry is likely to be exogenous (Abbring and Van Den Berg, 2003; Wooldridge, 2021).

2 Institutional Settings and Hypothesis Development

2.1 Revenue Recognition and ASC 606

Revenue is one of the key metrics to assess firm performance and one of the most persistent single items in financial statements (Schipper, Schrand, Shevlin, and Wilks, 2009), but there was no general revenue recognition standard in the US prior to 2014. In May 2014, FASB published an Accounting Standard Update (ASU) on "revenue recognition from contracts with customers," later known as Accounting Standard Codification (ASC) 606, after long discussions on the general revenue recognition standard (Schipper et al., 2009; Maines, Bartov, Fairfield, Hirst, Iannaconi, Mallett, Schrand, Skinner, and Vincent, 2003).[8] The vast majority of companies adopted it starting the fiscal year on December 15, 2017.[9]

[8]While replacement of the revenue recognition standard decision did not occur in a vacuum, the change was not immediately after an economic or political incident. Thus, there is less concern that my results are driven by incentives of policy makers (Watts and Zimmerman, 1979) and correlated omitted variables around the standard change (Leuz and Wysocki, 2016).

[9]FASB allowed either full retrospective adoption, in which a firm applies the new standard to all of the financial statements presented, or modified retrospective adoption, in which the new standard is applied only

The new revenue recognition standard replaces stringent and disparate industry-based rules with a principles-based revenue recognition model containing the following general five-step framework for all firms (FASB, 2016):

1. Identify contract(s) with customers
2. Identify the separate performance obligations in the contract
3. Determine the transaction price
4. Allocate the transaction price to separate performance obligations
5. Recognize revenue when (or as) each performance obligation is satisfied

One of the most significant changes with ASC 606 is the introduction of performance obligations. Firm management must break down the transaction into smaller performance obligations, which can involve significant judgment. ASC 606 also requires managers to disclose performance obligations and any judgment involved in the process. Thus, FASB aims to increase the information content of revenue by matching it to performance obligations and additional disclosure requirements.

Another significant change from the previous revenue recognition standard is in the determination of the transaction price when a contract involves "variable consideration", i.e., the payment amount a firm will receive is contingent on a future event. Both fixed payments and probable future payments involving variable consideration are included in the transaction price. Prior to ASC 606, variable consideration was typically deferred until the amount was known. However, variable consideration is now estimated and included in the transaction price either via expected-value or most-likely-amount methods if there is no significant reversal risk. In this case, firms have to disclose how they implement variable consideration. As a result, the new standard tends to accelerate revenue recognition of variable consideration

to the current and future financial statements. Even though the modified retrospective method decreases comparability between the past and present, because of its convenience, most of the companies used this approach.

with more disclosure but involves significantly more judgment since it must be estimated when initially determining the transaction price.

2.2 Drug Development Industry

A drug is brought to market upon regulatory approvals (e.g., from Food and Drug Administration (FDA) in the US and European Medicines Agency (EMA) in Europe) after a typically long (10-15 years) and costly ($2.56 billion) process (DiMasi, Grabowski, and Hansen, 2016). Generally, the process starts with the discovery of a molecule and its development by a life sciences entity as a drug candidate. Firms apply for patents typically in the early drug discovery stage since they will not be able to keep the drug candidates secret when they apply for regulatory approvals in the next stage. Thus, unlike other high-technology industries, patenting occurs at the beginning of the innovation process, at the drug discovery stage, rather than at the end. This provides precise and timely innovation measures based on patents which are observable to researchers[10] and mitigates the possible effects of confounding events.[11]

Following drug discovery, the drug candidate is tested in preclinical and three phases of clinical trials (Phase I, II, and III), with each stage requiring regulatory approval. Because milestones in these long development processes are few and far between, there is significant information asymmetry between managers and other market participants. The elevated information asymmetry and inherent risk in the drug development process (e.g., only 20 percent of the drug candidates in Phase I receive approval) is a significant concern in financing and innovation (Lo, 2021; Krieger et al., 2021; Thakor and Lo, 2017). As a result, collaboration and R&D alliances are essential in the life sciences industry to share risk, cost and expertise (Robinson and Stuart, 2007). Furthermore, drugs that are developed in an alliance are more

[10]Furthermore, patents provide good insights into the value of innovation for drug development firms. For instance, patent value at approval indicates drug candidates' net present value (Krieger et al., 2021).

[11]There can be still confounding events because of the time lag between starting an R&D project and applying for patents. However, untabulated robustness tests show that the patents applied after ASC 606 adoption is related to the alliances created after ASC 606. Thus, it is unlikely that patenting activities after ASC 606 adoption related to any event before ASC 606 adoption.

likely to be successful (Danzon et al., 2005).

Alliances not only impact innovation in the drug development industry but also shapes firm revenues. Drug development firms have two distinct types of operating revenue: direct sales and R&D-contract-driven alliance revenue, with the mix varying across different firms. Contracts for alliances generally include two types of payments; (a) upfront payments and (b) payments contingent on future developments (in the form of milestone and royalty payments). A typical contract involves two parties: the principal and the partner. The principal and the partner form an R&D alliance to co-develop a technology or drug. The principal firm provides a certain set of technologies to the partner firm by giving access to its intellectual property. To access the principal firm's technology and expertise, the partner firm pays an upfront fee and agrees contingent future payments to the principal firm. There are two main types of contingent future payments; royalty payments and milestone payments. Royalty payments are usually based on a specific percentage of revenue from drug sales. Milestone payments are typically tied to sales-volume and/or the progress of drug candidates. Progress milestones can be at any phase, from passing preclinical trials to receiving regulatory approval. For instance, a biotechnology company, Exelixis, received a $60 million milestone payment from Ipsen when the licensed drug, Cabozantinib, received approval from the European Medicines Agency. Similarly, the same company, Exelixis, received $7 million from Genentech when Cobimetinib, a cancer treatment drug candidate, completed Phase 1 clinical trials in the US. Specialty firms depend on these alliance revenues to sustain their businesses (Havenaar and Hiscocks, 2012).

2.3 ASC 606 and Drug Development Industry

ASC 606 has a dramatic impact on the drug development industry (see Figure 1). The impact of ASC 606 is likely to be significant because of the ubiquity of R&D alliances and complex multiperiod alliance revenues. Due to the recognition of alliance revenues, principal firms were significantly impacted by ASC 606 but the impact of ASC 606 on partner firms

(larger drug manufacturers) has been relatively minor.[12]

ASC 606 significantly changes the revenue recognition for the principal firm from these R&D contracts because technology deliveries to and payments from partners occur across multiple reporting periods. Specifically, ASC 606 requires firms to determine each contract's performance obligations and allocate prices to these obligations. It allows principals to recognize the payments as revenues upon completing interim performance obligations, which is earlier than allowed under the previous standard.

Earlier revenue recognition applies to both upfront payments and regulatory milestone payments. First, it was a common practice to recognize the upfront payment from contracts over time prior to ASC 606. However, under ASC 606, principal firms now recognize revenue on upfront payments when the IP is transferred to the partner since the transfer satisfies a performance obligation.[13] Second, the entities can recognize the revenue from milestones that are not sale- or usage-based (e.g., regulatory milestones) earlier because of the variable consideration approach in the third step of the ASC 606 framework. Under ASC 606, a firm can recognize milestone payments prior to receiving the payments once they can be reasonably estimated, and the company is confident that reversals are unlikely. Prior to ASC 606, firms could not recognize contingent payments until they were received.[14] As a result, drug development companies have considerably more control over when and how much to recognize upfront fees and milestone payments under ASC 606. To address this issue, ASC 606 additionally requires enhanced disclosures that explain the determination of the performance obligations and transaction price, the allocation of transaction price into

[12]Partner firms were impacted slightly by rules related to rebates and discounts. For example, under the legacy US GAAP, firms have to use the maximum discount available if it cannot reasonably estimate the discount. However, ASC 606 does not force to use the maximum discount method.

[13]As an example, Exelixis had recognized non-refundable upfront payments and milestone revenues over the life of the licensing contract prior to the adoption of ASC 606. The cumulative impact of the adoption in 2018 was $258 million, and a net reduction of the accumulated deficit to $1.29 billion. Furthermore, after the adoption, the company's collaboration revenues increased from $103.45 million to $234.55 million between 2017 and 2018, largely due to the immediate recognition of upfront payments and the portion of milestones.

[14]In the first quarter of 2018, after ASC 606 adoption, Exelixis recorded a $10 million contract asset for a probable milestone that would not be recognized prior to ASC 606, for example.

separate performance obligations, and when these performance obligations have been met.[15]

2.4 Hypothesis Development

ASC 606 was designed such that, when implemented objectively with interim performance obligations, there should be a better matching of the timing of revenue recognition to the economics of the underlying transactions. Further, firms with more complex transactions can provide more information under the flexible accounting standard, ASC 606 (Dye and Sridhar, 2008). However, there can be two opposite effects on the information content based on the credibility of the measurement (Gao and Jiang, 2020; Dye and Verrecchia, 1995; Dye et al., 2014). There is more information content if the revenue measurement is deemed credible after ASC 606 adoption. But if financial report users suspect the credibility of revenue measurement declines after ASC 606 adoption, the information content decreases. One potential source of information asymmetry from ASC 606 that affects the credibility is that managers have significant control (and also more information) over the number and granularity of performance obligations, allocation of transaction prices into various performance obligations, and the timing of the satisfaction of these performance obligations. However, in recognition of this issue, ASC 606 additionally requires enhanced disclosures that delineate the importance of interim performance obligations and articulate when they have been met.

If accelerated revenue recognition, together with credible disclosures that support this recognition, are jointly incrementally informative to investors, ASC 606 can increase the information content of financial statements and decrease information asymmetry between managers and investors.[16] Therefore, I expect that ASC 606 adoption lowers information

[15] Aveo Pharmaceuticals, another life sciences company, explains the disclosure requirements as follows (2018Q1):

> "ASU 2014-09 requires more robust disclosures than required by previous guidance, including disclosures related to disaggregation of revenue into appropriate categories, performance obligations, the judgments made in revenue recognition determinations, adjustments to revenue which relate to activities from previous quarters or years, any significant reversals of revenue, and costs to obtain or fulfill contracts."

[16] For instance, on November 14th, 2017, Wedbush published the analyst report for NovoCure, which is a

asymmetry (bid-ask spread) for more ARD firms because of their complex revenues. Furthermore, I expect this result holds only if disclosure accompanies the acceleration in revenue recognition. Finally, due to the decreased information asymmetry between managers and investors, I hypothesize that for more ARD firms, ASC 606 adoption facilitates easier access to capital (Lambert, Leuz, and Verrecchia, 2007; Beyer, Cohen, Lys, and Walther, 2010).

Even if ASC 606 increases the information content, since managers can change their *real* actions and there can be information spillover effects (Kanodia and Sapra, 2016; Roychowdhury et al., 2019), its impact on investment and innovation is unclear. Specifically, the impact of more information to peer firms on innovation investments and outcomes is ambiguous ex ante (Dye, 1990). More informative revenues with greater disclosure imply the revelation of proprietary information upon ASC 606 adoption (Beyer et al., 2010). This forced revelation of information potentially increases competition, and the focal firm may decrease its investment and innovation activities because of the increased competition (Breuer et al., 2021). On the other hand, as peer firms learn more about their profitability, especially through specific project revenues, the uncertainty about investment opportunities in technology fields decreases (Roychowdhury et al., 2019; Ferracuti and Stubben, 2019). In this case, as uncertainty about firms' technologies decreases, firms can cooperate for a common goal (Bonham and Riggs-Cragun, 2022). Thus, decreased information asymmetry between peer firms allows ARD firms to collaborate and consider expanded participation in R&D alliances. I expect higher innovation to follow the increase in R&D alliances since alliances generally yield better project performances compared to solo-firm projects because of risk and expertise sharing (Beshears, 2013; Bodnaruk, Massa, and Simonov, 2013; Cha, Saxena, Smietana, and Bansal, 2015; Danzon et al., 2005). Consequently, the primary testable implication is that R&D alliances and innovation for ARD firms will increase after the adoption of ASC 606. Furthermore, I predict stronger results when the information asymmetry between

cancer treatment firm with high dependence on alliance revenues. The report argues that with the adoption of ASC 606, investors will better understand and appreciate the underlying business model and firm growth. Prior to ASC 606, there were no separate performance obligations and the firm had to wait until cash was collected to record revenue, which makes it difficult to understand the true demand for its technology.

firms is expected to be higher.

There are at least three possible reasons that managers could not have accomplished the same goals by voluntarily disclosing the additional information subsequently mandated by ASC 606. First, even when voluntary disclosure resolves information asymmetry, disclosure of proprietary information has two countervailing effects on the disclosing (focal) firm: *spill-out* (bearing the cost of other firms learning about the focal firm) and *spill-in* (benefiting from other firms' information) (Kim and Valentine, 2021). In a voluntary disclosure regime, the firm bears the spill-out cost of disclosure in all states of the world but can benefit from spill-ins only if other firms *voluntarily* make similar disclosures. As a result, without mandated disclosure and corresponding enforcement, firms find themselves in economically suboptimal equilibrium if higher net proprietary costs of disclosure deter voluntary disclosure (Bhattacharya and Ritter, 1983; Verrecchia, 1983). Second, as the disclosure versus recognition literature points out, an entire fiduciary setup involving auditor scrutiny and SEC oversight is activated for mandatory disclosures, making such disclosures and accompanying revenue recognition more credible in mandated disclosure regimes (Davis-Friday, Folami, Liu, and Mittelstaedt, 1999; Roychowdhury and Srinivasan, 2019). Finally, accounting standards are established by specialized entities, e.g., Financial Accounting Standards Board (FASB) in the US. These standard setters might exist because of a market failure, i.e., firms might fail to invent accounting rules that are as effective as the ones established by standard setters. Furthermore, when all the firms report under the same standard, the financial performances can be more easily understood by the capital market, i.e., there will be network externalities. Thus, sharing a common accounting standard is value maximizing for the firms (Dye and Sridhar, 2008).

3 Sample and Research Design

3.1 Data and Sample Selection

The Cortellis database provides detailed information about drug development firms, like their drug candidates and technologies. Using this database, I obtain 510 US firms with at least one active or completed drug development project since 2010. I merge these firms with the Compustat database based on company names, websites, and phone numbers. I start the sample period in 2014 since Cortellis changed some data definitions in 2013, and I end it in 2019 to avoid interference by the effects of the COVID-19 pandemic on drug developing firms. I require at least four quarters of Compustat observation both before and after the ASC 606 adoption. I further require firms to have at least one quarter with positive revenue or deferred revenue before adopting ASC 606 to observe the impact of ASC 606. Finally, I merge the resultant 379 unique firms with the CRSP database. This yields 342 unique firms and 7,615 firm-quarters.

3.1.1 Financial Reporting Quality and Information Asymmetry

ASC 606 accelerates revenue recognition by increasing revenues and decreasing deferred revenues. It also requires more disclosure about the revenue recognition process. To confirm these conjectures and to test the role of a change in disclosure along with an acceleration in revenue recognition on the information asymmetry in the capital market, I randomly selected 170 firms and hand collected revenue recognition related disclosures from their annual financial reports. Then, I count the number of total words in the text. I utilize bid-ask spread as an information asymmetry measure. I calculate it by using daily bid and ask prices divided by the mid-point of them from CRSP daily data and take the quarterly median.

3.1.2 Contracts Data

Detailed deal data are obtained from the Cortellis Deals Intelligence database. Cortellis collects deal data from various public disclosures of public and private firms and extracts financial and drug level information such as principal firm (technology provider), partner firm (payer), drug therapy area, drug development stage, upfront payment value, milestone payment structures, and projected contract value. I first identify deals where either the principal or partner company is a US company. This yields 9,739 deals between 2014-2019. However, there is considerable heterogeneity in deals covered by Cortellis (e.g., collaborative licenses, supply-only licenses, and R&D). Since the focus of this study is revenue recognition and innovation, I restrict the sample to R&D-related deals, which reduces the sample to 3,984 R&D contracts.[17]

3.1.3 Innovation Measures

Patent characteristics are a widely accepted proxy for innovation activities (Lerner and Seru, 2022; Kogan, Papanikolaou, Seru, and Stoffman, 2017; Krieger et al., 2021). My primary source of innovation measure is the updated data from Kogan et al. (2017) (KPSS). The patent level dataset contains the number of citations that the patent received and the estimate of the patent value based on the equity market reaction around the patent grant date. I obtain the firm-quarter level the number of patents, the number of total citations, and the total value of patents (in 1982 US dollars) according to the application date. One limitation of using patent citations as a measure of innovation is citations are highly correlated with the age of the patents (i.e., ceteris paribus, newer patents will have fewer citations). KPSS patent value estimate overcomes this problem because patent value at approval indicates drug candidates' net present value (Krieger et al., 2021). Finally, I constructed the number of drug candidates dataset at the firm-quarter level based on the

[17] In untabulated robustness tests, I merge Cortellis contracts with the SDC Platinum database to identify "strategic alliances", leaving 1,822 alliances. All the results remain quantitatively similar in this sample.

data from the ClinicalTrials.gov website, Cortellis, and S&P Capital IQ.

3.1.4 Alliance Networks

The R&D alliance networks are created based on the principal and the partner firm connections for years between 2014 and 2019. If a principal firm i has a contract with a partner firm j in the last five years, there is a connection from firm i to firm j. I employ a common measure for centrality, closeness centrality. Specifically, the closeness centrality of a firm i is the reciprocal of the sum of all shortest paths between firm i and all the other firms in the network multiplied by *N-1* reachable firms, where N is the total number of firms in the network (Freeman, 1978). Thus, a high closeness centrality indicates higher access to technology. Formally, I compute closeness centrality as:

$$C(i) = \frac{N-1}{\sum_{j \in N} d(i,j)}$$

C(i) is the closeness centrality of firm i and $d(i,j)$ is the shortest path between firm i and firm j.

Furthermore, I also test centrality with the degree centrality measure, which is the fraction of connected firms to *N-1* reachable firms.

3.1.5 Descriptive Statistics

Even though the continuous treatment variable is used for the analysis, I divide the sample with respect to the median ARD ratio for descriptive statistics to observe firm characteristics based on ARD. The descriptive statistics in Table 2 show that ARD firms are younger and smaller compared to independent ones in terms of total assets and market capitalization. ARD firms have less cash, revenue, and net income but almost the same number of principal contracts and even more principal R&D alliances than the alliance revenue independent firms. In line with the multiperiod contracts aggravating the information asymmetry hypothesis,

alliance revenue-dependent firms have a significantly lower number of partnering alliances.

3.2 Research Design and Alliance Revenue Dependence

Identification in my empirical analysis relies on life sciences firms having two distinct types of operating revenue: sales and R&D-contracts-driven alliance revenue (in the form of upfront, milestone, and royalty payments), with the mix varying across different firms. ASC 606 has the most significant impact on alliance revenue. I use the firm's dependence on alliance revenues prior to ASC 606 adoption to identify the treatment, that is, the effect of the rule change on life sciences firms' alliance formation and innovation outcomes.

I collect the alliance revenues for the life sciences firms from quarterly XBRL data obtained from SEC EDGAR. I manually identify the tag keywords related to alliance revenue and hand collected a subsample of 170 firms' revenues to verify the accuracy of identified alliance revenues. To identify alliance revenue dependency, quarterly alliance revenues are deflated by total quarterly revenue. Formally, I first compute the alliance revenue dependence ratio in a quarter q for firm i as follows:

$$AllianceRevenueDependence(ARD)_{i,q} = \frac{AllianceRevenue_{i,q}}{TotalRevenue_{i,q}}$$

I determine dependence on alliance revenue for firm i based on its median alliance revenue to total revenue ratio between 2014-2016 to minimize the impact of influential observations and to filter any bias for the anticipation effect.

$$ARD_i = Median(ARD_{i,q})$$

This ratio serves as a continuous treatment variable in the analysis. Note that higher alliance revenue dependence implies that corresponding firms have a greater net tendency to enter R&D contracts as principals. That is, such firms (typically smaller) provide the R&D technology and/or know-how that partners (typically much larger firms) gain access

to through alliance payments. In robustness tests, I create separate treatment and control groups by assigning an alliance revenue dependence indicator variable that equals one if the firm's alliance revenue is higher than the sample's median alliance revenue ratio and zero otherwise.

To identify the treatment effect, I employ a difference-in-differences (DiD) design with the following general model:

$$y_{i,t} = \beta \times ARD_i \times ASC606_t + \gamma X_{i,t} + \delta_i + \pi_t + \epsilon_{i,t}$$

the main point of interest $y_{i,t}$ is either number of R&D alliances that firm i creates in quarter t or various innovation measures. $X_{i,t}$ is the matrix of control variables depending on a specific regression model. Firm and year-quarter fixed effects are included when appropriate. Detailed model specifications are given in the Section 4. Unless otherwise stated, the unit of observation is at the firm i and quarter t level. For there to be an endogeneity concern with the research design, any correlated omitted variable must not only vary with alliance revenue dependence, but its effect must also vary across time.

4 Results and Discussion

4.1 ASC 606 Impact on Financial Statements

The drug development industry is the second most materially impacted by ASC 606 adoption (Figure 1 shows the ten most impacted industries). One time effect of ASC 606 adoption on retained earnings is 2.1% of the beginning retained earnings balance for ARD life sciences firms and 1.1% for alliances revenue independent life sciences firms. To confirm that ARD life sciences firms are more affected by ASC 606 adoption, I estimate the following regression where the dependent variables are *Revenue*, *Deferred Revenue*, and *Disclosure* for

firm i in quarter t.

$$y_{i,t} = \beta_1 ARD_i \times ASC606_t + \delta_i + \pi_t + \epsilon_{i,t}$$

I include firm and time fixed effects to control for time invariant firm characteristics and any common shock in a given time period. The time fixed effect is at the year-quarter level for *Revenue* and *Deferred Revenue* regressions and at the year level for *Disclosure* regression. These fixed effects subsume ARD_i and $ASC606_t$ variables, and the coefficient of interest is β. Firm-quarter level results in Columns (1) and (2) in Table 4 show that there is a significant increase in revenue and a decrease in deferred revenue and suggest an acceleration in revenue recognition. Firm-year level result in Column (3) shows that more ARD firms significantly increase their disclosures. The point estimate in Column (3) suggests that firms with only alliance revenues, i.e., $ARD = 1$, increase their number of words in their revenue disclosures after ASC 606 adoption by 17.2% relative to the sample average of the number of words in the pre-ASC 606 period.[18]

4.2 Information Asymmetry

Next, I test if the changes in financial statements decrease information asymmetry in the capital market. I use the *Bid-Ask* measure to proxy information asymmetry and estimate the following regression:

$$BidAsk_{i,t} = \beta ARD_i \times ASC606_t + \gamma_1 MTB_{i,t} + \gamma_2 Size_{i,t} + \gamma_3 Leverage_{i,t} + \gamma_4 NumberOfAnalysts_{i,t} + \pi_i + \delta_t + \epsilon_{i,t} \quad (1)$$

I include *MTB*, *Size*, *Leverage*, and *Number of Analysts* variables to control the change in the information environment among life science firms over time. I also include firm and year-quarter fixed effects to control for time invariant firm characteristics and any common

[18]The point estimate in Column (3) of 422.266 divided by the pre-ASC 606 sample mean *Disclosure* of 2457.285 equates 17.18%.

shock in a given quarter.

Column (1) in Table 5 shows a significant decrease in the *Bid-Ask* measure after the adoption of ASC 606 for more ARD firms. The result is consistent with the hypothesis that ASC 606 provides more information and alleviates information asymmetry between the managers and investors. The point estimate of β implies an economically significant decrease (36.4%) in information asymmetry for firms with only alliance revenues after ASC 606 adoption relative to the sample average *Bid-Ask* in the pre-ASC 606 period.[19]

To strengthen the inference and to test if ASC 606 as an accounting standard is responsible for the decrease in the information asymmetry, or if the decrease is simply due to the increase in disclosure, I estimate the following regression:

$$\begin{aligned} BidAsk_{i,t} = \beta_1 ASC606Impact_i \times ASC606_t + \beta_2 \Delta Disclosure_i \times ASC606_t + \\ \beta_3 ASC606Impact_i \times \Delta Disclosure_i \times ASC606_t + \gamma_1 MTB_{i,t} + \gamma_2 Size_{i,t} + \\ \gamma_3 Leverage_{i,t} + \gamma_4 NumberOfAnalysts_{i,t} + \pi_i + \delta_t + \epsilon_{i,t} \quad (2) \end{aligned}$$

I include the same control variables and fixed effects as in Column (1). Since I hand collected the disclosures for randomly selected 170 firms, the sample size is 3,414 firm-quarters. Instead of estimating $ARD_i \times ASC606_t$, I disentangle the acceleration of revenue recognition and change in disclosure levels. Consistent with prior literature, I utilize the one time cumulative effect of adoption as a proxy for the impact of the new standard (Shroff, 2017). Specifically, I proxy the acceleration in revenue recognition with the one time effect of ASC 606 upon adoption on firms' retained earnings.[20] I computed the firm level mean differences in *Disclosure* measure for pre- and post-ASC606. The significantly negative β_3 in column (2) in Table 5 shows that the decrease in the *Bid-Ask* measure occurs only if

[19]The point estimate in Column (1) of -0.002 divided by the pre-ASC 606 sample mean *Bid-Ask* of 0.0055, equals -36.44%.

[20]Firms evaluate their prior contracts under ASC 606. If there is any change in revenues or deferred revenues due to the satisfaction of performance obligations under ASC 606, firms reflect that in the accumulated earnings (or deficits) as a one time effect upon adoption.

firms accelerate revenue recognition with more disclosure. Notably, the significantly positive coefficient on β_1 suggests that acceleration in revenue recognition without accompanying disclosure increases information asymmetry. These results confirm the mutually reinforcing effect of more disclosure and acceleration in revenue recognition in decreasing information asymmetry.[21]

Next, I test if the decrease in information asymmetry yields easier access to capital ex post. I use *New Equity Issuance* and *New Debt Issuance* measures as dependent variables for the following regression:

$$CapitalAccess_{i,t} = \beta ARD \times ASC606 + \gamma_1 ROA_{i,t} + \gamma_2 TangibleAssets_{i,t} + \gamma_3 Size_{i,t} + \gamma_4 Growth_{i,t} + \delta_i + \pi_t + \epsilon_{i,t} \quad (3)$$

I include *ROA*, *TangibleAssets*, *Size*, and *Growth* control variables which can vary across time depending on ARD and are known factors that affect equity issuance or debt issuance (Brav, 2009; Hovakimian, Hovakimian, and Tehranian, 2004). I include firm and year-quarter fixed effects to control for time invariant firm characteristics and common economic shocks in a quarter. Column (1) in Table 6 shows a statistically and economically significant increase in equity issuance. Firms with only alliance revenues 26.4% increase the equity issuance after ASC 606 adoption relative to the sample average *Equity Issuance* in the pre-ASC 606 period.[22] However, column (2) shows no significant change in debt issuance after ASC 606 adoption for ARD firms.

Collectively, there is strong evidence that ARD firms decrease information asymmetry between managers and investors after ASC 606 adoption. Consistently, ARD firms have

[21] Consistent with proprietary cost deterring voluntary disclosure, especially in high technological competition fields (Glaeser and Landsman, 2021), in untabulated results I find that the increase in revenue recognition disclosures post-ASC 606 is more pronounced for the firms in high technological competition fields before ASC 606, i.e., firms within a dense drug development technology cluster in terms of the number of firms sharing the same drug development technology.

[22] The point estimate in Column (1) of 0.019 divided by the pre-ASC 606 sample mean *Equity Issuance* of 0.0720, equals 26.4%.

easier access to capital via equity financing.

4.3 R&D Investment and Alliances

With easier access to capital, I predict an increase in R&D investments (Krieger et al., 2021). Thus, I estimate the following linear regression model:

$$R\&D_{i,t} = \beta ARD_i \times ASC606_t + \gamma_1 ROA_{i,t-1} + \gamma_2 MVE_{i,t-1} + \gamma_3 CFO_{i,t} + \gamma_4 TobinQ_{i,t-1} + \gamma_5 Cash_{i,t-1} + \gamma_6 Growth_{i,t-1} + \pi_t + \epsilon_{i,t} \quad (4)$$

I include *ROA*, *MVE*, *CFO*, *TobinQ*, and *Cash* control variables which can vary across time depending on ARD and are known factors that affect investment decisions (Shroff, 2017; Biddle et al., 2009; Fazzari, Hubbard, Petersen, Blinder, and Poterba, 1988). I include year-quarter fixed effects to control for common economic shocks in a quarter.[23] Column (1) in Table 7 shows that after ASC 606 adoption, ARD firms significantly increase investments in R&D. In terms of economic significance, firms with only alliance revenues increase their R&D intensity by 5.9% after the adoption of ASC 606 relative to the sample average of *R&D* in the pre-ASC 606 period.[24]

To further understand the changing nature of R&D investments, one of my primary tests is if there is a change in R&D alliances as a partner side. Consistent with increasing information content of revenues and decreasing information asymmetry, I expect peer firms to learn about each other. Thus, I hypothesize an increase in R&D partner alliances specifically. To test my hypothesis, I estimate the same DiD model with *R&D Partner Alliances* as a dependent variable since R&D alliance formation has very similar determinants as previous

[23] Adding firm fixed effects doesn't change results but decreases adjusted R^2 by half since this fixed effect adds no power in explaining the variation. Strictly speaking, adjusted R^2 tells very little about endogeneity concerns. Furthermore, for there to be an endogeneity concern, any correlated omitted variable must not only vary with ARD, but its effect must also vary across time. Thus, firm fixed effects do not control for endogeneity concerns.

[24] The point estimate in Column (1) of 0.006 divided by the pre-ASC 606 sample mean *R&D* of 0.1017, equals 5.90%.

control variables (Robinson and Stuart, 2007; Robinson, 2008; Kepler, 2021).

Column (2) in Table 7 supports the hypothesis that ARD firms decrease information asymmetry with peer firms and invest more in R&D alliances. The point estimate of 0.026 for β suggests a 16.4% increase in R&D partner alliances for firms with only alliance revenues after ASC 606 adoption relative to the sample average of *R&D Partner Alliance* in the pre-ASC 606 period.[25]

Since the dependent variable is a count, linear regression estimation can be a serious threat to identification (Rock, Sedo, and Willenborg, 2000). Hence, I also use the negative binomial model for estimation, which is the standard econometric model when the dependent variable is a count and, unlike Poisson models, it relaxes the equidispersion assumption (i.e., the variance must be equal to mean.) One caveat with a negative binomial regression is that adding many fixed effects can cause incidental parameters problem. Therefore, I do not include firm fixed effects but rather include firm level control variables in the negative binomial regressions. Column (3) in Table 7 verifies the results in Column (2).

4.3.1 Robustness Tests

One question is whether the increase in the number of R&D partner alliances is if it represents a *real* change. With ASC 606 adoption, firms might change the contracts. For instance, Ge, Ji, and Louis (2020) show that the number of alliance provisions decreases with increasing accounting quality. If there are contractual changes (e.g., obligations in a contract), the documented increase in the number of alliances might not be *real*.

In order to alleviate this concern, I implement two placebo tests with the same regression specification. First, I focus on supply-only partner alliances. These alliances are primarily used for production and are much less risky than R&D alliances. Thus, I do not expect any reduction in information asymmetry related to this alliance, but expect to observe a change in the number of alliances if contractual changes drive the increasing number of

[25]The point estimate in Column (1) of 0.026 divided by the pre-ASC 606 sample mean *R&D Partner Alliance* of 0.1587, equals 16.38%.

alliances. Column (1) in Table 8 shows no significant change in supply partner alliances for ARD firms after ASC 606. Second, I focus on R&D principal alliances instead of partner contracts. ARD firms are the technology providers and earn revenue from these alliances. If the increase in R&D partner alliances is due to a contractual change or due to managerial opportunism in contracting, I would expect to find an increase in R&D principal alliances. However, column (2) in Table 8 shows no significant change in R&D principal alliances for ARD firms after ASC 606 adoption. Consequently, it is difficult to explain the increase in R&D partner alliances with contractual changes only.

The key identifying assumption for all these tests is parallel trends. While there can be differences between the alliance revenue dependent and independent firms, the parallel trend assumption requires that those differences be constant in the pre-ASC 606 period and would have continued to be constant absent the treatment. To test this assumption, Figures 2 and 3 plot the coefficient estimates of the alliance revenue dependency for the quarters leading up to ASC 606, leaving out the quarter prior to ASC 606 to make this quarter benchmark level. Figure 2 shows the contracting effect of alliance revenue dependency is absent in the pre-ASC 606 quarters, whereas significant effects begin to appear in the quarters after the rule change for partner alliances. On the other hand, Figure 3 does not show any change after ASC 606 for principal alliances.

Another concern is related to the possible tax effects of ASC 606 adoption. Although ASC 606 does not directly intend any tax accounting implication or to change underlying cash flows, one might be concerned about the possible tax effects. Since ARD firms accelerate revenue recognition, the tax effect, if any, would increase cash outflow and bias against the results. Similarly, the Tax Cuts and Jobs Act of 2017 (TCJA), which was implemented close to ASC 606 adoption, unlikely drives the results since ARD firms are generally loss-carrying firms and are affected negatively by TCJA. I also empirically find no significant change in estimated effective tax rates, deferred tax assets, or liabilities in untabulated results.

4.3.2 Cross-Sectional Tests

To strengthen the inferences, I estimate two cross-sectional tests based on information asymmetry between peer firms. I expect to find stronger R&D partner alliance results when the information asymmetry between peer firms is higher. First, I run the same R&D partner alliances but distinguish if the principal side is a public or private firm. Because of resource constraints in private firms, I expect higher information asymmetry between ARD firms and private firms. Thus, I expect to find a significantly greater increase in R&D partner alliances when the principal is private. To test this hypothesis, I run the same R&D partner alliances regression specification but in two subsamples: private principals and public principals. Consistent with the prediction, Table 9 shows that β coefficient is significantly positive in Column (1), which is the subsample consisting of private principal firms, but insignificant in Column (2), which is the subsample consisting of public principal firms.

Second, I utilize the alliance network structure to test if elevated information asymmetry before ASC 606 adoption yields stronger results. Kepler (2021) shows that firms within alliances have private communication channels. Thus, I expect to find stronger R&D partner alliance formation for firms that are less central in the alliance network before ASC 606, which have less communication with peer firms and experience more information asymmetry. To test this hypothesis, I estimate the following regression model:

$$\begin{aligned} R\&D\_PartnerAlliance_{i,t} = \beta_1 LowCentrality + \beta_2 ARD_i \times ASC606_t + \\ \beta_3 ARD_i \times LowCentrality \times ASC606_t + \gamma_1 ROA_{i,t-1} + \\ \gamma_2 MVE_{i,t-1} + \gamma_3 CFO_{i,t} + \gamma_4 TobinQ_{i,t-1} + \gamma_5 Cash_{i,t-1} + \gamma_6 Growth_{i,t-1} + \pi_t + \epsilon_{i,t} \quad (5) \end{aligned}$$

Table 10 shows that β_3 coefficient is significantly positive in both Negative Binomial and OLS models. Thus, firms that experienced higher information asymmetry between peer firms increased their R&D partner alliances significantly more after ASC 606.

4.3.3 Network Analysis

It is important to identify industry-wide reallocation of resources or transactional relationships for policy implications (Breuer, 2021). The increase in partnering for ARD firms suggests that these smaller firms start investing in R&D alliances. This potentially yields an important change in the R&D alliance organization structure in the industry since these firms are historically on the principal side of the R&D alliances. To test if the increase in R&D alliance investments from more ARD firms changes structure of the R&D alliance network, I test the following differences-in-differences model:

$$Centrality_{i,t} = \beta ARD_i \times ASC606_t + \gamma_1 ROA_{i,t-1} + \gamma_2 MVE_{i,t-1} + \gamma_3 CFO_{i,t} + \gamma_4 TobinQ_{i,t-1} + \gamma_5 Cash_{i,t-1} + \gamma_6 Growth_{i,t-1} + \delta_i + \pi_t + \epsilon_{i,t} \quad (6)$$

$Centrality_{i,t}$ is either *Closeness Centrality* or *Degree Centrality* in the R&D alliance network for firm i in year t. I include the same control variables that can affect investment or alliance formation decisions. I include firm and year fixed effects since the unit observation is at firm-year level. I find a significant change in the R&D alliance network in Table 11, with more alliance revenue-dependent firms becoming more central in the R&D alliance network after ASC 606 adoption. Point estimates suggest that firms with only alliance revenues become 9.8% more central in terms of closeness centrality and 5.6% more central in terms of degree centrality relative to the sample averages of *Closeness Centrality* and *Degree Centrality* in the pre-ASC 606 period.[26]

4.4 Innovation Outcomes

Next, I test how these changes due to ASC 606 adoption affect innovation. First, I predict that an increase in R&D investments, especially through R&D alliances, yields more

[26]The point estimate in Column (2) of 0.008 divided by the pre-ASC 606 sample mean *Closeness Centrality* of 0.08172, equals 9.79%, and the point estimate in Column (4) of 0.125 divided by the pre-ASC 606 sample mean *Degree Centrality* of 0.056419, equals 5.64%.

innovation. To test this hypothesis, I estimate the following regression model:

$$Innovation_{i,t} = \beta ARD_i \times ASC606_t + \gamma_1 ROA_{i,t-1} + \gamma_2 Size_{i,t-1} + \gamma_3 HPIndex_{i,t-1} + \delta_i + \pi_t + \epsilon_{i,t} \tag{7}$$

The innovation measures are *Number of Patents*, *Forward Citations*, *Patent Value*, and *Number of Drug Candidates*. I include common control variables that can affect innovation and can vary across time and firms: *ROA*, *Size* and *HP Index* (Kim and Valentine, 2021; Allen et al., 2022). I also include firm and year-quarter fixed effects to control for time invariant firm characteristics and any common shock in a given quarter. The results in Table 12 show a statistically and economically significant increases in all innovation measures. Specifically, after ASC 606 adoption, firms with only alliance revenues increase the number of patents by 49.2%, receive 73.7% more citations, create 48.5% more valuable patents, and produce 15.8% more drug candidates relative to the corresponding sample averages in the pre-ASC 606 period.[27] These results are comparable to Kim and Valentine (2021), who find a 60% increase in forward citations for treated firms after a patent disclosure rule change.

The key identifying assumption for these tests is parallel trends. While there can be differences between the alliance revenue dependent and independent firms, the parallel trend assumption requires that those differences be constant in the pre-ASC 606 period and would have continued to be constant absent the treatment. To test this assumption, Figures 4 and 5 plot the coefficient estimates of the ARD for the quarters leading up to the ASC 606 adoption, leaving out the quarter prior to ASC 606 as a benchmark. Figure 4 shows that there is no significant difference in the number of patents in the pre-ASC 606 quarters, whereas significant effects begin to appear in the quarters after the rule change. Similarly, Figure 3 does not exhibit any pre-trend for patent values, while there is a significant increase

[27]The point estimate in Column (1) of 0.400 divided by the pre-ASC 606 sample mean *Number of Patents* of 0.81150, equals 49.29%; the point estimate in Column (2) of 0.474 divided by the pre-ASC 606 sample mean *Forward Citations* of 0.64300, equals 73.72%; the point estimate in Column (3) of 0.856 divided by the pre-ASC 606 sample mean *Patent Value* of 1.76537, equals 48.49%; and the point estimate in Column (4) of 0.032 divided by the pre-ASC 606 sample mean *Number of Drug Candidates* of 0.20301, equals 15.76%.

after ASC 606 adoption.

To strengthen the inferences and to tie the increase in innovation to the increase in R&D alliances, I implement a cross-sectional test. Since I find a greater increase in R&D partner alliances in less connected firms before ASC 606 adoption, I expect to observe stronger results for these firms. To test this hypothesis, I estimate the following regression:

$$Innovation_{i,t} = \beta_1 LowCentrality + \beta_2 ARD_i \times ASC606_t + \beta_3 ARD_i \times LowCentrality \times ASC606_t + \gamma_1 ROA_{i,t-1} + \gamma_2 Size_{i,t-1} + \gamma_3 HPIndex_{i,t-1} + \delta_i + \pi_t + \epsilon_{i,t} \quad (8)$$

I use *Patent Value* and *Number of Drug Candidates* as innovation measures. I estimate the model with and without firm and year-quarter fixed effects. I include the same firm-quarter level control variables. Consistent with the prediction, I find a significantly positive coefficient of β_3 for both innovation measures in Table 13.

5 Conclusion

This study highlights the real effects of ASC 606 on R&D alliances and innovation outcomes in an economically and socially important industry, life sciences. My results show that alliance revenue dependent (ARD) firms disclose significantly more about the revenue recognition process, accelerate revenue recognition, and decrease deferred revenues with the adoption of ASC 606. Consistent with these changes providing more information, information asymmetry in the capital market decreases, and ARD firms have easier access to capital and increase R&D investments after ASC 606 adoption. Notably, these firms invest more in R&D alliances as partners since the information asymmetry between peer firms decreases with the adoption of ASC 606. This increase significantly changes the structure of alliance organizations, as principal firms before ASC 606 are more likely to contract as partner firms after ASC 606. As a result of these changes, affected life sciences firms exhibit

higher innovation.

The findings are important not only for understanding the relation between ASC 606 and innovation but also essential to understand the consequences of ASC 606, which is the most significant rule change in revenue recognition in decades. The main purpose of the new revenue recognition rule is to provide one comprehensive model for revenue recognition and increase the comparability of revenue across firms and industries. My findings suggest that ASC 606 increases transparency with respect to revenue recognition, which, in turn, mitigates information asymmetry between managers and investors. The reduced information asymmetry allows for increased investment.

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6 Appendix A: Variable Definitions

Variable	Definition	Source
ARD	The median of the alliance revenue divided by total revenue ratio between 2014-2016	SEC EDGAR
Age	The natural logarithm of the difference between the first time the firm enters COMPUSTAT and the current quarter	Compustat
$ASC606$	An indicator equal to one for the quarters following ASC 606 adoption, zero otherwise	SEC EDGAR
$ASC606Impact$	One time cumulative impact of ASC 606 adoption on retained earnings deflated by total assets	SEC EDGAR
$Bid - Ask$	Quarterly median of the daily quoted spreads, measured as the daily closing bid and ask prices scaled by the midpoint	CRSP
$CapEx$	The funds used for additions to the company's property, plant, and equipment, excluding amounts arising from acquisitions, reported in the Statement of Cash Flows, divided by average assets	Compustat
$Cash$	Cash and cash equivalents of the firm ($cheq$) divided by the average total assets	Compustat
$DeferredRevenue$	The sum of short-term and long-term deferred revenue ($drcq + drltq$) deflated by the average total assets	Compustat
$Disclosure$	The total number of words in revenue and revenue recognition disclosures in the financial statements	SEC EDGAR
$\Delta Disclosure$	Change in the mean number of words after ASC 606 adoption	SEC EDGAR
$Growth$	The change in total assets from the previous period divided by total assets in the previous period	Compustat

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Variable	Definition	Source
$HPIndex$	The financial constraint measure developed by Hadlock and Pierce (2010): $HPIndex = 0.737Size + 0.043 \times Size^2 0.040 \times Age$	Compustat
$Leverage$	The firm's total short-term and long-term debt ($dlcq + dlttq$) divided by the average total assets for the most recent quarter	Compustat
$MarketValue$	The market value of equity ($prccq \times cshoq$)	Compustat
$NetStockIssuance$	The change in the natural logarithm of the split-adjusted shares outstanding. Split-adjusted shares outstanding is Compustat shares outstanding (cshoq) times the Compustat adjustment factor (ajexq)	Compustat
$NetDebtIssuance$	The change in the natural logarithm of the total debt (dlcq+dlttq)	Compustat
$NumberofAnalysts$	Number of analysts following the firm	I/B/E/S
$NumberofPatents$	The natural logarithm of the number of granted patents to the firm applied in the quarter t. If a patent has more than one assignee, it is divided equally among them.	USPTO & KPSS
$PatentCitation$	The natural logarithm of the sum of forward citations the firm receives from the patents granted t. If a patent has more than one assignee, it is divided equally among them.	USPTO & KPSS
$PatentValue$	The natural logarithm of the sum of patents' economic value estimated by Kogan et al. (2017). If a patent has more than one assignee, it is divided equally among them.	KPSS
$Alliances$	Number of alliances a firm starts (as principal and partner across different fields)	Cortellis
$R\&DExpenditure$	The costs incurred during the quarter that relate to the research and development of new products ($xrdq$)	Compustat

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Variable	Definition	Source
$R\&DIntensity$	The costs incurred during the quarter that relate to the research and development of new products ($xrdq$), divided by average total assets	Compustat
$Revenue$	Revenue of the firm ($revtq$) deflated by the average total assets	Compustat
$Size$	Natural logarithm of total assets (atq)	Compustat
$TangibleAssets$	The ratio of net property, plant and equipment (ppentq) to total assets	Compustat
$Tobin'sQ$	The sum of martket value, total short-term and long-term debt divided by total assets	Compustat
$TotalAssets$	The firm's total asset (atq)	Compustat

7 Appendix B: Figures and Tables

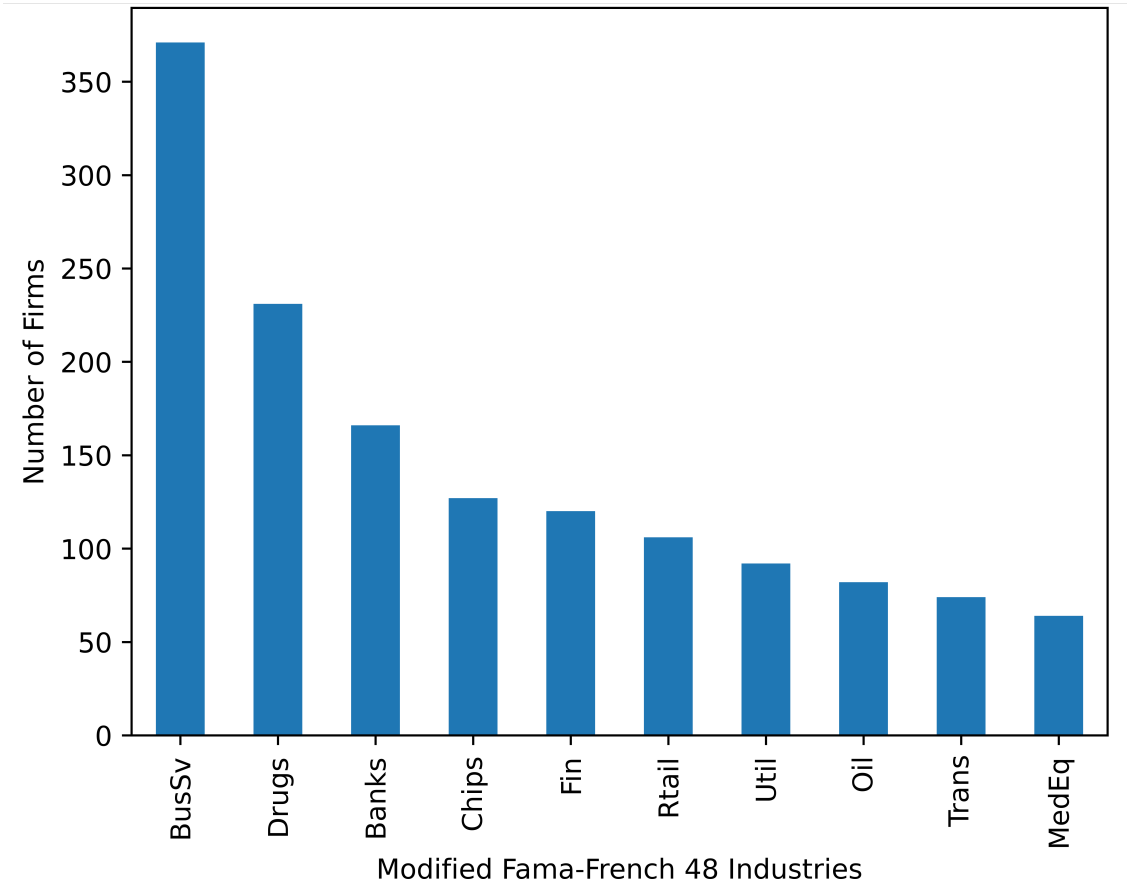

Figure 1: Ten Most Affected Industries by ASC 606

This figure shows the number of firms materially impacted by ASC 606 adoption across most impacted ten industries. Compustat's "adoption of accounting changes" variable ACCTCHGQ variable captures the "accounting changes that have a substantive impact on the measurement and presentation of financial data, or which require significant new disclosures." Using this variable for "ASU14-09" value, I identify the companies materially impacted by ASC 606. I use the Fama-French 48 industries to analyze the effect of ASC 606 across industries. Since there are biopharmaceutical companies under SIC 8731, I reclassified this industry to the Drug industry in the Fama-French 48 industry classification.

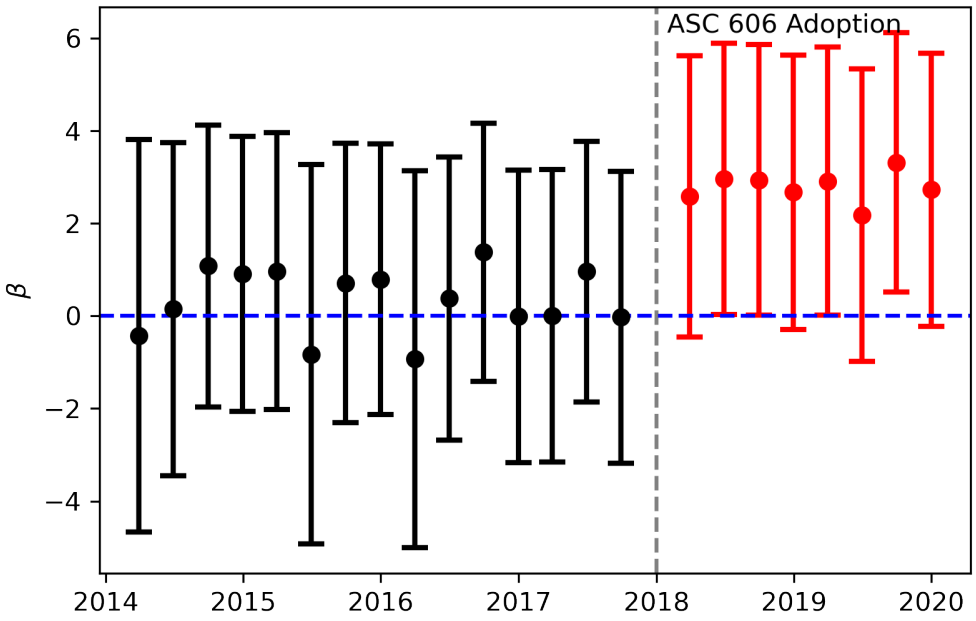

Figure 2: Parallel Trends Test in Partner Contracting

This figure shows changes in R&D alliance formation, as measured by Number of Partner R&D Alliances, in the quarters around the ASC 606 adoption. The estimates β_t and their 90% confidence intervals are from the following Negative Binomial model:

$$PartnerAlliances_{i,t} = \beta_t \sum_{\tau=-15, \tau\neq 0}^{\tau=8} ARD_i \times 1[t=\tau] + \gamma X_{i,t} + \delta_i + \pi_t + \epsilon_{i,t}$$

where $1[t=\tau]$ is a dummy variable, indicating the relative quarter around ASC 606 adoption (December 15, 2017) such that quarter "0" is 2017Q4. 2017Q4 is omitted for comparison. $X_{i,t}$ represents a vector of time-varying firm-level controls. δ_i and π_t are firm and year fixed effects, respectively. Standard errors are clustered at firm and year-quarter levels. Detailed definitions of all variables are provided in Appendix A.

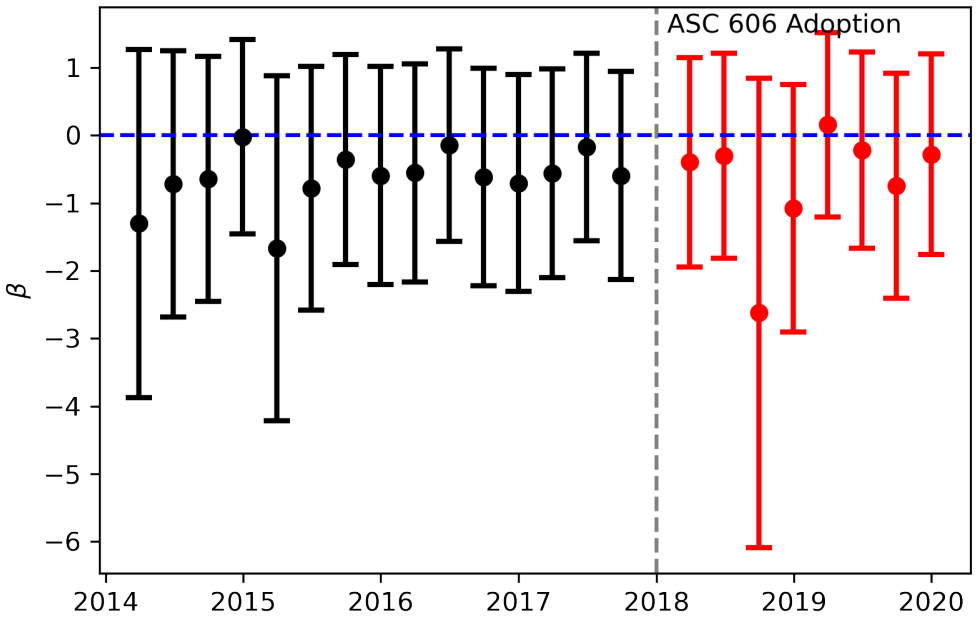

Figure 3: Parallel Trends Test in Principal Contracting

This figure shows changes in R&D alliance formation, as measured by Number of Principal R&D Alliances, in the quarters around the ASC 606 adoption. The estimates β_t and their 90% confidence intervals are from the following Negative Binomial model:

$$PrincipalAlliances_{i,t} = \beta_t \sum_{\tau=-15,\tau\neq 0}^{\tau=8} ARD_i \times 1[t=\tau] + \gamma X_{i,t} + \delta_i + \pi_t + \epsilon_{i,t}$$

where $1[t=\tau]$ is a dummy variable, indicating the relative quarter around ASC 606 adoption (December 15, 2017) such that quarter "0" is 2017Q4. 2017Q4 is omitted for comparison. $X_{i,t}$ represents a vector of time-varying firm-level controls. δ_i and π_t are firm and year fixed effects, respectively. Standard errors are clustered at firm and year-quarter levels. Detailed definitions of all variables are provided in Appendix A.

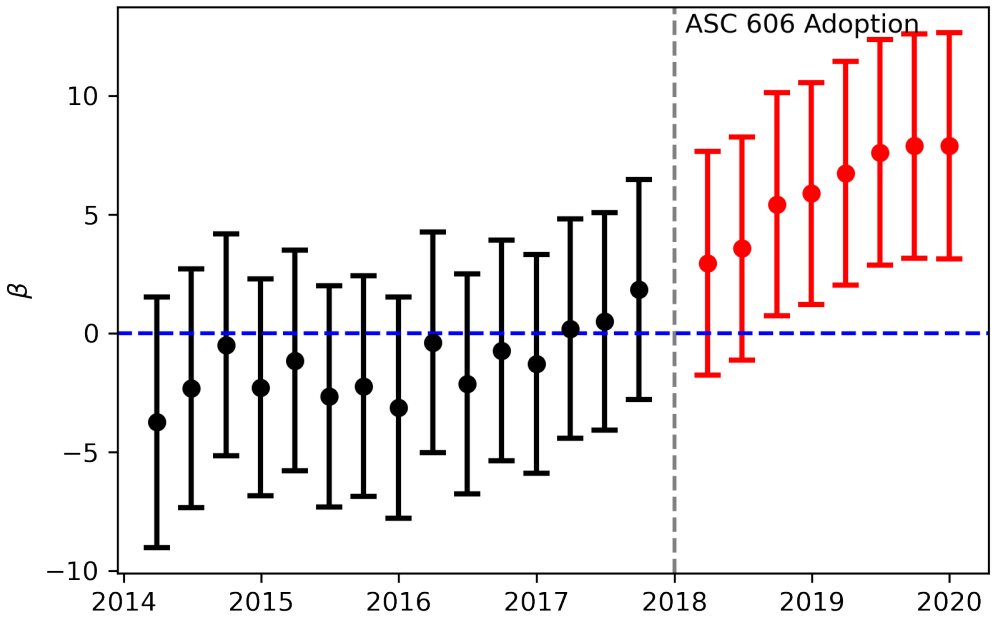

Figure 4: Parallel Trends Test for Number of Patents

This figure shows changes in innovation quality, as measured by Raw Number of Patents, in the quarters around the ASC 606 adoption. The estimates β_t and their 90% confidence intervals are from the following model:

$$NumberOfPatents_{i,t} = \beta_t \sum_{\tau=-15,\tau\neq 0}^{\tau=8} ARD_i \times 1[t=\tau] + \gamma X_{i,t} + \delta_i + \pi_t + \epsilon_{i,t}$$

where $1[t=\tau]$ is a dummy variable, indicating the relative quarter around ASC 606 adoption (December 15, 2017) such that quarter "0" is 2017Q4. 2017Q4 is omitted for comparison. $X_{i,t}$ represents a vector of time-varying firm-level controls. δ_i and π_t are firm and year fixed effects, respectively. Standard errors are clustered at firm and year-quarter levels. Detailed definitions of all variables are provided in Appendix A.

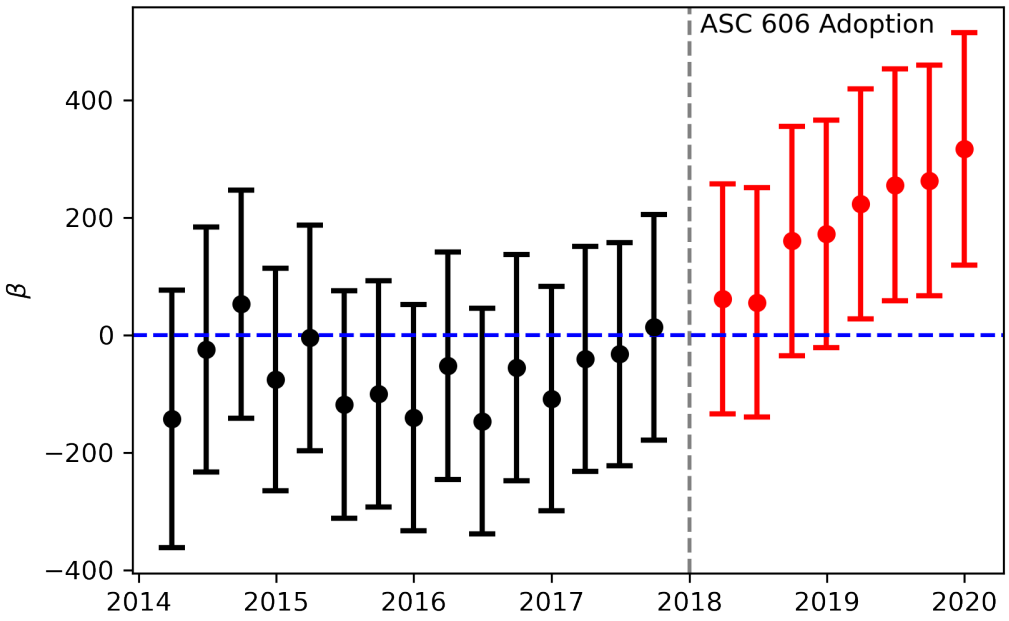

Figure 5: Parallel Trends Test for Patent Values

This figure shows changes in innovation quality, as measured by Raw Patent Value, in the quarters around the ASC 606 adoption. The estimates β_t and their 90% confidence intervals are from the following model:

$$NumberOfPatents_{i,t} = \beta_t \sum_{\tau=-15,\tau\neq 0}^{\tau=8} ARD_i \times 1[t=\tau] + \gamma X_{i,t} + \delta_i + \pi_t + \epsilon_{i,t}$$

where $1[t=\tau]$ is a dummy variable, indicating the relative quarter around ASC 606 adoption (December 15, 2017) such that quarter "0" is 2017Q4. 2017Q4 is omitted for comparison. $X_{i,t}$ represents a vector of time-varying firm-level controls. δ_i and π_t are firm and year fixed effects, respectively. Standard errors are clustered at firm and year-quarter levels. Detailed definitions of all variables are provided in Appendix A.

Table 2: Descriptive Statistics for pre-ASC 606 Sample Period

	Alliance Revenue Independent					Alliance Revenue Dependent				
	Count	Mean	25%	50%	75%	Count	Mean	25%	50%	75%
Age	2561	17.424	5.750	16.252	24.671	2234	10.222	3.751	6.001	16.000
Cash	2561	1080.747	27.793	104.022	328.707	2234	124.733	20.344	69.037	163.202
Deferred Revenue	2561	0.059	0.000	0.001	0.034	2234	0.159	0.000	0.014	0.128
Disclosure	355	2460.811	1242.000	2066.000	3580.500	287	2452.923	1059.000	2079.000	3585.500
HP Index	2561	-3.160	-3.847	-3.136	-2.631	2234	-2.705	-3.133	-2.820	-2.401
Leverage	2561	2232.463	0.000	15.088	295.980	2234	64.119	0.000	0.002	12.166
Market Cap	2561	14858.324	118.237	515.558	2992.465	2234	688.538	50.005	206.711	655.481
Net Income	2561	141.087	-13.930	-3.061	7.445	2234	-11.769	-18.657	-8.309	-2.843
New Debt Issuance	2561	0.039	-0.004	0.000	0.010	2234	0.018	0.000	0.000	0.000
New Equity Issuance	2561	0.046	0.000	0.003	0.015	2234	0.096	0.000	0.004	0.037
R&D Expenditures	2561	122.845	1.700	8.149	27.429	2234	12.809	2.687	6.998	16.336
R&D Intensity	2561	0.076	0.014	0.046	0.103	2234	0.125	0.051	0.086	0.134
Raw Deferred Revenue	2561	34.363	0.000	0.034	7.269	2234	27.633	0.000	1.089	14.242
Raw Drug Candidates	2561	0.411	0.000	0.000	0.000	2234	0.201	0.000	0.000	0.000
Raw Patents	2561	5.632	0.000	0.000	2.000	2234	0.598	0.000	0.000	1.000
Raw Patent Citations	2561	30.812	0.000	0.000	1.000	2234	0.691	0.000	0.000	0.000
Raw Patent Values	2561	238.605	0.000	0.000	12.757	2234	4.312	0.000	0.000	0.249
Raw Revenue	2561	992.575	0.669	9.750	139.118	2234	63.525	0.047	1.026	6.280
Revenue	2561	0.119	0.020	0.089	0.156	2234	0.082	0.001	0.014	0.060
Total Assets	2561	7225.217	54.886	163.925	1318.368	2234	258.022	32.579	94.462	222.941
Total Partner Alliances	2561	0.517	0.000	0.000	1.000	2234	0.206	0.000	0.000	0.000
Total Partner R&D Alliances	2561	0.091	0.000	0.000	0.000	2234	0.036	0.000	0.000	0.000
Total Principal Alliances	2561	0.337	0.000	0.000	0.000	2234	0.179	0.000	0.000	0.000
Total Principal R&D Alliances	2561	0.056	0.000	0.000	0.000	2234	0.066	0.000	0.000	0.000

This table presents descriptive statistics for variables for pre-ASC 606 period for Alliance Revenue Dependent and Independent Firms. Descriptive statistics are calculated whenever there are non-missing data available. All continuous variables are winsorized at 1% and 99% levels. Variable descriptions are available in Appendix A.

Table 3: Descriptive Statistics for post-ASC 606 Sample Period

	Alliance Revenue Independent					Alliance Revenue Dependent				
	Count	Mean	25%	50%	75%	Count	Mean	25%	50%	75%
Age	1323	19.537	7.877	18.500	27.502	1317	11.515	5.500	7.751	16.249
Cash	1323	1087.798	32.316	132.000	424.494	1317	160.825	26.077	90.048	183.033
Deferred Revenue	1323	0.065	0.000	0.000	0.018	1317	0.099	0.000	0.005	0.099
Disclosure	183	3197.814	1841.500	2871.000	4188.000	180	3498.844	2030.000	3149.500	4420.250
HP Index	1323	-3.309	-3.998	-3.300	-2.753	1317	-2.849	-3.234	-2.925	-2.575
Leverage	1323	2676.658	1.936	37.862	401.757	1317	128.558	0.000	6.427	35.963
Market Cap	1323	16520.535	100.243	637.159	3358.934	1317	998.133	75.655	235.410	762.695
Net Income	1323	161.478	-19.453	-3.838	11.508	1317	-17.109	-23.075	-10.869	-3.186
New Debt Issuance	1323	0.065	-0.012	0.000	0.020	1317	0.057	-0.011	0.000	0.006
New Equity Issuance	1323	0.050	0.000	0.003	0.014	1317	0.076	0.001	0.004	0.043
R&D Expenditures	1323	151.560	2.152	11.693	40.248	1317	17.029	2.998	9.477	20.083
R&D Intensity	1323	0.072	0.012	0.043	0.097	1317	0.106	0.049	0.084	0.128
Raw Deferred Revenue	1323	35.321	0.000	0.000	4.878	1317	29.301	0.000	0.365	14.650
Raw Drug Candidates	1323	0.255	0.000	0.000	0.000	1317	0.127	0.000	0.000	0.000
Raw Patents	1323	1.694	0.000	0.000	1.000	1317	0.186	0.000	0.000	0.000
Raw Patent Citations	1323	0.414	0.000	0.000	0.000	1317	0.014	0.000	0.000	0.000
Raw Patent Values	1323	103.963	0.000	0.000	0.937	1317	1.848	0.000	0.000	0.000
Raw Revenue	1323	1057.059	1.487	18.172	168.658	1317	61.706	0.132	1.649	10.184
Revenue	1323	0.116	0.027	0.090	0.153	1317	0.062	0.002	0.019	0.067
Total Assets	1323	7729.619	70.249	276.577	1631.747	1317	405.542	45.103	124.096	275.566
Total Partner Alliances	1323	0.507	0.000	0.000	1.000	1317	0.195	0.000	0.000	0.000
Total Partner R&D Alliances	1323	0.089	0.000	0.000	0.000	1317	0.039	0.000	0.000	0.000
Total Principal Alliances	1323	0.301	0.000	0.000	0.000	1317	0.166	0.000	0.000	0.000
Total Principal R&D Alliances	1323	0.056	0.000	0.000	0.000	1317	0.052	0.000	0.000	0.000

This table presents descriptive statistics for variables for post-ASC 606 period for Alliance Revenue Dependent and Independent Firms. Descriptive statistics are calculated whenever there are non-missing data available. All continuous variables are winsorized at 1% and 99% levels. Variable descriptions are available in Appendix A.

Table 4: The Impact of ASC 606 on Financial Statements in Revenue, Deferred Revenue and Revenue Disclosures

	Revenue	Deferred Revenue	Disclosure
	(1)	(2)	(3)
ARD $\times ASC606$	0.189***	-0.024***	422.266**
	(0.006)	(0.005)	(214.386)
Year-Quarter FE	Yes	Yes	No
Year FE	No	No	Yes
Firm FE	Yes	Yes	Yes
Observations	7,435	7,435	1,179
R^2	0.200	0.283	0.454
Adjusted R^2	0.153	0.241	0.311
Note:	*p<0.1; **p<0.05; ***p<0.01		

This table presents DiD regression for the impact of ASC 606 on financial statements from the regression of *Revenue*, *Deferred Revenue* and *Disclosure* on $ARD \times ASC606$. The unit of observation is at the firm-quarter level for *Revenue* and *Deferred Revenue*, and firm-year level for *Disclosure*. I include firm fixed effects in all specifications, year-quarter fixed effects for *Revenue* and *Deferred Revenue*, and year fixed effects for *Disclosure* regressions. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 5: The Impact of ASC 606 on Information Asymmetry

	Bid-Ask	
	(1)	(2)
MTB	-7.2×10^{-11}	-6.14×10^{-10}
	(1.05×10^{-10})	(4.24×10^{-10})
Size	-0.0025***	-0.0022***
	(0.0003)	(0.0002)
Leverage	0.0005	0.0004
	(0.0007)	(0.0006)
Number of Analysts	-0.0002***	-0.0001**
	(5.33×10^{-5})	(3.61×10^{-5})
ASC606 × ARD	-0.0020***	
	(0.0007)	
ASC606 × ASC606 Impact		0.0092**
		(0.0035)
ASC606 × $\Delta Disclosure$		0.0008
		(0.0007)
ASC606 × ASC606 Impact × $\Delta Disclosure$		-0.0204***
		(0.0057)
Firm FE	Yes	Yes
Year-Quarter FE	Yes	Yes
Observations	7,615	3,414
R^2	0.30334	0.38230
Adjusted R^2	0.26272	0.35237
Note:	*p<0.1; **p<0.05; ***p<0.01	

This table presents DiD regression for the impact of ASC 606 on information asymmetry from the regression of *Bid-Ask* on $ASC606 \times ARD$ and *ASC606* interacted with *ASC606 Impact* and $\Delta Disclosure$. The unit of observation is at the firm-quarter level. I include firm and year-quarter fixed effects in all specifications. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 6: The Impact of ASC 606 on Access to Captial

	New Equity Issuance	New Debt Issuance
	(1)	(2)
ARD $\times ASC606$	0.019**	0.009
	(0.009)	(0.028)
ROA	-0.024**	-0.069*
	(0.010)	(0.037)
Tangible Assets	-0.047	0.313*
	(0.034)	(0.171)
Size	0.007***	-0.001
	(0.001)	(0.003)
Growth	0.049***	0.064***
	(0.005)	(0.016)
Year-Quarter FE	Yes	Yes
Firm FE	Yes	Yes
Observations	6,908	6,908
R^2	0.108	0.014
Adjusted R^2	0.050	-0.050
Note:		*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the impact of ASC 606 on accessing capital from the regression of *New Equity Issuance* and *New Debt Issuance* on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. I include firm and year-quarter fixed effects in all specifications. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 7: The Impact of ASC 606 on R&D Investment

	R&D Intensity	R&D Partner Alliances	R&D Partner Alliances
	(1)	(2)	(3)
ARD $\times ASC606$	0.006***	0.026**	0.598***
	(0.002)	(0.013)	(0.130)
MVE_{t-1}	0.002***	0.029***	-0.009
	(0.000)	(0.001)	(0.007)
TobinQ_{t-1}	-0.000	-0.001**	-0.043***
	(0.000)	(0.000)	(0.011)
CFO	-0.221***	-0.003	0.836***
	(0.036)	(0.023)	(0.267)
Cash_{t-1}	0.025***	-0.085***	-1.567***
	(0.005)	(0.010)	(0.092)
Growth_{t-1}	-0.013***	0.013	0.326***
	(0.004)	(0.008)	(0.078)
ROA_{t-1}	0.020	-0.011	0.782***
	(0.013)	(0.018)	(0.219)
Model	OLS	OLS	Negative Binomial
Year-Quarter FE	Yes	Yes	No
Firm FE	No	No	No
Observations	7,336	7,368	7,610
R^2	0.724	0.179	
Adjusted R^2	0.720	0.178	
(Pseudo) R^2			0.016
Note:			*p<0.1; **p<0.05; ***p<0.01

This table presents DID regression for the impact of ASC 606 on R&D investments from the regression of *R&D Intensity* and *Number of R&D Partner Alliances* on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. The first two column utilizes OLS model and the third column uses Negative Binomial Model. I include year-quarter fixed effects for OLS regressions. Because of incidental parameters problem, I do not include any fixed effect to the Negative Binomial models. The addition of firm fixed effects does not change the results quantitatively, but shrinks the adjusted R^2 by more than half for the first two columns. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 8: Placebo Tests for The Impact of ASC 606 on R&D Investment

	Supply Partner Alliances	R&D Principal Alliances
	(1)	(2)
ARD $\times ASC606$	0.001	0.005
	(0.005)	(0.009)
MVE_{t-1}	0.007***	0.019***
	(0.000)	(0.001)
TobinQ_{t-1}	-0.000*	-0.000
	(0.000)	(0.000)
CFO	-0.022*	-0.034**
	(0.012)	(0.017)
Cash_{t-1}	-0.021***	-0.040***
	(0.005)	(0.008)
Growth_{t-1}	0.005	-0.005
	(0.004)	(0.006)
ROA_{t-1}	-0.015	-0.016
	(0.009)	(0.013)
Model	OLS	OLS
Year-Quarter FE	Yes	Yes
Firm FE	No	No
Observations	7,368	7,368
R^2	0.054	0.112
Adjusted R^2	0.053	0.101
Note:		*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the placebo test of ASC 606 impact on R&D investments from the regression of *Supply Partner Alliances* and *Number of R&D Principal Alliances* on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. All models utilizes OLS. I include year-quarter fixed effects. The addition of firm fixed effects does not change the results quantitatively, but shrinks the adjusted R^2 by more than half for the first two columns. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 9: Cross Sectional Test for Alliance Formation - Private Principals

	Dependent variable:	
	Partner Alliances with Private Firms	Partner Alliances with Public Firms
	(1)	(2)
ARD $\times ASC606$	0.023*	0.007
	(0.012)	(0.006)
MVE_{t-1}	0.024***	0.009***
	(0.001)	(0.000)
TobinQ_{t-1}	-0.001*	-0.000
	(0.000)	(0.000)
CFO	-0.007	-0.000
	(0.021)	(0.010)
Cash_{t-1}	-0.069***	-0.035***
	(0.009)	(0.005)
Growth_{t-1}	0.013*	0.002
	(0.007)	(0.004)
ROA_{t-1}	-0.015	0.005
	(0.016)	(0.008)
Year-Quarter FE	Yes	Yes
Firm FE	No	No
Observations	7,368	7,368
R^2	0.157	0.073
Adjusted R^2	0.156	0.072
Note:		*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the cross sectional impact of ASC 606 on R&D investment from the regression of *Number of Partner Alliances with Private Firms* and *Number of Partner Alliances with Public Firms* on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. I include year-quarter fixed effects in all specifications. The addition of firm fixed effects does not change the results quantitatively, but shrinks the adjusted R^2 by more than half for the first two columns. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 10: Cross Sectional Tests for Alliance Formation - Network Centrality

	Number of Partner Alliances	Number of Partner Alliances
	(1)	(2)
ARD $\times ASC606$	0.341**	-0.026
	(0.152)	(0.017)
ARD $\times LowCentrality \times ASC606$	1.458***	0.104***
	(0.158)	(0.016)
LowCentrality	-1.690***	-0.116***
	(0.097)	(0.009)
MVE_{t-1}	0.010	0.034***
	(0.007)	(0.001)
$TobinQ_{t-1}$	-0.007	-0.000
	(0.010)	(0.000)
CFO	0.805***	-0.000
	(0.274)	(0.026)
$Cash_{t-1}$	-1.134***	-0.043***
	(0.102)	(0.012)
$Growth_{t-1}$	0.421***	0.010
	(0.082)	(0.009)
ROA_{t-1}	0.846***	-0.029
	(0.258)	(0.021)
Model	Negative Binomial	OLS
Year-Quarter FE	No	Yes
Firm FE	No	No
Observations	6,974	6,974
R^2		0.221
Adjusted R^2		0.220
(Pseudo) R^2	0.093	
Note:		*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the cross sectional impact of ASC 606 on R&D investment from the regression of *Number of Partner Alliances* based on ARD firm centrality on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. I include year-quarter fixed effects in OLS model but not in Negative Binomial model due to potential incidental parameters problem. The addition of firm fixed effects does not change the results quantitatively, but shrinks the adjusted R^2 by more than half for the first two columns. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 11: The Impact of ASC 606 on the Alliance Network

	Closeness Centrality		Degree Centrality	
	(1)	(2)	(3)	(4)
ARD $\times ASC606$	0.185***	0.008***	5.292***	0.125***
	(0.003)	(0.002)	(0.077)	(0.030)
MVE_{t-1}		0.012***		0.335***
		(0.000)		(0.005)
TobinQ_{t-1}		-0.000		-0.004***
		(0.000)		(0.001)
CFO		-0.001		0.028
		(0.003)		(0.051)
Cash_{t-1}		0.004		0.292***
		(0.003)		(0.044)
Growth_{t-1}		-0.004***		-0.213***
		(0.001)		(0.022)
ROA_{t-1}		-0.005*		-0.068
		(0.003)		(0.042)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
Observations	5,690	5,690	5,690	5,690
R^2	0.435	0.893	0.468	0.969
Adjusted R^2	0.399	0.885	0.433	0.966
Note:				*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the impact of ASC 606 on R&D alliance network from the regression of *Closeness Centrality* and *Degree Centrality* on $ARD \times ASC606$. The unit of observation is at the firm-year level. I include firm and year fixed effects in all specifications. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 12: The Impact of ASC 606 on Innovation

	Number of Patents	Forwards Citations	Patent Value(KPSS)	Number of Drug Candidates
	(1)	(2)	(3)	(4)
ARD $\times ASC606$	0.400***	0.474***	0.856***	0.032*
	(0.108)	(0.139)	(0.198)	(0.019)
ROA	0.035	0.035	0.123	-0.002
	(0.036)	(0.029)	(0.097)	(0.004)
HPIndex	-0.431***	-0.544***	-1.471***	-0.080***
	(0.157)	(0.184)	(0.342)	(0.029)
Size	-0.172*	-0.268**	-0.665***	-0.014
	(0.089)	(0.104)	(0.193)	(0.017)
Year-Quarter FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Observations	6,209	6,209	6,209	6,234
R^2	0.493	0.245	0.509	0.253
Adjusted R^2	0.470	0.211	0.488	0.209
Note:				*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the impact of ASC 606 on innovation from the regression of *Number of Patents*, *Forward Citations*, *Patent Value* and *Number of Drug Candidates* on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. I include firm and year-quarter fixed effects in all specifications. The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Table 13: Cross Sectional Tests for Innovation

	Patent Value(KPSS)		Number of Drug Candidates	
	(1)	(2)	(3)	(4)
ASC606	-1.690***		-0.159***	
	(0.167)		(0.013)	
ARD	-0.790***		-0.039***	
	(0.193)		(0.014)	
ARD $\times ASC606$	0.800***	0.676***	-0.016	-0.001
	(0.266)	(0.235)	(0.025)	(0.023)
ARD $\times LowCentrality \times ASC606$	0.552**	0.210	0.127***	0.100***
	(0.230)	(0.198)	(0.024)	(0.026)
LowCentrality	-0.221	-4.222***	-0.114***	0.024
	(0.159)	(1.017)	(0.011)	(0.068)
ROA	-0.172**	-0.063	-0.011***	-0.001
	(0.078)	(0.049)	(0.003)	(0.003)
HPIndex	0.538***	-2.080***	0.027***	-0.047*
	(0.108)	(0.483)	(0.008)	(0.027)
Size	0.690***	-0.679***	0.071***	-0.002
	(0.059)	(0.206)	(0.004)	(0.013)
Year-Quarter FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Observations	6,108	6,108	6,129	6,129
R^2	0.582	0.532	0.282	0.232
Adjusted R^2	0.581	0.511	0.281	0.183
Note:				*p<0.1; **p<0.05; ***p<0.01

This table presents DiD regression for the cross sectional impact of ASC 606 on innovation from the regression of *Patent Value* and *Number of Drug Candidates* based on ARD firm centrality on $ARD \times ASC606$. The unit of observation is at the firm-quarter level. I include year-quarter fixed effects and firm fixed effects in Column (2) and (4). The standard errors, reported below the coefficient estimates in parentheses, are computed based on standard errors clustered at the firm and year-quarter level. All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are available in Appendix A.

Appendix C: Revenue Recognition Disclosure Examples

Exelixis – Revenue Disclosure Before ASC 606

Results of Operations

Revenues

Revenues by category were as follows (dollars in thousands):

	Three Months Ended March 31,	
	2017	2016
Product revenues:		
Gross product revenues	$ 77,959	$ 10,614
Discounts and allowances	(9,082)	(1,515)
Net product revenues	68,877	9,099
Collaboration revenues:		
License revenues (1)	6,192	1,198
Contract revenues (2)	2,500	5,000
Royalty and product supply revenues, net	2,186	130
Development cost reimbursements	1,132	—
Total collaboration revenues	12,010	6,328
Total revenues	$ 80,887	$ 15,427
Dollar change	$ 65,460	
Percentage change	424%	

(1) Includes amortization of upfront payments.

(2) Includes milestone payments.

Net product revenues by product were as follows (dollars in thousands):

	Three Months Ended March 31,	
	2017	2016
CABOMETYX	$ 62,359	$ —
COMETRIQ	6,518	9,099
Net product revenues	$ 68,877	$ 9,099
Dollar change	$ 59,778	
Percentage change	657%	

The increase in net product revenues for the three months ended March 31, 2017, as compared to the comparable period in 2016, was primarily due to the impact of the commercial launch of CABOMETYX in late April 2016. CABOMETYX was approved by the FDA on April 25, 2016 as a treatment for patients with advanced RCC who have received prior anti-angiogenic therapy. The 28% decrease in net product revenues for COMETRIQ for the three months ended March 31, 2017, as compared to the comparable period in 2016, was primarily due to a 24% decrease in the number of COMETRIQ units sold in the U.S., as well as a decrease in units sold related to the termination of our agreement with SOBI, which was partially offset by an increase in the average selling price of the product. The decrease in COMETRIQ sales volume was primarily driven by the adoption of CABOMETYX by our customers.

License revenues for the three months ended March 31, 2017 consisted of the recognition of $4.3 million and $1.9 million of the upfront payments and non-substantive milestone received in 2016 in connection with our collaboration agreements with Ipsen and Takeda, respectively. License revenues during the comparable period in 2016 were $1.2 million and solely related to the collaboration agreement with Ipsen.

Contract revenues for the three months ended March 31, 2017 reflect recognition of the $2.5 million milestone earned from BMS related to the ROR Gamma program. Contract revenues for the comparable period in 2016 reflect a $5.0 million milestone earned from Merck related to its worldwide license of our phosphoinositide-3 kinase-delta program.

Royalty and product supply revenues, net, for the three months ended March 31, 2017 and 2016 primarily consisted of royalties on ex-U.S. net sales of COTELLIC under our collaboration agreement with Genentech for cobimetinib totaling $2.3 million and $0.1 million, respectively.

Development cost reimbursements for the three months ended March 31, 2017 consisted of $0.8 million and $0.3 million of reimbursements pursuant to our collaboration and license agreements with Takeda and Ipsen, respectively. There was no such development cost reimbursements during the comparable period in 2016.

Total revenues by significant customer were as follows (dollars in thousands):

	Three Months Ended March 31,	
	2017	2016
Diplomat Specialty Pharmacy	$ 19,850	$ 8,464
Caremark L.L.C.	13,819	—
Affiliates of McKesson Corporation	11,278	—
Accredo Health, Incorporated	9,440	—
Merck	—	5,000
Others, individually less than 10% of total revenues for all periods presented	26,500	1,963
Total revenues	$ 80,887	$ 15,427

We recognize net product revenue net of discounts and allowances that are further described in "Note 1. Organization and Summary of Significant Accounting Policies" to our "Notes to Consolidated Financial Statements" contained in Part II, Item 8 of our Annual Report on Form 10-K filed with the SEC on February 27, 2017. The activities and ending reserve balances for each significant category of discount and allowance were as follows (dollars in thousands):

	Chargebacks and discounts for prompt payment	Other customer credits and co-pay assistance	Rebates	Returns	Total
Balance at December 31, 2016	$ 1,802	$ 794	$ 2,627	$ 351	$ 5,574
Provision related to sales made in:					
Current period	5,461	1,640	2,331	—	9,432
Prior periods	—	—	(350)	—	(350)
Payments and customer credits issued	(5,548)	(1,693)	(1,589)	—	(8,830)
Balance at March 31, 2017	$ 1,715	$ 741	$ 3,019	$ 351	$ 5,826

Chargebacks and discounts for prompt payment are recorded as a reduction of trade receivables and the remaining reserve balances are classified as Other current liabilities in the accompanying Condensed Consolidated Balance Sheets. Amounts presented as of December 31, 2016 have been restated to reflect that classification.

The increase in the reserve balance at March 31, 2017 was primarily the result of an increase in product sales volume. We expect our discounts and allowances as a percentage of gross product revenue to increase during the remainder of 2017 as our business evolves.

Exelixis – Revenue Disclosure After ASC 606

Results of Operations

Revenues

Revenues by category were as follows (dollars in thousands):

	Three Months Ended March 31,		Percentage Change - 2018 v. 2017
	2018	2017	
Net product revenues	$ 134,272	$ 68,877	95%
Collaboration revenues	78,074	12,010	550%
Total revenues	$ 212,346	$ 80,887	163%

Total revenues for the three months ended March 31, 2018 were impacted by our adoption of Accounting Standards Update No. 2014-09, *Revenue from Contracts with Customers (Accounting Standards Codification Topic 606)*, or Topic 606. For additional information on our adoption of Topic 606, see "Note 1. Organization and Summary of Significant Accounting Policies - Revenue", "Note 2. Revenues" and "Note 3. Collaboration Agreements" in the "Notes to Condensed Consolidated Financial Statements" contained in Part I, Item 1 of this Quarterly Report on Form 10-Q.

Net Product Revenues

Net product revenues by product were as follows (dollars in thousands):

	Three Months Ended March 31,		Percentage Change - 2018 v. 2017
	2018	2017	
CABOMETYX	$ 128,934	$ 62,359	107 %
COMETRIQ	5,338	6,518	(18)%
Net product revenues	$ 134,272	$ 68,877	95 %

The increase in net product revenues for CABOMETYX was primarily due to a 95% increase in the number of units of CABOMETYX sold, and to a lesser extent, an increase in the average selling price of the product. The increase in CABOMETYX sales volume reflects the growth of our second and later-line advanced RCC business and the impact of additional sales following the FDA's approval in December 2017 of the expanded indication for CABOMETYX to include advanced first-line RCC, which now encompass all patients with advanced RCC. The decrease in net product revenues for COMETRIQ was due to a 20% decline in the number of units of COMETRIQ sold. COMETRIQ sales volume has been decreasing since the launch of CABOMETYX in April 2016. The adoption of Topic 606 did not impact our net product revenues.

We recognize product revenues net of discounts and allowances that are described in "Note 1. Organization and Summary of Significant Accounting Policies" to our "Notes to Consolidated Condensed Financial Statements" contained in contained in Part I, Item 1 of this Quarterly Report on Form 10-Q. The total reserve balance for discounts and allowances was $14.5 million and $9.5 million as of March 31, 2018 and December 31, 2017, respectively. The increase in the reserve balance at March 31, 2018 was the result of an increase in product sales volume, which was offset by payments, the issuance of customer credits and the prior period adjustments for chargebacks and certain rebates. We expect our discounts and allowances as a percentage of gross product revenues to increase during the remainder of 2018 as our business evolves and the number of patients participating in government programs increases, the discounts and rebates to government payers increase, and as a result of the engagement in commercial contracting which may result in additional discounts or rebates.

Collaboration Revenues

Collaboration revenues were as follows (dollars in thousands):

Collaboration revenues were as follows (dollars in thousands):

	Three Months Ended March 31,		Percentage Change - 2018 v. 2017
	2018	2017	
Collaboration revenues:			
License revenues [1]	$ 69,030	$ 11,214	516%
Research and development services revenues [2]	10,099	1,132	792%
Product supply revenues, net	(1,055)	(336)	214%
Total collaboration revenues	$ 78,074	$ 12,010	550%

(1) License revenues for the three months ended March 31, 2018 included revenues related to the portion of two milestones that were allocated to the transfer of intellectual property licenses and were fully recognized in the current period and royalty revenues from Ipsen and Genentech. License revenues for the three months ended March 31, 2017 included the recognition of deferred revenue from upfront payments and a non-substantive milestone that were being amortized over various periods, royalty revenues from Ipsen and Genentech and one milestone. Upon the adoption of Topic 606, the allocation of proceeds from our collaboration partners between licenses and research and development services as well as the timing of recognition has changed. Therefore, among other changes, as of January 1, 2018, the portion of proceeds allocated to intellectual property licenses for our Ipsen and Takeda collaboration agreements are recognized immediately and license revenues no longer includes revenues related to the amortization of deferred revenue.

(2) Research and development services revenues for three months ended March 31, 2018 included the recognition of deferred revenue for the portion of the upfront payments and milestones that were allocated to the research and development services which are being amortized through early 2030, as well as development cost reimbursements earned on our collaboration agreements. As described in (1) above, we did not allocate any of our upfront payments or milestones to research and development services prior to the adoption of Topic 606 and therefore research and development services revenues for the three months ended March 31, 2017 included only development cost reimbursements earned on our collaboration agreements.

Collaboration revenues increased to $78.1 million for the three months ended March 31, 2018, as compared to $12.0 million for the comparable period in 2017. The increase in collaboration revenues was primarily the result of the recognition of two milestones during the three months ended March 31, 2018 as well as increases in royalties under our collaboration agreement with Ipsen and development cost reimbursement revenues; those increases were partially offset by a decrease in the recognition of deferred revenue due to the adoption of Topic 606, a decrease in royalties under our collaboration agreement with Genentech and an increase in losses under our product supply agreement with Ipsen.

During the three months ended March 31, 2018, we recorded $45.8 million in revenue relating to a $50.0 million milestone from Ipsen we expect to earn in the second quarter of 2018 for the approval of cabozantinib for the first-line treatment of advanced RCC by the European Commission, or the EC. The determination to recognize the $45.8 million in revenue was made following the CHMP's positive opinion of cabozantinib for the first-line treatment of advanced RCC. The $45.8 million in revenue we recognized during the three months ended March 31, 2018 represents the portion of the milestone that was allocated to the previously satisfied performance obligations for intellectual property and research and development services; the remainder was allocated to research and development services to be delivered in future periods through early 2030.

During the three months ended March 31, 2018, we also earned and recognized a $20.0 million milestone upon Daiichi Sankyo's submission to the Japanese Pharmaceutical and Medical Devices Agency of a regulatory application for esaxerenone as a treatment for patients with essential hypertension. We have determined that we previously satisfied our performance obligation to transfer an intellectual property license under the Daiichi Sankyo collaboration agreement and therefore, in accordance with Topic 606, the revenue for this milestone was fully recognized during the three months ended March 31, 2018. Collaboration revenues for the comparable period in 2017 reflect recognition of a $2.5 million milestone earned from the ROR collaboration agreement with BMS.

Royalties on net sales of cabozantinib by Ipsen outside of the U.S. and Japan increased to $4.4 million for the three months ended March 31, 2018, as compared to $0.2 million for the comparable period in 2017. Ipsen's net sales of cabozantinib have continued to grow since their first commercial sale of the product in December 2016.

Development cost reimbursements in connection with our collaboration arrangements with Ipsen and Takeda increased to $5.7 million for the three months ended March 31, 2018, as compared to $1.1 million for the comparable period in 2017 primarily as a result of their participation in the CheckMate 9ER study.

During the three months ended March 31, 2018, we recognized $1.8 million in revenues from the amortization of deferred revenue, including the upfront payments received in 2016 and 2017 in connection with our collaboration arrangements with Ipsen and Takeda, as compared to $6.2 million of such revenues during the comparable period in 2017. The decrease in such revenues was a result of the adoption of Topic 606. As a result of that adoption, on January 1, 2018 we recorded a $258.5 million net reduction to opening accumulated deficit, which included a $236.7 million reduction of the unrecognized upfront and non-substantive milestone payments previously received from our collaboration partners that had been included in deferred revenue at December 31, 2017.

Royalties on ex-U.S. net sales of COTELLIC under our collaboration agreement with Genentech decreased to $1.3 million for the three months ended March 31, 2018, as compared to $2.3 million for the comparable period in 2017. As a result of a change in the timing of when we receive sales information from Genentech in the first quarter of 2017, royalty revenues for the three months ended March 31, 2017 included both $1.1 million in royalty revenues for sales in the fourth quarter of 2016 and $1.2 million in royalty revenues for sales in the first quarter of 2017. Following a commercial review, commencing in January 2018 we and Genentech scaled back the personal promotion of COTELLIC as a treatment for patients with BRAF V600E or V600K mutation-positive advanced melanoma in the U.S. This decision is not indicative of any change in our intention to promote COTELLIC for other therapeutic indications for which it may be approved in the future.

The losses for Product supply revenues, net increased to $1.1 million for the three months ended March 31, 2018, as compared to $0.3 million for the comparable period in 2017. As part of the collaboration agreement with Ipsen, we entered into a supply agreement pursuant to which we supply finished, labeled product to Ipsen at our cost, as defined in the agreement, which excludes the 3% royalty we are required to pay GlaxoSmithKline, or GSK, on Ipsen's Net Sales of any product incorporating cabozantinib. As a result, as royalty generating sales of cabozantinib by Ipsen have increased, as described above, our losses on the related product supply agreement also increased.

NOTE 2. REVENUES

Revenues by disaggregated category were as follows (in thousands):

	Three Months Ended March 31,	
	2018	2017
Product revenues:		
Gross product revenues	$ 159,436	$ 77,959
Discounts and allowances	(25,164)	(9,082)
Net product revenues	134,272	68,877
Collaboration revenues:		
License revenues [1]	69,030	11,214
Research and development services revenues [2]	10,099	1,132
Product supply revenues, net	(1,055)	(336)
Total collaboration revenues	78,074	12,010
Total revenues	$ 212,346	$ 80,887

(1) License revenues for the three months ended March 31, 2018 included revenues related to the portion of two milestones that were allocated to the transfer of intellectual property licenses and were fully recognized in the current period and royalty revenue from Ipsen and Genentech. License revenues for the three months ended March 31, 2017 included the recognition of deferred revenues from upfront payments and a non-substantive milestone that were being amortized over various periods, royalty revenues from Ipsen and Genentech and one milestone. Upon the adoption of Topic 606, the allocation of proceeds from our collaboration partners between licenses and research and development services as well as the timing of recognition has changed. Therefore, among other changes, as of January 1, 2018, the portion of proceeds allocated to intellectual property licenses for our Ipsen and Takeda collaboration agreements are recognized immediately and license revenues no longer includes revenues related to the amortization of deferred revenue.

(2) Research and development services revenues for three months ended March 31, 2018 included the recognition of deferred revenue for the portion of the upfront payments and milestones that were allocated to the research and development services which are being amortized through early 2030, as well as development cost reimbursements earned on our collaboration agreements. As described above, we did not allocate any of our upfront payments or milestones to research and development services prior to the adoption of Topic 606 and therefore research and development services revenues for the three months ended March 31, 2017 included only development cost reimbursements earned on our collaboration agreements.

During the three months ended March 31, 2018, net product revenues and license revenues related to goods transferred at a point in time and research and development services revenues related to services performed over time. Product supply revenues, net, which include the royalty payable to GlaxoSmithKline (“GSK”) on net sales by Ipsen, were recorded in accordance with Topic 808 for all periods presented. Our remaining revenues were recorded in accordance with Topic 606 during 2018 and Topic 605 in prior periods.

Net product revenues disaggregated by product were as follows (in thousands):

	Three Months Ended March 31,	
	2018	2017
CABOMETYX	$ 128,934	$ 62,359
COMETRIQ	5,338	6,518
Net product revenues	$ 134,272	$ 68,877

Total revenues disaggregated by significant customer were as follows (dollars in thousands):

	Three Months Ended March 31,			
	2018		2017	
	Dollars	Percent of total	Dollars	Percent of total
Ipsen	$ 53,809	25%	$ 4,530	6%
Caremark L.L.C.	$ 26,388	12%	$ 13,819	17%
Affiliates of McKesson Corporation	$ 21,331	10%	$ 11,278	14%
Diplomat Specialty Pharmacy	$ 20,147	9%	$ 19,850	25%
Accredo Health, Incorporated	$ 18,286	9%	$ 9,440	12%

Total revenues disaggregated by geographic region were as follows (in thousands):

	Three Months Ended March 31,	
	2018	2017
U.S.	$ 135,620	$ 73,675
Europe	$ 53,809	$ 4,530
Rest of the world	$ 22,917	$ 2,682

Net product revenues are attributed to regions based on the ship-to location. Collaboration revenues are attributed to regions based on the location of our collaboration partners' headquarters.

Product Sales Discounts and Allowances

The activities and ending reserve balances for each significant category of discounts and allowances (which constitute variable consideration) were as follows (in thousands):

	Chargebacks and Discounts for Prompt Payment	Other Customer Credits/Fees and Co-pay Assistance	Rebates	Returns	Total
Balance at December 31, 2017	$ 1,928	$ 1,795	$5,770	$ —	$ 9,493
Provision related to sales made in:					
Current period	14,475	4,197	6,625	—	25,297
Prior periods	(331)	—	199	—	(132)
Payments and customer credits issued	(13,556)	(3,294)	(3,303)	—	(20,153)
Balance at March 31, 2018	$ 2,516	$ 2,698	$9,291	$ —	$14,505

Chargebacks and discounts for prompt payment are recorded as a reduction of trade receivables and the remaining reserve balances are classified as Other current liabilities in the accompanying Condensed Consolidated Balance Sheets.

Contract Assets and Liabilities

We receive payments from our licensees based on billing schedules established in each contract. Amounts are recorded as accounts receivable when our right to consideration is unconditional. Upfront and milestone payments may require deferral of revenue recognition to a future period until we perform our obligations under these arrangements and are recorded as deferred revenue upon receipt or when due. We may also recognize revenue in advance of the contractual billing schedule and such amounts are recorded as unbilled collaboration revenue when recognized. Changes in our contract assets and liabilities under Topic 606 were as follows (in thousands):

	Contract Assets: Unbilled Collaboration Revenue		Contract Liabilities: Deferred Revenue	
	Current Portion	Long-term Portion	Current Portion	Long-term Portion
Balance at December 31, 2017	$ —	$ —	$ 31,984	$ 238,520
Adoption of Topic 606	9,588	12,247	(23,591)	(213,079)
Balance at January 1, 2018	9,588	12,247	8,393	25,441
Increases as a result of a change in transaction price and recognition of revenues as services are performed	46,006	1,166	—	—
Transfer to receivables from contract assets recognized at the beginning of the period	(9,159)	—	—	—
Increases as a result of the deferral of milestones earned in period, excluding amounts recognized as revenue	—	—	173	666
Revenue recognized that was included in the contract liability balance at the beginning of the period	—	—	(3,492)	—
Other adjustments [(1)]	(14,591)	(13,413)	(5,074)	(22,930)
Balance at March 31, 2018	$ 31,844	$ —	$ —	$ 3,177

(1) Includes reclassification of deferred revenue from long-term to current and adjustments made due to netting of contract assets and liabilities by collaboration agreement.

During the three months ended March 31, 2018, we recognized $71.3 million in revenues under Topic 606 for performance obligations satisfied in previous periods. Such revenues primarily related to milestone and royalty payments allocated to our license performance obligations of our collaborations with Ipsen and Daiichi Sankyo Company, Limited (“Daiichi Sankyo”).

Exelixis – Alliance Revenue Disclosure Before ASC 606

Ipsen Collaboration

In February 2016, we entered into a collaboration and license agreement with Ipsen (the "Ipsen Collaboration Agreement") for the commercialization and further development of cabozantinib. Pursuant to the terms of the Ipsen Collaboration Agreement, Ipsen received exclusive commercialization rights for current and potential future cabozantinib indications outside of the U.S., Canada and Japan (the "Ipsen Territory"). The Ipsen Collaboration Agreement was subsequently amended in December 2016 (the "Amendment") to include commercialization rights in Canada in the Ipsen Territory. We have also agreed to collaborate with Ipsen on the development of cabozantinib for current and potential future indications.

In consideration for the exclusive license and other rights contained in the Ipsen Collaboration Agreement, Ipsen paid us an upfront nonrefundable payment of $200.0 million in March 2016. Additionally, as a result of the Amendment, we received a $10.0 million upfront nonrefundable payment from Ipsen in December 2016 and, as a result of the approval of cabozantinib in second-line renal cell carcinoma ("RCC") by the European Commission ("EC") in September 2016, we received a $60.0 million milestone in November 2016. We are receiving a 2% royalty on the initial $50.0 million of net sales by Ipsen, and are entitled to receive a 12% royalty on the next $100.0 million of net sales by Ipsen. After the initial $150.0 million of sales, we are entitled to receive a tiered royalty of 22% to 26% on annual net sales by Ipsen; these tiers will reset each calendar year. We are primarily responsible for funding cabozantinib-related development costs for those trials in existence at the time we entered into the Ipsen Collaboration Agreement; global development costs for additional trials will be shared between the parties, with Ipsen reimbursing us for 35% of such costs, provided Ipsen opts in to participate in such additional trials. Pursuant to the terms of the Ipsen Collaboration Agreement, we will remain responsible for the manufacture and supply of cabozantinib for all development and commercialization activities. As part of the collaboration agreement, we entered into a supply agreement pursuant to which we will supply finished, labeled product to Ipsen for distribution in the Ipsen Territories at our cost, as defined in the agreement, which excludes the 3% royalty we are required to pay GlaxoSmithKline on Ipsen's Net Sales of any product incorporating cabozantinib.

The Ipsen Collaboration Agreement contains multiple deliverables consisting of intellectual property licenses, delivery of products and/or materials containing cabozantinib to Ipsen for all development and commercial activities, research and development services, and participation on the joint steering, development and commercialization committees (as defined in the Ipsen Collaboration Agreement). We determined that these deliverables do not have stand-alone value and accordingly, combined these deliverables into a single unit of accounting and allocated the entire arrangement consideration to that combined unit of accounting. As a result, the upfront payment of $200.0 million, received in the first quarter of 2016 and the $10.0 million upfront payment received in December 2016 in consideration for the development and commercialization rights in Canada are being recognized ratably over the term of the Ipsen Collaboration Agreement, through early 2030, which is the current estimated patent expiration of cabozantinib in the European Union. At the time we entered into the Ipsen Collaboration Agreement, we also determined that the $60.0 million milestone we achieved upon the approval of cabozantinib by the EC in second-line RCC was not substantive due to the relatively low degree of uncertainty and relatively low amount of effort required on our part to achieve the milestone as of the date of the collaboration agreement; the $60.0 million was deferred as of the date of the European Medicines Agency's approval of cabozantinib in second-line RCC in September 2016 and is being recognized ratably over the term of the Ipsen Collaboration Agreement. The two $10.0 million milestones for the first commercial sales of CABOMETYX in Germany and the United Kingdom were determined to be substantive at the time we entered into the Ipsen Collaboration Agreement and were recognized as collaboration revenues in the fourth quarter of 2016. We determined that the remaining development and

regulatory milestones are substantive and will be recognized as revenue in the periods in which they are achieved. We consider the contingent payments due to us upon the achievement of specified sales volumes to be similar to royalty payments. Reimbursements for development costs are classified as revenue as the development services represent our ongoing major or central operations.

During the quarter ended March 31, 2017, we reclassified $9.0 million of deferred revenue to Other current and long-term liabilities, and accordingly adjusted our amortization of the upfront payment of $200.0 million as a result of a change in operational responsibilities for certain clinical programs in the Ipsen Territory. As of March 31, 2017, we had paid $1.1 million toward the $9.0 million of reimbursements due to Ipsen for these clinical programs.

See "Note 2 - Collaboration Agreements" to our Consolidated Financial Statements included in our Annual Report on Form 10-K for the year ended December 31, 2016 filed with the SEC on February 27, 2017 for additional description of our collaboration agreement with Ipsen.

During the three months ended March 31, 2017 and 2016, collaboration revenues under the Ipsen Collaboration Agreement were as follows (in thousands):

	Three Months Ended March 31,	
	2017	2016
Amortization of upfront payments and deferred milestone	$ 4,305	$ 1,198
Royalty revenue	224	—
Development cost reimbursements	337	—
Product supply agreement revenue	991	—
Cost of supplied product	(991)	—
Royalty payable to GlaxoSmithKline on net sales by Ipsen	(336)	—
Collaboration revenues under the Ipsen Collaboration Agreement	$ 4,530	$ 1,198

As of March 31, 2017, short-term and long-term deferred revenue relating to the Ipsen Collaboration Agreement was $19.0 million and $224.4 million, respectively.

Exelixis – Alliance Revenue Disclosure After ASC 606

Ipsen Collaboration

In February 2016, we entered into a collaboration and license agreement with Ipsen for the commercialization and further development of cabozantinib. Pursuant to the terms of the collaboration agreement, Ipsen received exclusive commercialization rights for current and potential future cabozantinib indications outside of the U.S., Canada and Japan. The collaboration agreement was subsequently amended in December 2016 to include commercialization rights in Canada. We have also agreed to collaborate with Ipsen on the development of cabozantinib for current and potential future indications. The parties' efforts are governed through a joint steering committee and appropriate subcommittees established to guide and oversee the collaboration's operation and strategic direction; provided, however, that we retain final decision-making authority with respect to cabozantinib's ongoing development.

In consideration for the exclusive license and other rights contained in the collaboration agreement, including commercialization rights in Canada, Ipsen paid us aggregate upfront payments of $210.0 million. As of December 31, 2017 we had earned various milestones totaling $125.0 million. During the three months ended March 31, 2018 we earned an additional $10.0 million milestone upon Ipsen's filing with the EMA for cabozantinib as a treatment for patients with previously treated advanced HCC.

We are also eligible to receive future development and regulatory milestone payments, totaling up to an additional $199.0 million, including a $40.0 million milestone upon the EMA's approval of cabozantinib as a treatment for patients with previously treated advanced HCC, a $50.0 million milestone upon the EMA's approval of cabozantinib as a first-line treatment of advanced RCC and additional milestone payments for other future indications and/or jurisdictions. The collaboration agreement also provides that we will be eligible to receive contingent payments of up to $545.5 million associated with the achievement of specified levels of Ipsen sales to end users. We will also receive royalties on net sales of cabozantinib by Ipsen outside of the U.S. and Japan. Excluding Ipsen sales in Canada, we received a 2% royalty on the initial $50.0 million of net sales, which was achieved in the fourth quarter of 2017, and are entitled to receive a 12% royalty on the next $100.0 million of net sales, and following this initial $150.0 million of net sales, we are then entitled to receive a tiered royalty of 22% to 26% on annual net sales. These tiers will reset each calendar year. In Canada, we are entitled to receive a tiered royalty of 22% on the first Can$30.0 million of annual net sales and a tiered royalty thereafter, up to 26% on annual net sales; these tiers will also reset each calendar year.

We are primarily responsible for funding cabozantinib-related development costs for those trials in existence at the time we entered into the collaboration agreement with Ipsen; global development costs for additional trials are shared between the parties, with Ipsen reimbursing us for 35% of such costs, provided Ipsen chooses to opt into such trials. In accordance with the collaboration agreement, Ipsen has opted into and is co-funding: CheckMate 9ER, the phase 3 pivotal trial evaluating the combination of cabozantinib with nivolumab versus sunitinib in patients with previously untreated, advanced or metastatic RCC being conducted in collaboration with Bristol-Myers Squibb Company ("BMS"); CheckMate 040, the phase 1/2 study evaluating the combination of cabozantinib with nivolumab in patients with both previously treated and previously untreated advanced HCC being conducted in collaboration with BMS (though Ipsen will not be co-funding the triplet arm of the study evaluating cabozantinib with nivolumab and ipilimumab); and the phase 1b trial evaluating cabozantinib in combination with atezolizumab in locally advanced or metastatic solid tumors being conducted in collaboration with the Roche Group.

We remain responsible for the manufacture and supply of cabozantinib for all development and commercialization activities under the collaboration agreement. In connection with the collaboration agreement, we entered into a supply agreement with Ipsen to supply finished, labeled drug product to Ipsen for distribution in

the territories outside of the U.S. and Japan for the term of the collaboration agreement. The product will be supplied at our cost, as defined in the agreement, which excludes the 3% royalty we are required to pay GSK on Ipsen's net sales of any product incorporating cabozantinib.

Unless terminated earlier, the collaboration agreement has a term that continues, on a product-by-product and country-by-country basis, until the latter of (i) the expiration of patent claims related to cabozantinib, (ii) the expiration of regulatory exclusivity covering cabozantinib or (iii) ten years after the first commercial sale of cabozantinib, other than COMETRIQ. The supply agreement will continue in effect until expiration or termination of the collaboration agreement. The collaboration agreement may be terminated for cause by either party based on uncured material breach of either the collaboration agreement or the supply agreement by the other party, bankruptcy of the other party or for safety reasons. We may terminate the collaboration agreement if Ipsen challenges or opposes any patent covered by the collaboration agreement. Ipsen may terminate the collaboration agreement if the U.S. Food and Drug Administration ("FDA") or EMA orders or requires substantially all cabozantinib clinical trials to be terminated. Ipsen also has the right to terminate the collaboration agreement on a region-by-region basis after the first commercial sale of cabozantinib in advanced RCC in the given region. Upon termination by either party, all licenses granted by us to Ipsen will automatically terminate, and, except in the event of a termination by Ipsen for our material breach, the licenses granted by Ipsen to us shall survive such termination and shall automatically become worldwide, or, if Ipsen terminated only for a particular region, then for the terminated region. Following termination by us for Ipsen's material breach, or termination by Ipsen without cause or because we undergo a change of control by a party engaged in a competing program, Ipsen is prohibited from competing with us for a period of time.

We identified the following performance obligations under the collaboration agreement with Ipsen: (1) an exclusive license for the commercialization and further development of cabozantinib, as described above; and (2) research and development services which includes certain committed studies for the development of cabozantinib, pharmacovigilance services and participation on the joint steering and development committees (as defined in the collaboration agreement).

We evaluated the collaboration agreement with Ipsen under Topic 606 as of January 1, 2018. Based on the evaluation as of that date, the up-front, nonrefundable fees, the milestones earned and royalties earned as of December 31, 2017, the $10.0 million milestone we expected to earn in the first quarter of 2018 upon Ipsen's filing with the EMA for cabozantinib as a treatment for patients with previously treated advanced HCC, and the estimated reimbursements for our research and development services performance obligation constituted the amount of the consideration to be included in the transaction price. The transaction price was allocated to the performance obligations identified based on our best estimate of the relative standalone selling price. Other than the $10.0 million HCC filing milestone discussed above, variable consideration related to regulatory and development milestones not previously recognized was constrained due to the fact that it was not probable that a significant reversal of cumulative revenue would not occur, given the inherent uncertainty of success with these milestones. Any variable consideration related to sales based milestones, including royalties, will be recognized when the related sales occur as these amounts have been determined to relate predominantly to the license transferred to Ipsen and therefore is recognized at the later of when the performance obligation is satisfied or the related sales occur. We will re-evaluate the transaction price in each reporting period and as uncertain events are resolved or other changes in circumstances occur.

Revenues for our research and development services performance obligation are being recognized using the inputs method based on our internal development projected cost estimates through early 2030, which is the current estimated patent expiration of cabozantinib in the European Union. Revenues related to our license performance obligation are recorded immediately as our license represents functional intellectual property that was

transferred at a point in time, upon execution of the collaboration agreement. As of March 31, 2018, $54.0 million of the transaction price allocated to our research and development services performance obligation had not been satisfied.

As of March 31, 2018, we determined that we expect to earn a $50.0 million milestone in the second quarter of 2018 for the approval of cabozantinib for the first-line treatment of advanced RCC by the European Commission ("EC"). The determination was made following the Committee for Medicinal Products for Human Use's ("CHMP") positive opinion of cabozantinib for the first-line treatment of advanced RCC. The positive CHMP opinion is being reviewed by the EC as part of their approval process. Our determination that we expect to earn that $50.0 million milestone resulted in a change in the overall transaction price of the collaboration agreement, as it was probable that a significant reversal of cumulative revenue would not occur, triggering recognition of $45.8 million in additional collaboration revenues during the three months ended March 31, 2018 which was recorded as Unbilled collaboration revenue as of March 31, 2018. The remaining portion of the milestone will be recorded as we continue to satisfy our research and development services performance obligation and once we have an unconditional right to payment, upon approval of cabozantinib for the first-line treatment of advanced RCC by the EC.

As of March 31, 2018, the net contract asset for the collaboration agreement with Ipsen was $31.8 million, which was included in current Unbilled collaboration revenue on the accompanying Condensed Consolidated Balance Sheets.

Collaboration revenues under the collaboration agreement with Ipsen were as follows (in thousands):

	Three Months Ended March 31,	
	2018	2017
Ipsen collaboration revenues	$ 53,809	$ 4,530