Business Method Innovations and Firm Value: An Empirical Investigation

Tian Chan
Emory University's Goizueta Business School, tian.chan@emory.edu

Anandhi Bharadwaj
Emory University's Goizueta Business School, a.bharadwaj@emory.edu

Deepa Varadarajan
Georgia State University's J. Mack Robinson College of Business, d.varadarajan@gsu.edu

ABSTRACT

We examine business method innovations that received patent grants in the US manufacturing, trade and distribution sectors from 1999-2013. We find that business method patents, on average, generate roughly 11% more market value (as measured by the abnormal returns around the patenting time window) than other types of patents in these sectors. They also have more citations by subsequent patents, those subsequent patents come from a wider range of technological classes, and owners of business method patents are more likely to pay renewal fees to delay their expiration. We also show two characteristics of business method innovations that are associated with higher value. First, business method patents that are novel to the firm, although not necessarily novel to the world, have higher market value. Second, business method patents that involve more aspects of a business (i.e., greater scope) also have higher market value. Overall, in spite of legal uncertainties surrounding the patentability of business methods, we find robust indications of private value of business method innovations in these industries. Our work provides empirical support for the widely held assumption in strategy that business method innovations are key drivers of firm performance in the digital age.

Keywords: business methods, business model innovation, abnormal returns, patents, manufacturing, retail, trade and distribution

1 INTRODUCTION

Business models, or specifications of how a firm defines its value proposition, have received a lot of attention in the digital age. During the Internet boom, business models were used as a quick shorthand to describe how the firm intended to make money (Lewis, 2001). Today, business models are understood as detailed blueprints of how a firm creates and captures value (Teece, 2010), and innovations in business models have been touted as important sources of competitive advantage in the digital age as technological changes have enabled new configurations for organizing business methods and operations (Amit & Zott, 2001; Chesbrough, 2007; Netessine & Girotra, 2014).

While business model innovations can affect the whole enterprise (Amit & Zott, 2001), they can also be discretized as innovations in specific business operations or *methods for doing business* (Desyllas & Sako, 2013). These include, for example, new ways of customizing products and services based on consumer profiles, new approaches for pricing based on dynamic information and new methods for delivering products and services based on new technology-mediated interactions. As with product innovations, appropriating value from business method innovations is also subject to the same forces of competitive imitation (Casadesus-Masanell & Zhu, 2013). Businesses have therefore aggressively sought patents for a number of these business method innovations—evidenced by a near tenfold increase in annual business method patent grants over the last two decades (see Figure 1).

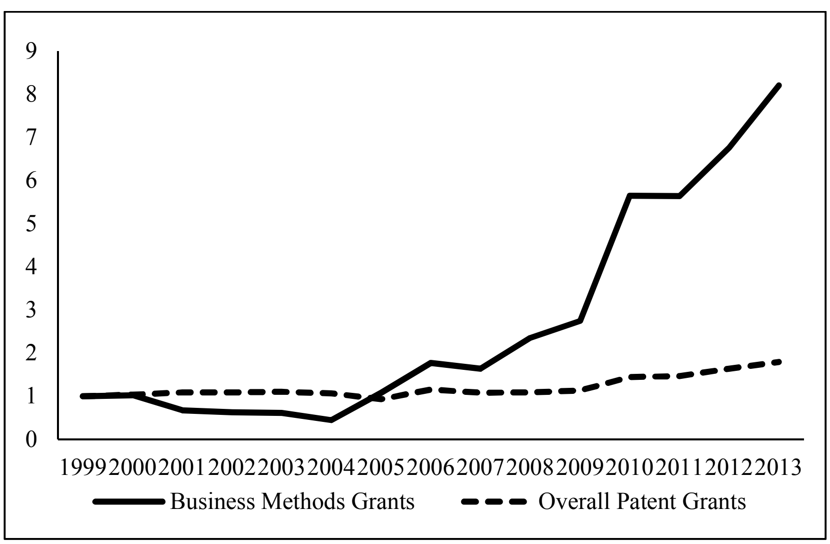

Figure 1: Prevalence of business method patents compared to all patents over time (base year 1999=1)

Despite the growing importance of business method innovation to firms and the significant increase in business method patenting over the past two decades, this category of patents has provoked significant debate and controversy. Ever since 1998, when the landmark *State Street Bank and Trust Co., Inc. v. Signature Financial Group, Inc.*, 149 F.3d 1368 (Fed. Cir. 1998) decision first recognized the patentability of business methods, critics have called into question the legitimacy of business method patents (Merges, 1999; Dreyfuss, 2000; Bagley, 2001; Burk & Lemley, 2003; Bessen & Meurer, 2008). Legal scholars have argued that business method innovations are too obvious or vaguely defined to meet the statutory requirements of patentability, and that the US Patent and Trademark Office (USPTO) has issued business method patents without sufficiently considering prior art (e.g., prior patents and printed publications describing a similar innovation). These critiques of business method patents tend to focus on anecdotal evidence from a few widely-publicized patents, such as Amazon's 'One-Click' technology for online ordering, rather than empirical evidence. Yet, perhaps in response to these vociferous critiques, judicial decisions and administrative changes following *State Street* have made it harder for firms to obtain business methods patents from the USPTO and to withstand legal challenges after such patents have been granted. Following the most recent of these legal changes, the Supreme Court's 2014 decision in *Alice Corp. v. CLS Bank International*, 134 S. Ct. 2347 (2014), the USPTO's grant rate for business method patents has sharply declined from 33% (in 2013) to 10% (in 2015) (USPTO, 2018).

In contrast to the legal skepticism towards business method patenting, the rapidly growing literature on business model innovation (BMI) is premised on the assumption that such innovations produce value for the firm. While many papers focus on the antecedents and mechanisms of BMI (see Massa and Tucci, 2013; Foss and Saebi, 2017 for reviews), the basic question justifying the existence of this body of research—that is, whether BMI actually produces value for the firm—has not been rigorously tested. Indeed, while Massa and Tucci (2013) have argued that the next wave of BMI research should focus on its consequences, research in this area remains sparse, possibly hampered by the "the sheer complexity of linking BMI and performance" (Foss & Saebi, 2017, p. 212).

Since business models have been described in terms of the underlying activities that characterize a firm's value creation and capture mechanisms, we can examine the performance implications of business model innovation through the lens of the discretized innovations in the underlying activity sets or *business methods*. Business method patents provide a measurable unit of business method innovation that can be linked to performance. In particular, we examine the economic significance of business method patents relative to other types of patented innovations. In doing so, we help illuminate two literatures—the strategy literature that has touted the importance of BMI for firm performance and the legal literature that doubts the validity of business method patents—that to date, seem to offer somewhat conflicting and empirically unsubstantiated accounts of the value of business method innovation. Using comprehensive patent data, we present new statistical evidence showing the economic significance of business method patents to publicly traded US firms in the manufacturing and allied sectors that received patent grants on business method innovations from 1999-2013. While patent data cannot account for all kinds of business method innovation (e.g., trade secrecy and internal processes), patents provide the advantage of being a visible and documented way to capture the degree of business method innovation in firms (Antonipillai & Lee, 2016).

We rely on financial market assessments as the basis of valuation for business method patents. Specifically, we measure the value of business method patents by examining the stock price movements of the innovating firms in the days following patent grants (Kogan et al., 2017). Because stock market valuations are forward looking, they provide an estimate of the market's assessment of the private value to the firm from the specific innovation. Unlike other approaches that rely, for example, primarily on citation data, our market valuation approach recognizes that the locus of value for business methods can reside in various strategic dimensions, including their use in negotiations and prevention of lawsuits (Cohen, Nelson & Walsh, 2000; Hall, 2003). Results from our analysis show that on average, business method patents generate roughly 11% more market value (as measured by the abnormal returns around the patenting time window) compared to other types of patents over the same time period in the manufacturing and distribution sectors.

We also find that business method patents exhibit other indications of value. A greater number of subsequent patents cite them (forward citations), and these subsequent patents belong to a greater number of technology classes (forward citation breadth). In addition, we find that the owners of business method patents exhibit a greater willingness to pay renewal fees, in order to delay expiration and extend the life of the patent. Taken together, these results present robust evidence that business method innovations produce superior value to the firm relative to other kinds of product and process innovations.

Our research offers two main contributions for understanding the role that business method innovations play in the economy. First, as one of the first empirical studies to focus on the market valuation of business method patents, our study reveals that relative to other types of innovations, business method innovations confer greater value to the investing firms. Our results thus provide empirical validation for the growing consensus in the strategy literature that business model innovations are crucial to firm performance (Zott & Amit, 2008). Given the growing legal uncertainty about the patentability of business method patents, our results also suggest that policy-makers should exercise caution when restricting or rejecting business method patents as an entire class of innovation.

Second, our study identifies important value drivers of business method innovations. We classify business method innovations along two dimensions: the *novelty* of an innovation (which we distinguish further as novelty *to the world* versus novelty *to the firm* that owns the patent), and the *scope* of the innovation (which we define as the number of aspects of a business that the invention affects). With respect to novelty, we find that business method innovations novel to the firm are predictive of greater value, but we do not find any economically or statistically sizable effects on value for business method patents that are novel to the world. Thus, our results show that an important source of the value of business method innovation lies in transforming a firm's *existing* ways of conducting business, even if it does not aim to disrupt or revolutionize the industry. With respect to scope, we find that business method innovations affecting more aspects of a business generate greater value. This finding suggests that unlocking the value of a business method innovation depends, in part, on locating complementarities across multiple dimensions of a business.

2 BUSINESS MODEL INNOVATION AND BUSINESS METHOD PATENTS

2.1 Defining and measuring business model innovation

A rapidly growing strain of strategy and management literature touts the importance of *business model innovation* (BMI) to firms. A key contribution of this literature has been conceptual: to recognize that novel changes to a firm's business model can lead to substantial value creation and competitive advantage for the firm. Business model innovation is generally viewed as a new source of innovation that "complements the traditional subjects of process, product, and organizational innovation" (Zott, Amit & Massa, 2011, p. 1032). Beyond that, however, there appears to be little definitional clarity on what constitutes business model innovation or how to measure it. In their comprehensive review of the BMI literature, Foss and Saebi observe that definitions of business model innovation "abound, differ markedly, and are often ambiguous" (Foss & Saebi, 2017, p. 207). By contrast, the definition of a business model has garnered more consensus: it is the design or architecture of the value creation, delivery, and capture mechanisms that a firm employs (Teece, 2010; Desyllas & Sako, 2013). While the BMI literature seems to build on this more accepted definition of a business model, scholarly definitions of BMI nonetheless differ with respect to the extent of novelty required—e.g., does the innovation have to be new to firm or new to industry to qualify as BMI—as well as its requisite scope—e.g., does the innovation have to be to the overall "architecture," affecting the whole enterprise, or just to one or more components of a business model in order to constitute BMI.

BMI is an emerging area of research, and thus far, the existing scholarship has largely focused on firm-specific case studies and anecdotal evidence to illustrate the benefits of this kind of innovation (see Girotra and Netessine, 2013; Massa and Tucci, 2013; Foss and Saebi, 2017 for reviews). Much of the BMI research is motivated by the presumed beneficial consequences of BMI for firms, despite a lack of empirical evidence supporting such a presumption. One of the reasons for a lack of studies that examine rigorously the performance consequences of BMI "may lie in the sheer complexity of linking BMI and performance" (Foss & Saebi, 2017: 212).

Business method patents offer a measurable unit of business model innovation that can be linked to firm performance. Strategy scholars have emphasized the links between business model and business method innovations. For example, David Teece, in assessing barriers to the imitation of business models, compares the patentability of business models and business methods: "[A] new business model, being more general than a business method, is very unlikely to qualify for a patent even if certain business methods underpinning it may be patentable." (Teece, 2010, p. 181). Similarly, Desyllas and Sako suggest that while a new business model is unlikely to qualify for patent protection, innovative business methods underlying a new business model (particularly those "reflecting novel applications of Information and Communication Technology") are patentable (Desyllas & Sako, 2013, p. 101). As an example, Desyllas and Sako highlight Progressive Insurance's various business method patents on "Pay-as-You-Drive" (PAYD) auto insurance—a novel method of calculating insurance premiums based on driving behavior.

Although these studies draw some definitional distinctions between business *model* innovation and business *method* innovation, the line between the two can be hard to discern in practice—especially given the definitional ambiguities surrounding the term "business model innovation." Particularly, if one adopts a definition of business model innovation that encompasses changes to individual *components* of a firm's business model, rather than one that focuses solely on changes to the overall *architecture* of a business model, then many business method patents are clearly examples of business model innovation. Consider, for example, Priceline's innovative reverse auction mechanism for purchasing airline tickets, which was granted a business method patent. Notably, Amit and Zott describe Priceline's reverse auction patent as an example of business model innovation (Amit & Zott, 2012). One could similarly characterize Progressive's first business method patent on PAYD insurance as reflecting an underlying business model innovation premised on calculating auto insurance premiums based on the driving habits of its customers.

Thus, while business model innovation is typically viewed as a distinct or more "general" category of innovation than business method innovation (Teece, 2010), the distinction is a blurry one. A number of business method patents disclose activities that could be characterized as business model innovation—or at the very least, underlying components of business model innovation. A clear overlap exists between many business method patents and business model innovation—even if the two are not always synonymous. Patent data is, however, under-inclusive, in that it does not account for all business model or business method innovations; innovative activities may be appropriated through other means, like trade secrecy. Yet patents are nonetheless a useful way of quantifying business model innovation, for they offer the advantage of being measured in a consistent way. By using business method patents as a unit of measurement for BMI, one can empirically test and quantify the effects of BMI on firm performance. To date, the BMI literature has presumed these kinds of innovations have a significant beneficial impact on firm performance, but it has not offered robust empirical evidence to support these assumptions.

To be sure, previous studies have measured the value implications of adopting *specific* business model innovations. Some examples include studies on the value of "Power by the Hour" maintenance contracting (Guajardo et al., 2012), combinatorial auctions as a way to provision and deliver school lunches (Olivares et al., 2012), and "Pay-As-You-Drive" auto-insurance scheme (Desyllas & Sako, 2013). While these largely firm-specific case studies offer useful insights as to the potential value of adopting a particular business model innovation, our goal is to abstract away from any one specific business model. Instead, we study whether engaging in business model innovation—viewed through the lens of business method patenting—creates value for firms across the manufacturing, trade and distribution sectors.

2.2 The economic significance of business method innovations to manufacturing firms

We focus on the manufacturing and allied sectors, for several reasons. First, manufacturing industries have experienced important shifts in their external environment. In particular, an increasing share of their revenue stream now comes from services (Karmarkar, 2004; Sawhney, Balasubramanian & Krishnan, 2004). The transition to services (or servitization) can trigger significant changes in the revenue model and internal operations of manufacturing firms (Oliva and Kallenberg, 2003; Visnjic Kastalli and Van Looy, 2013; Chan, de Véricourt and Besbes, 2018). In turn, servitization has increased interest in how manufacturers can engage in BMI to better deliver value to consumers and improve competitive outcomes for firms (Netessine & Girotra, 2014). Second, these sectors are by far the most patent intensive sector in the US economy. Large firms in manufacturing (which form our sample) are more likely than not to patent their innovations (Antonipillai & Lee, 2016). Thus, patents are a meaningful measure of innovation output for this industry, as reflected in a number of studies (see e.g., Cohen et al., 2000; Lanjouw & Schankerman, 2004; Arora, Branstetter & Drev, 2013; Arora, Cohen & Walsh, 2016). Indeed, business method patents in these sectors comprise a significant portion of all business method patents issued by the USPTO. In our study period, we find them contributing close to 30% of all business method patents issued to public firms. In sum, despite much anecdotal evidence on how BMI has played a crucial role in transforming the manufacturing industry, no prior study has empirically examined the value of such innovation in these sectors. By focusing on business method patents as a reflection of how manufacturing firms innovate and transform their business models, our work aims to address this gap.

BMI can create value for a firm through multiple pathways (Amit & Zott, 2001). First, BMI can help a firm create new markets or better identify customers. For example, consider the recent patent (US 8249946) granted to General Mills Inc. for a business method designed to deliver made-to-order cereals to a consumer's home. As background for this patent application, General Mills cited problems with the conventional mass marketing of food products and the need for more customized solutions, especially for health-conscious consumers. The patent application described a computer-based business method for selecting and ordering a customized food product. Second, business method innovations have helped firms design new ways of connecting with their suppliers and logistics partners. For example, consider the patent granted to Amazon (US 9984351) for its business method of dynamically determining how to handle items returned by customers while the items are in transit. The patent application claimed that various factors have to be considered in determining the appropriate handling of the returned item, including the selection of one of various potential return destinations and types of return routing. Third, BMI can help lock-in existing customers through creating complementarities. For example, business method innovations have allowed manufacturers to embed their core product or service offerings to create new solution bundles for customers through complementary business activities (Tuli, Kohli & Bharadwaj, 2007). Fourth, BMI has the potential to reduce cost of operations. Dell, for example, secured a business method patent (US 7756760) for a computer algorithm that helped determine inventory shortage costs resulting from a delay in component shipments.

Beyond crystallizing the pathways through which BMI generates value, some scholars have argued further (and perhaps, more provocatively) that BMI should generate greater returns to the firm relative to other kinds of innovations, despite being largely overlooked by firms in favor of product innovation. Girotra and Netessine (2014) observe that BMI tends to be rooted in principles of operations and customer management, and therefore are potentially applicable to a wider variety of business contexts than product innovations. Similarly, Amit and Zott (2012) emphasize how firms can create more sustainable competitive advantages through BMI than other kinds of innovation, because competitors have difficulty imitating an entire novel activity system. To illustrate this principle, they point to Apple's innovations in music distribution, which link music label owners and end customers through the co-development of iTunes with iPod hardware and software.

Despite its potential benefits, however, BMI is not costless. BMI can entail significant adjustment costs to the organization. For example, firms may have to break up work routines, reorganize activity networks, obtain new suppliers, train staff, adopt new systems, and restructure incentives in order to leverage these innovations (Oliva & Kallenberg, 2003; Amit & Zott, 2012; McElheran, 2015). Success is by no means clear, despite the multiple pathways through which business model innovation can generate value. And as we discuss next, another potential impediment to capturing value from BMI is the increasingly skeptical legal environment toward business method patenting. Over the past two decades, business method patents have seen subject to greater legal uncertainties than other kinds of patents, including increased scrutiny and higher risk of invalidation.

2.3 Legal developments, uncertainties, and critiques of business method patenting

To understand the economic value of business method patents and its variation over time, one must also understand the legal shifts surrounding these patents. Prior to the late twentieth century, business methods were not viewed as patentable subject matter. This changed in 1998, when the Court of Appeals for the

Federal Circuit (CAFC) issued a full court (en banc) decision in *State Street Bank & Trust Co. v. Signature Financial Group, Inc.* In upholding a business method patent for administering mutual funds, the CAFC held that methods of doing business were eligible for patent protection so long as they produced a "useful, concrete and tangible result." *State Street*'s permissive stance towards business method patenting led to a dramatic increase in business method patent applications (Meurer, 2002).

Not only did the *State Street* decision open the floodgates to business method patents, it also unleashed a flood of critical legal commentary. Business method patents are often criticized for being "poor quality" patents. While the concept of patent "quality" lacks clear definition, it is generally linked to the statutory requirements for obtaining patents (Allison & Tiller, 2003; Hall & MacGarvie, 2010). Critics argue that business method patents are often granted despite lacking the statutory requirements of novelty or non-obviousness, because USPTO examiners lack sufficient expertise in relatively "newer" categories of patentable subject matter (like software and business methods) and overlook relevant "unpublished" prior art in these areas (Burk & Lemley, 2003). Business method patents are also criticized for being ambiguous and vague, because they correspond to abstract rather than tangible inventions (Bessen & Meurer, 2008).

By and large, such critiques of business method patenting have not stemmed from empirical evidence. Instead, commentators tend to focus on limited anecdotal evidence—for example, the litigation surrounding highly-publicized business method patents like Amazon's "one-click" patent (Allison & Tiller, 2003). Yet in response to the numerous critiques of business method patents over the past few decades, the policy makers, and courts have increasingly singled them out for more scrutinizing treatment than other kinds of innovations.

For example, in 1999, Congress enacted the First Inventor Defense Act of 1999, which created a "prior user" defense specifically for business method patents. Alleged infringers were protected from liability as long as they commercially used and practiced the business method at least one year before the patent's filing date. Enacted just one year after the Federal Circuit's 1998 *State Street* decision, the statute was meant to ease concerns over an influx of business method patents and related litigation. At the administrative level, the USPTO has singled out business method patents for various quality control measures. In 2000, for example, the PTO introduced a procedure requiring two examiners for business method patent applications (i.e., "second pair of eyes" review). At the judicial level, recent court decisions have tightened the standard for patenting business methods. For example, in 2008, the CAFC revisited the issue of business method patenting in *In re Bilski*, 545 F.3d 943 (Fed. Cir. 2008). The CAFC held that Bilski's patent for a computer-implemented method for hedging risk in commodity transactions was an unpatentable abstract idea, and rejected the lenient "useful, concrete and tangible result" test that it had previously adopted in *State Street*. Later appeals at the Supreme Court level revisited the issue, but offered little guidance for distinguishing patentable business methods from unpatentable abstract ideas.

Most recently, in 2014, the Supreme Court toughened the standard for patenting business methods once again in *Alice Corp. v. CLS Bank International*. The rejected business method patent in this case concerned a computer-implemented escrow service for facilitating settlement of financial transactions by using a third-party intermediary. In *Alice*, the Supreme Court set forth a stricter test for assessing patentable subject matter, which asks whether a patented method reflects an "inventive concept" with elements "sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the abstract idea itself." The Supreme Court also explained that merely including generic computer elements in a patent claim would not provide the requisite "inventive concept." In the wake of *Alice*, firms seeking business method patents have higher hurdles to face in satisfying the patentable subject matter requirement. In fact, the grant rate for business method patents dropped from 33% (in 2013) to 10% (in 2015), after the *Alice* decision. Thus, over the past two decades, the shifting legal landscape reflects increasing doubts about the validity of business method patents, creating uncertainties with respect to the economic value of these innovations.

To summarize, we began Section 2 with a discussion of business model innovation, its growing importance to firms, the paucity of empirical data assessing the value of this category of innovation, and the use of business method patents as a relevant measure of BMI. Then we described why business method patenting in the manufacturing, trade and distribution sectors provides a strong testing ground for examining how BMI creates economic value for firms, and we also delineated specific ways that BMI can create value and impose adjustment costs for firms. Finally, we described the legal uncertainties and critiques that have cast doubt on the patentability and value of business method innovations. Despite the growing interest in business model innovation and the pervasive critiques of business method patenting, the economic significance of these patents has remained unexamined, even as these patents have increased in number over the last two decades. In the next section, we empirically examine the value of business method patents using a variety of short term and long-term valuation metrics.

3 DATA

The USPTO classifies business method innovations into a separate class of innovations (class 705), which houses a wide variety of innovations in business operations. Broadly, these innovations fall into two categories: those related to customer service (including and not limited to those in the area of incentive programs, coupons, electronic shopping, cost/price determination, and reservations) and those related to operations/administration (such as operations research, health care management, inventory management, accounting, and shipping) (USPTO, 2017). In defining class 705 patents as the set of business method innovations under consideration, we explicitly focus on the value implications of "pure" business method innovations (Hall, 2003, p. 4)—that is, inventions whose primary novel contribution is in creating or improving business operations.[1]

To capture stock-price reactions to patent grant and firm-level accounting measures, we combined patent data with firm-level stock-price and accounting data from the CRSP/Compustat database. We use the extensively curated patent-firm matching identifiers from the NBER Patent Data Project (Hall, Jaffe & Trajtenberg, 2005) that covers patents from 1976-2006 to merge the databases. For the 2007-2013 period, we rely on the name-matching algorithm by Bessen 2008 to match firms between databases. The process identified 8,837 business method patents (out of 865,686 patents) granted to firms publicly listed in the US from 1999-2013.

[1] While they include software patents, not all business method patents are software patents.

Finally, to focus on studying the impact of business method innovation to firms in manufacturing and allied sectors, we limited our data to patents granted to firms in the manufacturing sector (NAICS 31-33), wholesale and retail trade (41, 44, 45), and transportation and warehousing (48-49). We also exclude industries (at the 6-digit level) that have no business method patenting throughout the entire observation period. Our final sample consists 2,516 business-method patents over 587,517 patents granted to firms in these industries.

3.1 Measuring the value of a patent

The USPTO issues patents every Tuesday. On the same day, the USPTO publishes the *Official Gazette* - a publication listing the patents issued and their details. The stock market reaction in the days subsequent to patent grant thus provides a window into the value attached by the market on a patent granted to a company. We adopt the method employed by Kogan et al. (2017) to assess increased volality in stock prices for firms in the days following the receipt of a patent grant. By exploiting immediate stock market changes due to an information event (the grant of patents), Kogan et al. developed and validated an approach that uses the three-day cumulative abnormal returns (CAR) after a patent grant to derive a value for individual patents. This approach accounts for the firm's market capitalization and filters out the component of abnormal return arising due to noise. We follow their approach to assign values to patents (described in Appendix A), and call the patent value established thus *FilteredCAR*.

3.2 Independent variables

Business Method. Our main independent variable, *BizMethod*, indicates whether a patent is a business method patent (i.e., classified into class 705, *BizMethod* = 1) or otherwise (*BizMethod* = 0).

Novelty. The concept of novelty can be usefully distinguished in two ways—an innovation that is novel to the world versus an innovation that is novel to the firm that owns the patent but not necessarily to the world (Dahlin & Behrens, 2005; Zott & Amit, 2007; Foss & Saebi, 2017).

While all patents are by definition novel or different in some way from previous inventions, some innovations constitute radical or discontinuous change from previous inventions, whereas others are more incremental (Anderson & Tushman, 1990). Measuring patent novelty remains an evolving area of research. Enabled by advances in natural language processing, the state-of-the-art approach to measure novelty in patents is a lexical one, whereby the texts in the patents themselves are analyzed for indications of novelty (Kaplan & Vakili, 2015; Balsmeier et al., 2018). In particular, we rely on the works of Balsmeier et al. (2018), which identify novel patents based on whether they introduce novel word(s) relative to a past body of patents.[2] We hence create a binary measure *NewToWorld* that is one if the patent contains words that are not previously observed in the patent database, and zero otherwise.

In contrast to a textual analysis approach to identify "novel to the world" patents, the USPTO has a processing mechanism to identify patents that are "novel to the firm". Specifically, other than original patent applications, the USPTO also grants *continuation* patents, where an inventor files a patent application whose content follows closely from his/her existing patents. These continuation patents are by definition less novel than the original patents that they follow. Relative to a text analysis approach, identifying patents that are "novel to the firm" in this way allows us to capture novelty as it is interpreted through the eyes of inventors and patent examiners.[3]

In addition, the USPTO further categorizes continuation patents based on the extent of the changes they introduce. *Continuation-in-part* patents contain both new descriptions and new claims, as compared to the original patents on which they are based. *Continuation* patents contain new claims, but the description is same as the original patents on which they are based. Finally, *divisional* patents contain no major changes to either specifications or claims from the original patents. These four types of patents can thus be rank-ordered in decreasing novelty. We create indicator variables for these four types of patents: *NewToFirm* identifies original patents, whereas *Continuation-in-part, Continuation, and Divisional* capture the different types of continuation patents.

[2] The novelty dataset is available at https://console.cloud.google.com/marketplace/partners/patents-public-data
[3] We can alternatively use a novel word approach following Balsmeier et al. (2018) to identify novel-to-the-firm patents. While our results are robust to this alternative, we find the approach over-identifying many continuing patents as novel-to-the-firm.

Scope. Another fundamental dimension of a business method patent relates to its scope (Amit & Zott, 2012; Foss & Saebi, 2017). That is, does the innovation invoke changes to a single "component" of the business, or does it affect multiple components? The classical approach to measuring patent scope counts the number of claims in a patent, an approach that thinks of each claim as representing a single discrete "idea" of the invention (Lanjouw & Schankerman, 2004; Singh & Fleming, 2010). Such an approach, however, does not consider that multiple claims can be variants involving the *same* "component".

As an example, consider patent 8478605, a business method patent granted to Walgreens. The patent identifies an appropriate medication therapy regimen for customers, and we can summarize the invention as a "non-transitory computer-readable medium" (that is, a computer; claim 1) with a set of "instructions" (claim 2) targeting certain "chronic medical condition" (claim 8) with certain "medication" (claim 9). While the patent totals 16 claims, the other claims describe variations of these four components. Clearly, then, focusing solely on the number of claims can overstate scope in terms of the degree of hardware, software, process and/or target customer changes to implement the business idea.

To address this deficiency, we use a simple approach to count the number of components of a business impacted by a patent by leveraging on the rigidity of the language in the claim section of the patent document (Chan, Mihm & Sosa, 2018). Specifically, the claim section provides well-defined descriptions of an invention's novel aspects and defines the extent of the intellectual property. The claim section of a patent is highly structured in that each claim must be made in exactly one sentence, is uniquely numbered, and most importantly, must first clearly establish the subject matter that is to be protected (Fish, 2007). Our measure of the number of components of an invention hinges on the ability to identify clearly the core subject matter in each claim.

Specifically, we identify the subject matter of each claim by the first noun or noun phrase appearing in the claim (using the Stanford CoreNLP program by Manning et al. 2014 to tag words; see Appendix B for details). We then measure scope (variable *Scope*) by counting the number of distinct subject matter that appear in the claims. Consider patent 8315887, also issued to Walgreens, which identifies a system to separate and distribute pharmacy order processing and contains 22 claims. Using our approach, we identified 16 different components in this invention, including “specialty drug”, “insurance investigation”, “payment”, “pharmacy workflow system”, “pharmacy expertise level”, and “prescription order.” While both of these Walgreens’ patents have a similar number of claims, using our approach, we can discern the broader scope of this latter patent. By decomposing the patent in this way, we are able to avoid double-counting claims that are variants of the same subject matter and can better identify the different aspects of the business affected by the invention.

Patent Characteristics: We also introduce other invention-related variables available from the patent that could be potential indicators of value. We include the overall number of claims in the patent (*LogClaims*) as a measure of the legal scope (Singh & Fleming, 2010), the number of technology classes assigned to the patent (*LogClasses*) as a measure of the generalizability of the patent (Lerner, 1994), and the number of backward citations made by the patent to prior patents (*LogCites*) as a measure of the degree to which a patent recombines existing knowledge (Lanjouw & Schankerman, 2004).

Firm Characteristics: To improve further comparability at the firm level, we additionally control for firm characteristics in the regressions. To this end, we include the following firm characteristics as control: the amount of resources available to the firm via the amount of assets (*LogAssets*), the number of employees (*LogEmployees*), the annual R&D expenditure of the firm (*LogR&D*) and age of the firm in years (*FirmAge*). Finally, all our models include fixed effects at the finest industry level (6-digit NAICS) and grant-year of the patent. We report all standard errors clustered at the firm level.

4 ANALYSIS

Table 1 presents the summary statistics of the overall population of patents versus the business method patents. Throughout the entire period, the prevalence of business method innovation is small at 0.4%. However, we observe even from the raw data that business method innovations generate higher value per patent (mean for *LogFilteredCAR* at 1.31 vs. 1.19 for the average patent, or about 12% higher in value).

Table 1 and 3 present the raw correlations between the variables (on the overall and business method-only population of patents). The highest raw correlation figure is on measures of the firm (assets,

Table 2: Summary statistics of the variables

Variable	Description	Overall	Business Method
Dependent variable			
LogFilteredCAR	Log of the value of the patent inferred from 3-day cumulative abnormal returns (deflated to 1983 US dollars)	1.19 (1.31)	1.31 (1.47)
Patent level variables			
BizMethod	Indicator set to 1 only if the patent is in class 705	0.004 (0.065)	-
NewToWorld	Indicator set to 1 only if the patent introduced one or more novel words.	0.22 (0.41)	0.23 (0.42)
NewToFirm	Indicator set to 1 if the patent is original	0.75 (0.43)	0.75 (0.43)
Continuation-in-part	Indicator set to 1 if the patent is continuation-in-part of a past patent	0.05 (0.23)	0.06 (0.24)
Continuation	Indicator set to 1 if the patent is continuation of a past patent	0.13 (0.33)	0.15 (0.36)
Divisional	Indicator set to 1 if the patent is divisional of a past patent	0.09 (0.28)	0.06 (0.24)
LogScope	Log of the distinct number of subject matters appearing in the claim section of the patent.	2.00 (0.59)	2.06 (0.60)
LogClaims	Log of the number of claims	2.68 (0.73)	2.76 (0.74)
LogClasses	Log of the number of assigned patent classes	1.53 (0.51)	1.40 (0.54)
LogCites	Log of the number of backward patent citations	2.41 (0.99)	2.73 (0.96)
Firm level variables			
LogAssets	Log of the assets (in 1983 US dollars)	8.68 (1.71)	9.01 (1.55)
LogEmployees	Log of the number of employees	3.81 (1.50)	4.29 (1.32)
LogR&D	Log of the annual R&D expenditure (in 1983 US dollars)	5.81 (1.64)	5.39 (2.24)
FirmAge	Age of the firm in years	28.65 (14.02)	34.41 (13.85)
N	**Number of patent observations**	**587,517**	**2,516**

Note: Reported values are means, with standard deviations given in parentheses.

Table 1: Correlation matrix (*N* = 587,517)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.LogFilteredCAR	1.00													
2.BizMethod	0.01	1.00												
3.NewToWorld	0.10	0.00	1											
4.NewToFirm	0.01	0.00	0.08	1.00										
5.Continuation-in-part	0.03	0.00	0.02	-0.42	1.00									
6.Continuation	-0.02	0.00	-0.07	-0.67	0.11	1.00								
7.Divisional	-0.01	-0.01	-0.06	-0.54	0.02	-0.09	1.00							
8.LogScope	0.02	0.01	0.08	0.13	0.02	-0.05	-0.16	1.00						
9.LogClaims	0.03	0.01	0.09	0.10	0.04	-0.03	-0.15	0.82	1.00					
10.LogClasses	0.02	-0.02	0.06	-0.05	0.03	0.01	0.06	0.01	0.03	1.00				
11.LogCites	-0.01	0.02	-0.08	-0.20	0.14	0.17	0.06	0.14	0.17	0.02	1.00			
12.LogAssets	0.27	0.01	-0.01	0.13	-0.14	-0.08	-0.04	-0.11	-0.13	-0.01	-0.13	1.00		
13.LogEmployees	0.09	0.02	-0.03	0.14	-0.15	-0.10	-0.04	-0.13	-0.16	-0.02	-0.12	0.91	1.00	
14.LogR&D	0.19	-0.02	0.01	0.11	-0.14	-0.06	-0.03	-0.09	-0.10	0.00	-0.19	0.82	0.74	1.00
15.FirmAge	0.00	0.03	-0.02	0.08	-0.04	-0.08	-0.01	-0.06	-0.09	-0.04	0.02	0.51	0.55	0.37

Table 3: Correlation matrix for business method patent dataset (N = 2,516)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.LogFilteredCAR	1.00												
2.NewToWorld	0.02	1.00											
3.NewToFirm	-0.03	0.14	1.00										
4.Continuation-in-part	-0.01	-0.05	-0.43	1.00									
5.Continuation	0.09	-0.10	-0.72	0.01	1.00								
6.Divisional	-0.07	-0.07	-0.45	0.11	-0.10	1.00							
7.LogScope	0.15	0.09	0.09	0.05	-0.08	-0.09	1.00						
8.LogClaims	0.19	0.08	0.07	0.05	-0.06	-0.09	0.84	1.00					
9.LogClasses	-0.07	-0.02	-0.05	0.02	0.06	-0.01	-0.03	-0.04	1.00				
10.LogCites	0.11	-0.07	-0.18	0.10	0.16	0.04	0.07	0.09	0.02	1.00			
11.LogAssets	0.07	0.03	0.12	-0.17	-0.07	-0.02	-0.10	-0.11	0.07	-0.17	1.00		
12.LogEmployees	0.01	0.04	0.13	-0.16	-0.10	-0.01	-0.11	-0.15	0.04	-0.16	0.90	1.00	
13.LogR&D	-0.18	0.04	0.07	-0.10	-0.05	-0.01	-0.06	-0.08	0.12	-0.20	0.66	0.47	1.00
14.FirmAge	-0.37	-0.04	0.12	-0.02	-0.16	0.03	-0.09	-0.13	-0.02	-0.10	0.34	0.39	0.18

employees and R&D). We can de-correlate by introducing instead a normalized variable (e.g., log number of employee per dollar of asset, which reduces the raw correlation to -0.06), or drop one or all firm-level variables. All results remain robust.

4.1 Value of business method patents

We begin our analysis by testing whether, on average, business method patents elicit a more positive short-term market reaction based on *LogFilteredCAR* relative to other types of innovations. We present these results in Table 4.

Model 1 shows a regression controlling only for industry and year fixed effects. Here, we see a coefficient for *BizMethod* to be 0.18 ($p < 0.01$). Given the log scale of our dependent variable, we can interpret that business method patents elicit on average an 18% premium relative to other kinds of patents in the same industry over the studied period.

By interacting the variable *BizMethod* with grant-year dummies, we can further examine how the business method premium evolved over time in a similar setup as Model 1. We plot the resulting coefficients which represents the business method premium (or discount) for patents granted in year, compared against other patents granted in the same year to firms in the same industry in Figure 2. The graph shows a general upward trend, punctuated by shocks that roughly coincide with negative legal

Table 4: Market premium of business method innovations. GLS model predicting *LogFilteredCAR*. (N = 587,517)

	Model 1	**Model 2**	**Model 3**
BizMethod	0.18**	0.11*	0.11*
	(0.06)	(0.05)	(0.05)
LogScope			0.08*
			(0.04)
NewToWorld			0.02
			(0.01)
NewToFirm			0.09
			(0.09)
Continuation-in-part			0.13
			(0.09)
Continuation			-0.04
			(0.04)
Divisional			Baseline
LogClaims			-0.05
			(0.04)
LogClasses			-0.04*
			(0.02)
LogCites			0.01
			(0.03)
LogAssets		0.73***	0.73***
		(0.08)	(0.08)
LogEmployees		-0.38***	-0.38***
		(0.09)	(0.09)
LogR&D		-0.02	-0.02
		(0.07)	(0.06)
FirmAge		-0.00	-0.00
		(0.01)	(0.01)
Grant Year FE	Yes	Yes	Yes
6-digit NAICS FE	Yes	Yes	Yes
Within R^2	0.13	0.41	0.42
F	30.5	57.9	46.9

Notes: Standard errors (in parentheses) are clustered by lead inventor; FE = fixed effects
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

events. Such legal events include the USPTO's Second-Pair-of-Eyes Review that subjected business method patents to more rigorous examination procedures—by two examiners—beginning in 2000 and expanded in 2003, and *In re Bilski*, which was decided near the end of 2008 and resulted in additional restrictions on eligible subject matter relevant to business methods.[4] Overall, the chart suggests that the market internalizes how legal events can affect value, but even then, generally regards business method patents as valuable.

[4] We excluded year 2014 due to *Alice*, which reduced grant rates for business method sharply. If we included the sample, we also see that Alice has a negative effect on the value of business method patents.

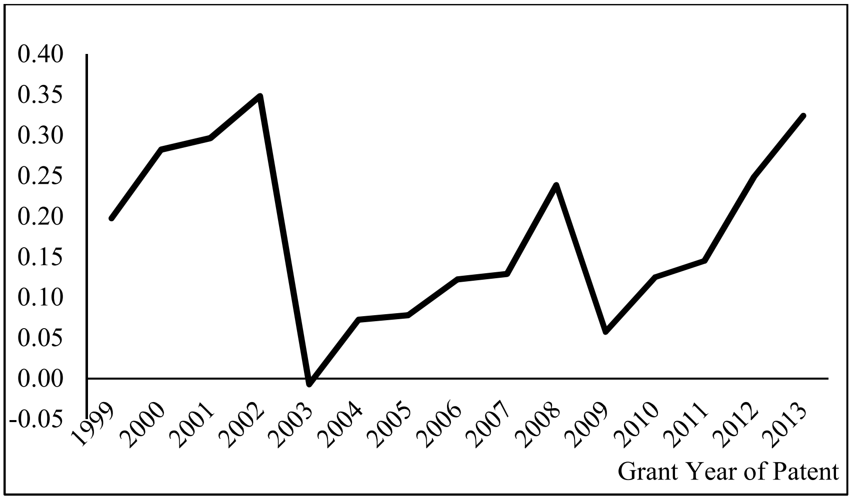

Figure 2: The premium of business method patent over other patents over time

In Models 2 and 3, we control for additional measures at the firm level (Model 2), and measures at both the firm and patent level (Model 3) to compare business method patents against other kinds of patents with similar firm and patent level characteristics. In both models, we continue to see a significant premium to business method innovation, at 0.11 ($p < 0.05$). The results show that the market perceives business method innovations as more valuable, and that the premium is not explained by observable heterogeneity as proxied by measurable firm and patent characteristics.

4.2 Alternative measures of value

Forward citations, patent renewals, and longer-term market-value measures are alternative indicators of value that have been examined in prior literature on patent valuation (Hall et al., 2005; Bessen & Meurer, 2008; Hall & MacGarvie, 2010). In this section, we demonstrate that business method innovations exhibit value across these additional measures. First, the number of forward citations for a patent captures its influence on future innovation. While not directly capturing the amount of private value received by the firm, forward citations have been used extensively within the patent literature as a proxy for private value (Hall et al., 2005). In Model 4 (Table 5), we test if business method patents receive more forward citations (using the log of count of the number of forward citations *LogForwCites* as dependent variable). We find that business method patents receive 19% ($p < 0.001$) more citations than other kinds of patents.

Table 5: Alternative ways of measuring value.

Dependent Variable	Model 4 *LogForwCites*	Model 5 *LogBreadth*	Model 6 *Renewed4thYr*	Model 7 *Renewed8thYr*	Model 8 *Renewed12thYr*
BizMethod	0.19***	0.14***	-0.01	0.00	0.08**
	(0.04)	(0.03)	(0.01)	(0.02)	(0.03)
NewToWorld	0.03*	0.02***	-0.01**	-0.01**	-0.01
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
NewToFirm	0.31***	0.19***	-0.01*	0.01	0.04*
	(0.03)	(0.02)	(0.00)	(0.01)	(0.02)
Continuation-in-part	0.40***	0.24***	0.00	0.01	-0.01
	(0.03)	(0.02)	(0.00)	(0.01)	(0.02)
Continuation	0.03	0.02	0.00	0.01	-0.03**
	(0.02)	(0.01)	(0.00)	(0.01)	(0.01)
Divisional			Baseline		
LogScope	0.09***	0.07***	-0.00	-0.00	0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
LogClaims	0.13***	0.08***	0.02***	0.02***	0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
LogClasses	0.10***	0.11***	-0.00	-0.01*	-0.00
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
LogCites	0.27***	0.15***	0.01***	0.01	0.01
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
LogAssets	0.00	-0.00	-0.00	0.01	-0.00
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
LogEmployees	-0.09**	-0.06***	0.01	-0.00	-0.01
	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)
LogR&D	0.04	0.03*	-0.01	-0.01	0.01
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
FirmAge	0.00	0.00*	0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Grant Year FE	Yes	Yes	Yes	Yes	Yes
6-digit NAICS FE	Yes	Yes	Yes	Yes	Yes
N	587,517	587,517	587,118	355,819	181,554
Within R^2	0.28	0.32	0.0097	0.0097	0.016
F	232.0	243.1	4.18	5.41	6.75

Notes: Standard errors (in parentheses) are clustered by lead inventor; FE = fixed effects; The number of observations for renewal data is smaller due to right censoring (we observe renewals up to end 2016) and early expiry (patents expired at the 4th year mark are not observed in the 8th and 12th year).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

An alternative to measuring impact is to consider how *widely* the patent influences future innovation. Hence, we also test in Model 5 whether business method patents receive more forward citations from diverse sources, by counting the number of distinct technology classes that a patent receives its citation from (*LogBreadth*) as a dependent variable. This measure would in turn capture the generalizability of the invention across different technology domains. We find that business method patents also tend to be cited from a more diverse set of domains (at 14% ($p < 0.001$)) than other kinds of patents in our dataset. The results from Model 4 and 5 thus suggest consistency on the value of business method innovations as measured by classical indicators of patent value.

Another possible indication of value comes from asking if inventors are willing to incur subsequent costs in renewing patents (Bessen, 2008). Patents have a validity of 20 years from the date the patent application is filed (or the longer of 20 years from filing date and 17 years from grant date if the patent is filed before June 8th 1995). They will expire earlier if inventors do not pay a cost (in the order of thousands of US dollars) to renew them at the fourth, eighth, and twelfth year mark. Renewals therefore indicate whether patent owners themselves perceive the patents as valuable enough to incur renewal costs.

We code binary variables *Renewed4thYr*, *Renewed8thYr*, and *Renewed12thYr* to (respectively) take the value one if a patent is renewed at the end of the fourth, eighth, and twelfth year mark, and zero otherwise. Models 6-8 report results with these three dependent variables using a linear probability model. Our results show that business method patents have similar renewal rates at the fourth and eighth year mark to other patents. However, business method patents are 8% ($p < 0.01$) more likely to be renewed at the twelfth year mark. The result indicates that patent owners themselves perceive business method patents as valuable (especially after a significant amount of time has passed and clearer indications of the patent's value have emerged).

Third, instead of measuring instantaneous market reactions at patent issuance, we can also measure the impact of business method innovation on a firm's longer term market value. We do this in two ways. Our first approach uses Tobin's q as an alternative measure of value. Tobin's q (or market to book value of assets ratio) is a standard metric in assessing the over- or under-valuation of a company that is frequently used in the management literature (see e.g., Bharadwaj, Bharadwaj & Konsynski, 1999; Hall & MacGarvie, 2010; Branstetter, Drev & Kwon, 2018). In contrast to 3-day abnormal returns (which allows us to attach a value to each individual patent), Tobin's q (an annualized accounting measure) allows us to examine variations in a firm's market value at any particular year as a function of the *history* of its business model innovation. Our analysis in this section consists of 22,013 firm-year observations in the same set of industries described in Section 1 (manufacturing, wholesale, retail, and transportation) over the same period (1999-2013).[5]

To perform this analysis, we also need to make assumptions about the *timing* of returns to those innovations (that is, a depreciation rate for existing innovation stock). Specifically, we follow the approach of Hall et al. 2005; Lanjouw & Schankerman 2004; Hall & MacGarvie 2010; and Branstetter et al. 2015 by assuming a 15% depreciation rate for past patents. We then sum up the history of R&D and patent amounts into a (properly depreciated) account of stock. We create two new variables: the stock of business method innovation (*LogBMPatStk*), and to control for the effect of overall patenting, the overall stock of patents (*LogPatentStk*).

Model 9 in Table 6 shows how having a stock of business method patents affect market value. Specifically, we see that the coefficient of *LogBMPatStk* is 0.048 ($p = 0.05$). This implies that a 1% increase in the stock of business method patents increases Tobin's q by 0.048%. Because our model accounts for the overall patent stock, we can interpret the effect as the marginal benefit of business method innovation that is not due to other kind of innovation activity within the firm's portfolio. Finally, we developed a one-year buy-and-hold-abnormal return (BHAR) analysis (Barber & Lyon, 1997). Specifically, we compare the one-year return (in percentage terms) of buying and holding a firm that has been granted a business method patent, against a matched benchmark firm that has not. We follow the approach of Hendricks and Singhal (2001) in creating a "match". Specifically, for each focal firm experiencing a business method patent grant event, we first locate a set of control firms within the same industry that is of a similar size—i.e., not more than 30% different in terms of its market value of equity to the focal firm, and yet did not have a history of business method patenting.[6] Within the set of

[5] Because the analysis is performed using the firm-year as the unit of analysis, we do not include patent level characteristics as control in the model.
[6] We follow Hendricks and Singhal (2001) to match first at the 6-digit level, and progressively coarsen the industry match (up to NAICS 3-digit level) if there are no companies in the set that is of a similar size.

control firms, we then select one that has the closest book-to-market ratio of equity to form a "matched" firm. Using this approach, we identified matches covering 1,302 patent grant events over 148 firms.[7]

Model 10 in Table 6 presents the estimate for BHAR, i.e., the paired difference in one-year buy-and-hold returns between a focal vs. control firm. The estimate shows BHAR = 7.8% ($p < 0.05$). Specifically, the number represents the difference of one-year returns in buying the stock of business method patenting firms at business method patent grant events (at 13.1%) versus those in the control set (at 5.3%).

Table 6: Evidence of long-term market value of business method patents.

Dependent Variable	**Model 9** **Log Tobin's *q***	**Model 10** **BHAR**
Constant (BHAR)		0.078* (0.036)
LogBMPatStk	0.048* (0.025)	
LogPatentStk	0.022** (0.008)	
LogAssets	-0.099*** (0.011)	
LogEmployees	-0.062*** (0.017)	
LogR&DStk	0.067*** (0.009)	
FirmAge	-0.005*** (0.001)	
Grant year FE	Yes	Matched
6-digit NAICS FE	Yes	Matched[1]
Within R^2	0.09	-
F	84.6	-
N	22,013	1,302

Notes: Standard errors (in parentheses) are clustered by firm.
$^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$
[1] Matching with at least the 3-digit NAICS level

Overall, the results in this section show a robust pattern of premium that is attached to business method innovation. In addition to value expectations captured in short-term stock-market shocks (our main approach), we also see the value of business method patents recognized by future inventors (forward citations), the owners to whom they are assigned (patent renewals), and also by the public in longer term stock-market returns (Tobin's *q* and BHAR).

[7] We acknowledge that the BHAR approach in our setting is imperfect—even at a coarse match we lose significant amount of data for identification. However, the results provides another layer of consistency and robustness.

4.3 Value heterogeneity within business method innovations

We explore possible drivers of the value heterogeneity of business method patents by focusing on the novelty and scope of business model innovations (Zott & Amit, 2007; Foss & Saebi, 2017). To exploit variation in value across different kinds of business method innovations, the analysis here leverages on the subsample containing only business method patents.

Models 11BM (in Table 7; models using only the business method patent subset have a "BM" postfix) presents our analysis by putting in all the controls in our main model into the subsample of business method patents. Focusing on the novelty aspect of the business method innovation, we find that *NewToWorld* is not statistically significant (this might be a function of the difficulty of recognizing the value of a new to the world invention). However, *NewToFirm* is statistically significant at 0.21 ($p < 0.01$), suggesting that business method patents that are novel to the firm command a significant premium of 21% (relative to divisional patents). Successively less novel patents to the firm in the form of continuation-in-part and continuation patents also exhibit a premium (but decreasingly so) relative to divisional patents. These results suggest that the market recognizes the value in innovation *within a company* to improve its way of doing business.

We also find a statistically significant effect on *LogScope* at 0.22 ($p < 0.001$). This provides evidence that innovations affecting multiple aspects of a business are recognized as more valuable. In finding this link, our results suggest that BMI has *high returns to scope*. In other words, the market recognizes that BMI affecting multiple aspects of the business has potential for greater complementarity—an important pathway through which BMI creates value.

Finally, in Model 12BM we consider if there might be further interactions between novelty and scope, by including in the regression additional variables *NewToWorld* × *LogScope* and *NewToFirm* × *LogScope* (note that we demean *LogScope*, that is, subtract *LogScope* by its mean value of 2.06 prior to inclusion in the regression, to help with interpretability). We do not find further statistically significant interactions. In other words, the combination of high novelty and high scope does not appear to generate supernormal or subnormal gains.

Table 7: Drivers of value of business method innovations. GLS model predicting *LogFilteredCAR* (*N* = 2,516).

	Model 11BM	Model 12BM
NewToWorld	-0.00	-0.00
	(0.03)	(0.03)
NewToFirm	0.21^{**}	0.21^{**}
	(0.07)	(0.07)
Continuation-in-part	0.18^{*}	0.19^{*}
	(0.08)	(0.08)
Continuation	0.13^{*}	0.13^{*}
	(0.07)	(0.07)
Divisional	Baseline	
LogScope(dm)	0.22^{***}	0.21^{***}
	(0.04)	(0.06)
LogClaims	-0.12^{**}	-0.12^{**}
	(0.04)	(0.04)
LogClasses	-0.05^{*}	-0.05^{*}
	(0.02)	(0.02)
LogCites	0.02	0.02
	(0.02)	(0.02)
LogAssets	0.77^{***}	0.77^{***}
	(0.14)	(0.14)
LogEmployees	-0.26	-0.26
	(0.20)	(0.20)
LogR&D	-0.15	-0.15
	(0.13)	(0.13)
FirmAge	0.00	0.00
	(0.01)	(0.01)
NewToWorld × LogScope(dm)		-0.01
		(0.05)
NewToFirm × LogScope(dm)		0.01
		(0.05)
Grant year FE	Yes	Yes
6-digit NAICS FE	Yes	Yes
Within R^2	0.36	0.36
F	35.2	34.5

Notes: Standard errors (in parentheses) are clustered by lead inventor;
FE = fixed effects, (dm) = demeaned
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5 ROBUSTNESS CHECKS

In this section, we present results using alternative measures and methods of estimation. In particular, we are concerned with potential confounding due to unmeasured heterogeneity at the firm and patent level. For unmeasured heterogeneity at the firm level, we leverage on a firm fixed models to capture unobserved but time-invariant differences across firms (that is, differences across firms in their capability to capture value from business method innovations). Model 13 in Table 8 presents results of our pooled dataset comparing the value of business method patents against other patents—we continue to find the coefficient

Table 8: Robustness against unmeasured firm / patent-level characteristics.

	Model 13	Model 14BM	Model 15	Model 16BM
BizMethod	0.04*		0.11*	
	(0.02)		(0.04)	
NewToIndustry	0.01	-0.01	0.02^{+}	-0.00
	(0.00)	(0.02)	(0.01)	(0.03)
NewToFirm	0.01	0.11*	0.08	0.21**
	(0.01)	(0.05)	(0.09)	(0.07)
Continuation-in-part	0.02	0.10	0.13	0.19*
	(0.01)	(0.06)	(0.08)	(0.08)
Continuation	0.01	0.15**	-0.04	0.13*
	(0.01)	(0.05)	(0.04)	(0.07)
LogScope	0.00	0.15***	0.08*	0.22***
	(0.01)	(0.04)	(0.04)	(0.05)
Software			0.07^{+}	-0.03
			(0.04)	(0.05)
ProcessRatio			-0.03	-0.00
			(0.04)	(0.06)
LogClaims	-0.02	-0.12***	-0.05	-0.12**
	(0.01)	(0.03)	(0.04)	(0.04)
LogClasses	-0.01	-0.00	-0.04*	-0.05*
	(0.01)	(0.02)	(0.02)	(0.02)
LogCites	0.01	-0.00	0.01	0.02
	(0.01)	(0.02)	(0.03)	(0.02)
LogAssets	0.48***	0.48^{+}	0.73***	0.77***
	(0.10)	(0.24)	(0.08)	(0.14)
LogEmployees	-0.17^{+}	-0.03	-0.37***	-0.26
	(0.10)	(0.27)	(0.09)	(0.20)
LogR&D	-0.03	0.02	-0.02	-0.15
	(0.07)	(0.25)	(0.06)	(0.13)
FirmAge	-0.04^{+}	-0.04***	-0.00	0.00
	(0.02)	(0.01)	(0.01)	(0.01)
Grant year FE	Yes	Yes	Yes	Yes
6-digit NAICS FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No
N	587,517	2,516	587,517	2,516
Within R^2	0.35	0.40	0.42	0.36
F	36.3	76.3	55.7	38.4

Notes: Standard errors (in parentheses) are clustered by lead inventor; FE = fixed effects
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

of *BizMethod* to be significantly positive at 0.04 (p <0.05). Because a firm fixed effect model exploits within-firm variations of patent value, we can interpret this coefficient as the premium of business method patents compared to other patents that are granted to the same firm.

We perform the same analysis on the subsample of business method patents in Model 14BM. Here again, we find the coefficients of *LogScope* and *NewToFirm* to be significantly positive—at 0.15 (p < 0.001) and 0.11 (p <0.05) respectively. Consistent with the main results, we do not find a statistical relationship between *NewToIndustry* and value. These results reinforce the idea that business method innovations with significant changes to multiple components, and those with changes that are new to the firm (but not necessarily disruptive to the industry) may be the predominant source of value among business method innovations.

With respect to unmeasured heterogeneity at the patent level, we construct two measures with which business method innovations are most likely to link. Particularly, we explore whether the premium for business method innovations that we observe is predominantly attributable to the *software* and *process* nature of business method patents.

Business method innovations, although recognized as distinct from software innovations, are sometimes discussed as a pair due to their prevalence in internet and finance-related businesses (Hall & MacGarvie, 2010). Thus, testing whether the software aspect of an innovation can explain the premium we observe in business method patents is particularly relevant because of the increasingly important role of software in manufacturing industries (Arora et al., 2013). To perform such an analysis, we require a measure of whether a patent is a software patent (or not). We follow the same approach as Arora, Branstetter & Drev (2013) and Branstetter, Drev & Kwon (2018) to identify software patents. Specifically, they identify software patents as the union of two sub-approaches established previously (1) a keyword approach (e.g., “computer program” or “software”) in the title and abstract of patents as developed by Bessen & Hunt (2007), and (2) software IPC categories as defined in Graham & Mowery (2003). We create an indicator variable *Software* that is one if a patent is a software patent and zero otherwise. The approach identifies 10% of the overall patent population as software. Amongst business method patents, we see a significantly higher 15% of patents tagged as software. Clearly, while software is more prevalent in business method patents, they are not always central to a business method innovation (at least not within the manufacturing and distribution sectors).

Another factor worth considering that potentially contributes to the value to business method innovation is that it is inherently process-oriented. Hence, we can also explore if business method innovation derives its value predominantly from being process-oriented. To do so, we create a measure based on the ratio of claims that are process claims. We identify process claims as those that contain either the word “method”, “process” or “step” in its subject matter (i.e., appearing as the first noun or noun-phrase in the claim). We then divide the number of process claims by the total number of claims in the patent to generate a measure *ProcessRatio*, which captures the degree to which a patent is process-based. The approach identifies an average patent in the overall population as having 36% process claims. By contrast, business method patents have on average 55% process claims.

Model 15 includes both *Software* and *ProcessRatio* as possible explanatory variables. Our results suggest that software patents might have a slightly higher value relative to other kinds of patents (0.07, $p < 0.10$), while the degree of process-based claims in the patent does not seem to significantly influence value. Critically, the coefficient of *BizMethod* is almost unmoved, and remains statistically significant at 0.11 ($p < 0.05$).

In Model 16BM, we include these two variables in the subsample of business method patents. In doing so, we are explicitly considering if business method patents that are also software or process-oriented may have higher / lower valuation. That does not seem to be case as both coefficients are not significant. Our insights that business method innovations that are (1) new to the firm, and (2) has larger scope, remain robust to this variation.

Finally, our main model relies on a market-adjusted approach to identify abnormal returns. Hence, we define abnormal returns as any excess returns over the value-weighted returns of the U.S. stock market. As an alternative, we modelled market returns using a Carhart four-factor model (Alan, Gao & Gaur, 2014; Xia, Singhal & Zhang, 2016). We also considered sensitivity of our model to the three-day window assumption by testing all our results using two or four-day windows. These (untabulated) results confirm our insights, and are available upon request.

6 DISCUSSION AND CONCLUSION

Despite significant interest in the phenomenon of business model innovation (BMI), much of the scholarly work in the area has focused on the antecedents of BMI. To the best of our knowledge, this is the first paper that provides detailed empirical evidence of the *consequences* of business model innovation, examined through the lens of business method patents. Our study thus provides important empirical validation to the anecdotal evidence that BMI are important drivers of firm value.

Our study shows that, relative to other types of product and process innovations, business method innovations are more valuable and generate higher returns to manufacturing firms, both in the short term (three-day CAR) as well as in the long term (BHAR, Tobin's *q*, and firm's willingness to pay for patent renewal). By using business method patents as the underlying unit of measurement of the larger phenomena of innovations in business methods and models, we are able to more precisely quantify the nature and magnitude of the private returns accruing to investing firms, and show how these valuations have sustained over the last two decades despite legal uncertainties surrounding the validity of business method patents.

Despite the rapid growth in business method patenting rates, business method innovations as a whole still compose less than one percent of the patent portfolio of public manufacturing firms. While scholars in the management community have offered conceptual arguments as to why firms should orient their innovation strategy towards business model and method innovation, our empirical work provides validation for these conceptual insights and impetus for firms to reorient their innovation strategy (Amit & Zott, 2001; Chesbrough, 2007; Netessine & Girotra, 2014). Indeed, firms that do not consider business method innovations may risk long-term economic consequences, as the gains due to such innovations may confer sustained competitive advantages to the investing manufacturers, as indicated by the long-term returns of business method patents.

Our research also carries important implications for policy makers. Although a full assessment of the legal and policy debate regarding the desirability of business method patenting is beyond the scope of this paper, our results call into question certain critiques of business method patenting. Legal and policy critiques have focused, by and large, on the allegedly poor quality of business method patents. Yet such critiques have been based on a limited set of examples that have dominated the business press, such as Amazon Inc.'s "One-click" and Priceline's "reverse auction" patents, rather than detailed empirical evidence. While patent quality is an elusive concept that is difficult to measure, the private value of a patent is often correlated with its quality (Allison & Tiller, 2003). More broadly, understanding the private value of patents can "inform patent policy so as to give greater emphasis to more important patents" (Allison et al., 2004, p. 448). The business method patents in our sample, taken as a whole, exhibit higher value compared to other kinds of patents and these valuations are robust to a variety of measures. Thus, our results suggest that policy-makers should exercise caution when restricting or narrowing the availability of patent protection for this broad category of innovation.

Our study shows that beyond the positive average returns to business method innovations, there is additional heterogeneity in the underlying returns that is discerned by examining the novelty and scope of the patents. The finding that patents that are novel to the firm generate additional value (when compared to patents that are totally novel to the world) has important implications for business leaders. Financial markets are known to be efficient processors of available information, and business methods that are new to the firm are important signals of innovations in firm level operations that can yield significant private gains to the firm. On the other hand, patents that are new to the world may require significant additional investments of time and effort before they bear fruit. The underlying value of patents that are new to the world may also be harder to discern by market analysts with limited information about the appropriability conditions for highly novel patents. To the extent that incumbent firms face difficult choices regarding innovation investment decisions, our study informs managers to be circumspect about the value implications of highly novel patents whose potential value may be difficult to discern.

Our finding that business method innovations with broader scope generate higher value highlights the importance of creating innovations that encompass multiple tasks or processes instead of narrowly focused innovations that address specific activities. Recall that our measure of scope focused on the number of distinct subject matters appearing in the patent claims. As such, broader patents are more likely to represent innovations at the level of the business model, rather than just one or more components of the business model. Therefore they represent more complex strategies that are likely to provide higher resistance to the forces of imitation.

Our research carries some limitations that need to be emphasized. Our interest in linking business method innovations to market value restricts our attention to patented innovations granted to public firms. We do not observe innovations protected by other means, for example, trade secrecy. Yet, compared to patent protection, trade secrecy is less desirable for protecting business method innovations because many business method innovations (such as Priceline Inc.'s reverse auction mechanism) are publicly observable and imitable. An additional limitation of our study is that we include only publicly traded firms in the manufacturing and allied sectors. Thus, further empirical study extending to other sectors of the economy and including private firms can help build generalizability to the findings reported here.

Despite the limitations of this work, as product markets become increasingly competitive and the scope of cost-reduction manufacturing process improvements exhausted, the role of BMI can become more central over time. We hope our work can serve as a guide to future scholars on the usefulness of business method patents as an empirical basis to study BMI.

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ONLINE SUPPLEMENT

APPENDIX A: VALUATION OF PATENTS

Here we describe the approach taken by Kogan et al. (2017) to derive patent-level estimates of economic value by exploiting the response of stock market returns to news about patent issuance events. We follow the same approach.

First, we decompose the idiosyncratic stock return R for a given firm (i.e., the stock return two days after a patent grant *minus* the return on the market portfolio) around the time of a patent issuance event into two parts: v (the return's component associated with the announcement) and an unrelated noise component ε:

$$R = v + \varepsilon.$$

To obtain $E[v|R]$, or the posterior expectation of the patent announcement component conditional on observing the stock return, we assume that $\varepsilon \sim N(0, \sigma_{\varepsilon ft}^2)$ and allow the noise term to vary across firm f and year t. Because a patent's value should be positive, we suppose that v follows a half-normal distribution and that its variance is a constant ratio of $\sigma_{\varepsilon ft}^2$; thus $v \sim N^+(0, \theta\sigma_{\varepsilon ft}^2)$. We then obtain the expression

$$E[v|R] = \delta R + \sqrt{\delta}\sigma_{\varepsilon ft}\frac{\phi\left(-\frac{\sqrt{\delta}R}{\sigma_{\varepsilon ft}}\right)}{1 - \Phi\left(-\frac{\sqrt{\delta}R}{\sigma_{\varepsilon ft}}\right)};$$

Here ϕ and Φ are the standard normal pdf and cdf, respectively, and $\delta = \theta/(1+\theta)$ is the fractional increase in stock price volatility three days after a patent grant. We can estimate δ by comparing how much volatility increases on patent grant days (versus other days). With δ, the overall volatility in stock price for firm f in year t, and the fraction of trading days that are patent grant days, we can then obtain $\sigma_{\varepsilon ft}^2$, the volatility in stock price on normal days (for details, see Kogan et al., 2017).

Finally, because the issuance event may involve *multiple* patents, we assign each patent a fraction $1/N$ of their total economic value. Let V denote the economic value of a single patent and let M represent the firm's market value; then

$$V = \frac{1}{N}E[v|R]M.$$

APPENDIX B: IDENTIFYING THE COMPONENTS OF A PATENT

What follows is pseudo-code for the algorithm used to identify the number of components in a patent. This algorithm uses Stanford CoreNLP (9 December 2015 version).

1. For each claim, identify whether it is independent or dependent by using a regular expression search for the term "claim #", where # signifies any number.
2. If the claim is independent:
   a. Break down the claim into individual words.
   b. Tag each word in the claim with its type: noun, adjective, verb, etc.
   c. Identify the root for each word (e.g., reduce the word "instructions" to "instruction").
   d. Identify the subject matter for the claim based on first occurring noun phrase with adjectives (e.g., "non-transitory computer-readable medium", "computer-executable instruction", or "medication").
3. If the claim is dependent:
   a. Take the sentence starting after "claim #"—for example, from the text "The non-transitory computer-readable medium having computer-executable instructions of claim 1, wherein the medication comprises…" use only "wherein the medication comprises…".
   b. Return to steps a.–d. of Step 2.
4. Count the number of distinct subject matter in the patent.