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Democratizing Business Software: Small Business Ecosystems for Open Source Applications

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Abstract:

Open source has democratized software innovation to an unprecedented degree, but doubts persist as to whether democratized innovation can extend to business applications, where individual developers are not the end users. We report on a new kind of ecosystem around extensions to open source business applications, and examine the types of contributors and contributions relative to previous open source research. Our results show a surprising presence of small businesses, particularly consultants and freelance developers. These smaller firms bridge an important gap between lead users and producers, contributing disproportionately to new back-end and integration features. This study shows how new networks of commercial and semi-commercial players, particularly small businesses, are combining their efforts to create viable business ecosystems around successful open source business applications.

Keywords: user innovation, open source, business applications, business ecosystems, WordPress, small business

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I. INTRODUCTION

When I say that innovation is being democratized, I mean that users of products and services—both firms and individual consumers—are increasingly able to innovate for themselves.

E. von Hippel, *Democratizing Innovation*

Open source software has democratized software innovation to an unprecedented degree, by allowing users to easily modify software and contribute those modifications back to the community. Successful open source projects such as Linux and Apache have inspired a broader interest in what is now called *open innovation* (e.g., Chesbrough, 2003, 2006). The open innovation movement encourages organizations to look beyond their own boundaries for new ideas, for new customers of internally-generated innovations, and for new partners to co-create with (e.g., Enkel, Gassmann, and Chesbrough, 2009). The open innovation movement has, in turn, inspired Information Systems (IS) researchers to investigate anew the co-creation of value across organizational boundaries (e.g., Dhar and Sundararajan, 2007; Kohli and Grover, 2008).

Within the open innovation movement, research on democratized innovation focuses on the user perspective—how many users innovate, what types of innovation they create, why they decide to innovate for themselves, and how and why users freely reveal their innovations to others (e.g., von Hippel, 2005; von Hippel and von Krogh, 2003). This research has found that surprisingly large numbers of users innovate for themselves and that user innovation is important for physical products such as medical equipment, chemicals, transportation, and sporting goods. But information-based products such as Linux, built by tens of thousands of volunteers around the world, remain some of most impressive examples of democratized innovation.

Despite the success and influence of certain open source projects, doubts persist as to whether democratized innovation can extend to all kinds of software applications. Early commentators on open source believed a key to its success was that developers were "'scratching their own itch"' [Raymond, 2001]. For infrastructural software such as operating systems and Web servers, developers are also the end users, giving contributors both a powerful incentive to innovate, and the knowledge of user requirements to do so. Because individual developers are not the primary end users of business applications, such as content management, customer relationship management, and enterprise resource planning, some have predicted that traditional open source developers would have neither have the incentive to do the "'tedious"' work of developing features end users would value, nor the right expertise in areas such as user interface design (e.g., Fitzgerald, 2006). As commercial firms have joined open source projects, new questions have been raised about whether volunteers and employees "'working for a paycheck"' can successfully collaborate (e.g., Wagstrom, Mockus, Herbsleb, and Kraut et al., 2010).

How can open source projects promote user innovation for business applications? In this research, we report on a new kind of ecosystem that has emerged around open source business applications. In these ecosystems, small businesses, quasi-businesses (individuals seeking donations or advertising revenue), and individual volunteers cooperate by contributing self-contained extensions to a platform. These extensions (also known as modules or plugins) are one way of taking advantage of the modular design of open source software (e.g., Langlois and Garzarelli, 2008; MacCormack, Rusnak, and Baldwin, 2006) to make user contributions more accessible than attempts to contribute directly to the code base.

Compared to previous research on open source software, our results show a surprising presence of small businesses, particularly consultants and freelance developers. These small firms bridge an important gap between lead users and producers, contributing disproportionately to new back-end and integration features. For the literature on co-creation of IT-based value, a network of open innovation with a significant small business presence is worth exploring in more detail. The examples of co-creation networks in the IS literature to date have focused on large corporations collaborating in supply chains, large corporations "crowdsourcing" to outsiders, and open source communities of individual volunteers (e.g., Kohli and Grover, 2008; Sharaf, Landgon, and Gosain, 2008). This study shows how new networks of commercial and quasi-commercial players, particularly small businesses, are combining their efforts to create and realize IT-based value.

II. RESEARCH QUESTIONS:DEMOCRATIZED INNOVATION AND BUSINESS ECOSYSTEMS

Why would it be difficult to use an open source approach for developing business software applications? We draw on two research traditions for understanding the challenges: the literature on democratized innovation, particularly open source development (e.g., von Hippel, 2005; von Hippel and von Krogh, 2003; Crowston, Wei, Howison, and Wiggins, 2012) and the literature on business ecosystems in IT industries (e.g., Basole, 2009; Iansiti and Levine, 2004). The democratized innovation literature focuses on the incentive and skill differences between commercial manufacturers and user volunteers, with a more recent emphasis on the challenges of combining both commercial and volunteer contributions in a single open source project. The business ecosystem literature focuses on the need for business applications to be supported by a healthy, diversified ecosystem of contributors, playing specialized roles in the software development and delivery process.

As privately-produced public goods (e.g., von Hippel and von Krogh, 2003), open source software projects have experienced the challenges of operating in both commercial and noncommercial worlds. Much of the early open source literature was dominated by questions of who would contribute to open source projects and why. This literature divides contributor motivations into three kinds: intrinsic (enjoyment, personal learning), extrinsic (reputation, career enhancement), and unique user needs [Crowston et al., 2012]. Business users tend to have different motivations, and different requirements, than individual volunteers have (e.g., Bonaccorsi and Rossi, 2004), making open source development potentially more difficult for business applications.

Research on democratized innovation provides a simple model of the differences between commercial producers and noncommercial users. Users are firms or individuals who benefit from the use of an innovation, while manufacturers obtain the benefits of an innovation by selling a product or service to others [von Hippel, 2007]. In this model, users choose to innovate for themselves, rather than rely on a manufactured product, because of two basic misalignments: misalignments of information and misalignments of incentive [von Hippel, 2005]. Information misalignments exist because information about user needs and potential solutions is “sticky,” or difficult to transfer to others [von Hippel, 1986]. Users have better information about user needs and problems, and this information is difficult to transfer to potential manufacturers. Incentive misalignments exist because users seek innovations that are an exact fit to their (possibly unique) requirements, regardless of which solution approach is used. Manufacturers seek to make products suitable for larger audiences by modifying already existing solutions whenever possible. Commercial producers and noncommercial users would create different types of innovation in this model: user innovations would focus on specialized new features and functionality that users have direct experience with, while manufacturer innovations would focus on “behind the scenes,” infrastructural-type solutions that make products attractive to a wider audience (e.g., von Hippel, 2005).

This model of democratized innovation predicts that users are more likely to innovate when they are on the cutting edge of an important market trend (i.e., have the most information about important new user needs) and will receive large usage benefits from innovating. This type of user-innovator is called a “lead user” (e.g., von Hippel, 1986; Schreier and Prügl, 2008). Open source business applications would be difficult to develop because traditional open source developers are not “lead users” of business software—they are not on the leading edge of important business application trends and are not as likely to receive high personal benefits from innovating.

Recent research in open source has focused on the process of developing open source software—how decisions are made and how joint work is coordinated (e.g., Crowston et al., 2012). As commercial businesses have become significant contributors to open source projects, a research stream has developed around questions of how commercial firms involve themselves in open source. Though “not many studies of the details of firm participation in projects” have yet been made [Crowston et al., 2012], early studies suggest there is a potential for clashes between volunteers and commercial contributors (e.g., Wagstrom et al., 2010). Specialized expertise in certain aspects of business applications, such as user interface design, can be difficult to integrate into the normal processes and community structures of open source (e.g., Bach and Carroll, 2010).

One possible mechanism for firm involvement in open source is for a relatively large and well-known commercial enterprise to “attach to or assume complementary rules” with a user-created product, once it has achieved sufficient maturity (e.g., von Hippel, 2007). Examples of this kind of large firm involvement are Red Hat, a commercial open source firm that creates, certifies, and maintains distributions of Linux, and IBM’s use of Linux and Apache with their commercial products and consulting. Another type of firm involvement, not yet prominent in the open source literature but discussed in open innovation research, is for an individual user to go into business him- or herself as a “user-manufacturer” (e.g., Baldwin, Hienerth, and von Hippel, 2006) or a “user-entrepreneur” (e.g. Shah and Tripsas, 2007). User-manufacturers have advantages that allow them to compete against established manufacturers, particularly when the capital costs of production are low [Baldwin et al., 2006]. In some industries, it has been argued, traditional manufacturers can be completed replaced by ‘horizontal innovation networks’ of users and user-manufacturers [von Hippel, 2007], as long as a fraction of the user community freely reveals their innovations. The

question would be whether these user-entrepreneurs, occupying a position somewhere between noncommercial users and existing commercial producers, could fill an important role in open source business applications.

Large open source business applications are also likely to be offered as platforms. Many open source applications take advantage of a modular architecture in order to better coordinate development between individual contributors (e.g., MacCormack et al., 2006). Modularity makes open source projects more tolerant of uncertainty and more welcoming to experiments, as the effects of changes can be limited to parts of the system (e.g., Baldwin and Clark, 2006). However, opening a modular platform to a wider audience introduces a new set of complexities and tradeoffs that can threaten open source business applications. The success of a business application platform depends on a tradeoff between encouraging widespread adoption through greater openness versus the ability of specific firms to appropriate and capture the value created (e.g., Boudreau, 2010). A greater diversity of contributions opens a business application to promising new directions, but the corresponding lack of control can make the overall platform less effective as a functioning application. The diversity and openness of platforms turns contributors into potential cooperators and competitors at the same time.

The literature on business ecosystems adds to this discussion of platform openness and firm competition by introducing the concept of variety. Variety is introduced by having different contributors take on specialized roles as a way of increasing the performance and amount of innovation for a software platform as a whole. Business ecosystems are "complex, networked systems in which a variety of firms coexist, and interdependent and symbiotic relationships are formed" [Basole, 2009]. Participants in a business ecosystem "are not all created equal and do not necessarily pursue the same strategies" [Iansiti and Levien, 2004]. Divisions of labor can develop and stabilize over time, but the ways in which roles are distributed among interacting firms are not determined by the technology itself—they can, and do, vary based on institutional, historical, and national differences (e.g., Tee and Gawer, 2009; Jacobides, Knudsen, and Augier, 2006). A key question, from the business ecosystems perspective, is to what extent different co-specialized roles emerge and how each role divides up the overall labor to be performed. A limitation of current business ecosystems research, however, is that specialized roles tend to be identified using post-hoc, casual observation, rather than through explicit dimensions along which ecosystem members vary, which would "provide a more systematic way to understand the structure and evolutions" of business ecosystems over time [Basole, 2009].

The two research questions in this study are a preliminary attempt to identify the roles emerging in business ecosystems for open source business applications, especially when those ecosystems mix contributions from commercial and noncommercial sources. Following from the unique challenges of creating open source business applications identified above, the first research question uses the concept of commercial orientation to explore how differentiated roles might be forming in these business ecosystems.

> RQ1. *What are the different types of contributors to open source business applications, with respect to their commercial orientation?*

The specialized division of labor that emerges, according to the business ecosystems literature, results not just in different types of contributors to the overall ecosystem, but in specialization of their work products. The simple model provided by the democratized innovation literature offers a prediction about how the division of labor for open source contributions might begin to form. Because of the information and incentive differences that exist between manufacturers and users, users are a more likely source of innovations that provide new functionality. Users tend to develop innovations that are "functionally novel" [von Hippel, 2005] because of their insights into new user needs, and the benefits they obtain from meeting their own unique requirements. Manufacturers emphasize innovations that "are improvements on well-known needs, and that require a rich understanding of solution information for their development" [von Hippel, 2005]. This prediction leads to our second research question:

> RQ2. *Do different types of contributors to open source business applications freely reveal different types of innovations?*

III. RESEARCH DESIGN

Case Selection

The most important case selection requirement was to find an open source business application that was an important type of business software, in widespread use, and perceived to be competitive with proprietary offerings. Content Management Systems (CMS) software in general, and WordPress in particular, was chosen for these reasons.

Content Management Systems are software applications "that allow the creation, collection, management, publication and modification of the content of web sites" [Vitari and Ravarini, 2009]. CMS software was explicitly

designed for use by business end-users, making Web management tasks accessible to nonprogrammers. With CMS, the "responsibility for content deployment partially or completely moved from the Webmaster and his/her team out to the actual authors within the business" [McKeever, 2003]. CMS is an important, fast-growing business application market (e.g., Vitari and Ravarini, 2009; McKeever, 2003) whose use has been tied to higher retail e-commerce sales (e.g., Ayanso, Lertwachara, and Thongpapanl, 2010) and improved financial results in small and medium sized businesses (e.g., Johnston, Wade, and McClean, 2007).

CMS in general, and open source CMS in particular, are in widespread use. According to w3tech.com [2011], 26 percent of all websites use CMS technology. Open source CMS accounts for the top three most used CMS software packages, six out of the top ten, and fourteen out of the top twenty-five, with over 80 percent of website domains using open source. Open source CMS began to appear in 2002; by 2007, open source CMS had evolved similar functionality to proprietary software packages costing, in some cases, hundreds of thousands of U.S. dollars [Vitari and Ravarini, 2009]. Vitari and Ravirini [2009] observed in their five-year study of CMS evolution that "the development of new functions by [open source] CMS developers appears faster than by packaged CMS developers."

One open source CMS project, WordPress, currently dominates the market with an over 50 percent share of all CMS-backed websites [w3tech.com, 2011]; the nearest competitor, the open source Joomla! project, is used in less than 11 percent of websites. WordPress also has the greatest number of community contributions, in the form of extensions [Allen, 2009]. Extensions (also known as modules, or plug-ins) are self-contained pieces of software code that interact with a software package through application programming interfaces (APIs). Extensions can be contributed and shared without modifying the code base of a software project, meaning that official approval for a contribution (in the form of a code commit) is typically not required. This research focused on extension contributions, rather than contributions to an open source code repository, because extension contributions can come from a wider variety of contributors, and because more information is usually available about the author of an extension, and its intended purpose, than for a contribution to an open source code repository.

WordPress is known for its origins as blogging software. The project started in 2003 as a fork of a previous open source project known as b2, or evolution. Today, WordPress is "the largest self-hosted blogging tool in the world" [wordpress.com, 2009]. Though it has its roots in blogging, WordPress has grown in functionality to the point where it is used as a Content Management System (CMS) to create more sophisticated and full-featured websites. WordPress is used by Fortune 500 firms that include Intel, GM, VW, BestBuy, Ford, Samsung, GE, American Express, Coca-Cola, Xerox, and CBS [wordpress.com, 2009]. WordPress won a Packt Open Source CMS Award in 2007 as the "Best Open Source Social Networking Content Management System" and was a finalist for the "Best Open Source CMS System" in 2009 [packtpub.com, 2009].

WordPress has attracted an impressive amount of interest from developers. The project had almost 12,000 distinct code commits at the time of the study, adding up to a total of over 100,000 lines of code. Even more impressive are the over 4,500 extensions (or plugins, to use WordPress terminology) that have been contributed by the wider community. Assuming that each extension contains at least twenty-five lines of code on average, the total amount of extension code is already larger than the software package itself. While extension code does not receive the same kind of scrutiny and testing from project administrators as code committed to the core, stand-alone extensions form an alternative, and perhaps more accessible, path to sharing innovations with the wider community.

WordPress extensions cover a wide range of features and functionality, from user interface changes, to security and administration, to integration with other software packages and services. The most popular WordPress plugin at the time of the study, the "All-In-One-SEO-Pack," was contributed by a small, four-person Web design and development company founded by combat veterans and located in North Carolina, U.S.

Data Collection

Data collection took place over a two-week period in September, 2009. We downloaded the name, description, tags, number of downloads, plugin homepage URL, and author homepage URL from the official extensions database at wordpress.org. Because the ratio of downloads to actual users can be high in open source projects [Crowston, Annabi, and Howison, 2003], we focused our efforts on the 567 plugins that had at least 10,000 downloads. This was to ensure that only community contributions used by others would be included.

All of the 567 author homepages and plugin homepages were downloaded. Each author homepage was visited manually at least twice during the two-week period. The entire history of code commits to WordPress was also downloaded from the project's official SVN repository during this same period.

Data Coding

Each WordPress plugin was categorized along two dimensions: by type of contributor, and by type of innovation. Data from the author homepage was used to determine the type of contributor. Data from the name, description, and tags was used for categorizing the type of innovation.

Coding of contributor type was based on the decision rules listed in Table 1. The decision rules were applied to the Web page identified in the official WordPress extensions repository as the Author Homepage URL. The five major types of contributors are listed in bold. The major groupings are classified by their commercial orientation relative to the contributed innovation.

Author URLs pointing to a page owned by an employee of Automattic, the for-profit company most closely associated with WordPress and whose employees are largely in control of contributions to the software core, were classified as WORDPRESS. URLs pointing to a commercial venture's page, including sites selling WordPress-related merchandise or services, were classified as COMMERCIAL. Of the remaining sites, URLs pointing to a page where an individual is asking for donations or contains potentially revenue-generating advertisements were classified as QUASI-COMMERCIAL, reflecting their position as user-entrepreneurs who might wish to develop their innovations more commercially, but are not yet fully in business for themselves. Any remaining available sites were classified as NONCOMMERCIAL. Classifications were made on 551 of the 567 plugins. Within the major categories, subcategories were identified to show the diversity of contributors to the WordPress extensions ecosystem.

Using Web pages as data raises similar concerns regarding the use of documents in social research [Flick, 2009]. As with documents, the researcher must be aware of the context and purpose for which these websites were created. For this research, the pages are submitted by the contributor of a plugin to a public database under the heading "Author Homepage URL." Websites, like documents, should be chosen for analysis that are authentic, credible, representative of the universe of documents of interest, and have a clear and unambiguous meaning [Scott, 1990].

As self-submitted URLs to a heavily used website subject to public scrutiny, we have little reason to doubt the authenticity and credibility of the author Web pages. We have captured the entire population of author pages. As for a clear and unambiguous meaning, our research seeks to classify these author pages through the simple lens of their commercial orientation. Do the pages belong to a commercial firm, or not? Do they offer a commercial solitication explicitly, ask for donations, or contain advertisements? As with all document analysis, having an unambiguous set of instructions for assigning data to categories is essential [Prior, 2003]. The decision rules enumerated in Table 1 were tested with two separate research assistants on subsets of the data, with only one disagreement about coding that required creating a new category and decision rule (the "Topic Site" subcategory).

Coding along a second dimension, by innovation type, operationalized the distinction made in the democratized innovation literature between functionally novel innovations and innovations that improve on existing functionality using an in-depth understanding of current solutions (e.g., von Hippel, 2005). We defined FRONT-END contributions as plugins whose primary purpose was to contribute new functionality accessible to the end user. BACK-END contributions were defined as plugins whose primary purpose was to improve the workings of the system without adding new user features.

We defined the list of FRONT-END contributions to WordPress as the following types of functionality: new ways to organize content for user access ("Content organization"), new user interface features ("User interface"), improved media display ("Media"), language translation ("Translation"), mobile access features ("Mobile"), e-commerce shopping carts and payment mechanisms ("E-commerce"), and any other new feature for WordPress sites that users could interact with directly ("User feature"). We defined the list of BACK-END contributions to include new administrator features ("Admin"), Web analytics and statistics ("Analytics"), performance enhancements ("Performance"), search engine optimization ("Search engine"), and security features ("Security"). The plugin name, description, and tags contained in the official WordPress extensions database were the data used for this classification. We defined INTEGRATION contributions as plugins whose primary purpose was to connect to outside services or other software packages. Despite the categorization information contained in the official WordPress extensions database, determining the primary purpose of plugins required the expert judgment of the researchers in a small number of cases (less than twenty), because some plugins serve multiple functions. We would suggest treating sub-categorizations within the FRONT-END category with particular caution, as illustrative of the kinds of diversity one can find in open source business application ecosystems rather than as definitive percentages of feature types.

Table 1: Types of Contributors		
Contributor Type	Decision Rule	Example
WORDPRESS	Page is owned by an employee of Automattic.	Integration with the Akismet spam protection service offered by Automattic
COMMERCIAL	Page offers commercial products or services.	
Small Developers	Page contains an offer for Web design or development services, including on an "About" or "Services" page one click away.	Four-person custom development company contributes a search engine optimization plugin.
Commercial—Related	Page owned by a company offering a commercial product or service related to plugin functionality	Company offering social bookmarking service makes their service available on a WordPress site through a plugin.
Commercial—Unrelated	Page owned by a company offering a commercial product or service unrelated to plugin functionality	Online bunk beds store offers a plugin for displaying a random page.
Merchandise	Page offers WordPress ebooks, plugins, or themes for sale.	Site selling WordPress themes offers a plugin for customizing pings (update notifications).
Freemium	Page offers a premium version of a plugin for sale.	Company shares free version of shopping cart plugin, offers "Pro" version with additional functionality.
QUASI-COMMERCIAL	Page not classified as WORDPRESS or COMMERCIAL that contains a request for donations, or advertisements	
Donations	Page contains a request for donations, including on a "Donate" page one click away.	Programmer creates a plugin for an improved contact form, and asks for donations via a PayPal button.
Advertisements	Page contains advertisements, but no request for donations.	Programmer creates plugins for improved administration, then advertises on their personal page.
NONCOMMERCIAL	All available pages not classified as WORDPRESS, COMMERCIAL, or QUASI-COMMERCIAL	
Personal	Page is a personal site with no commercial solicitations.	Improved text editor offered by programmer who wants to "try to give back"
Open Source Project	Page is a project page for an open source project.	An authentication plugin using existing technology from another open source software project.
Topic Site	Page is a noncommercial site dedicated to a specific topic, rather than focused on an individual contributor.	SMS plugin created by a site offering free resources and tips for churches.
University	Page owned by a university	UN University contributes a translation plugin.
NOT AVAILABLE	No author homepage listed, or page not available	Entry for text-to-speech plugin in WordPress repository contains no Author Homepage URL.

IV. DATA ANALYSIS

Who Contributes Extensions to Open Source Business Applications?

The number of plugins contributed to the WordPress extensions ecosystem, by type of contributor, is listed in Figure 1. The number of downloads (in thousands) is also listed for each contributor type, and their corresponding percentage of the approximately 38 million total plugin downloads.

The percentages of contributions show a ratio of roughly 2 to 1.5 to 1 between commercial, noncommercial, and quasi-commercial innovators. The official contributions from WordPress authors are less than 2 percent of the total plugins, but are over 8 percent of the downloads.

	Plugins #	%	Downloads # (thousands)	%
WORDPRESS	**10**	**1.8%**	**3218**	**8.5%**
COMMERCIAL	**237**	**41.8%**	**17057**	**44.9%**
Small Developers	171	30.2%	13199	34.8%
Commercial—Related	28	4.9%	1564	4.1%
Commercial—Unrelated	22	3.9%	1457	3.8%
Merchandise	11	1.9%	290	0.8%
Freemium	5	0.9%	547	1.4%
QUASI-COMMERCIAL	**114**	**20.1%**	**5588**	**14.7%**
Donations	62	10.9%	3618	9.5%
Advertisements	52	9.2%	1970	5.2%
NONCOMMERCIAL	**190**	**33.5%**	**11591**	**30.5%**
Personal	181	31.9%	11273	29.7%
Open Source Project	7	1.2%	295	0.8%
Topic Site	1	0.2%	11	0.1%
University	1	0.2%	12	0.1%
NOT AVAILABLE	**16**	**2.8%**	**515**	**1.4%**
TOTAL	***567***		***37969***	

Figure 1. Plugins Contributed to WordPress, by Type of Contributor

What Types of Innovations Are Contributed to Open Source Business Applications?

The number of plugins contributed to the WordPress extensions ecosystem, by type of innovation, is listed in Figure 2. The majority of plugins (56.1 percent) are primarily intended to offer new functionality that end users can access directly.

Relating Contributor Types to Innovation Types

A simple chi-squared test was used to test if the distribution of innovation types made by each type of contributor was substantially different from what would be expected, given their relative sizes. For the chi-squared test, the distribution was calculated with five types of contributors (WORDPRESS, COMMERCIAL, QUASI-COMMERCIAL, NONCOMMERCIAL, and NOT AVAILABLE) and three types of innovations (FRONT-END, BACK-END, and INTEGRATION). To ensure that no more than 20 percent of the table would have expected values less than 5 [Jupp, 2006], the two smallest categories of WORDPRESS and NOT AVAILABLE were combined into a single residual category of contributions outside of the normal WordPress ecosystem. Table 2 shows the final 4 × 3 distribution used for the analysis.

The significant result of the chi-squared test ($p = 0.0028$, $D = 19.977$, $df = 6$) supports the claim that different types of contributors offer different types of innovations to the community. New user features (FRONT-END) are more likely to come from noncommercial contributors, despite their lower number of contributions overall. For features that work behind the scenes (BACK-END), the reverse is true. 48.5 percent of all BACK-END plugins come from commercial contributors, versus only 24.6 percent from noncommercial contributors.

For both FRONT-END and BACK-END plugins, the quasi-commercial contributors are fixed firmly in the middle between commercial and noncommercial. Quasi-commercial contributors made 22.4 percent of all BACK-END contributions and 20.8 percent of all FRONT-END contributions, closely matching their proportion of 20.1 percent contributions in total.

	Number of Plugins	% of Plugins
FRONT-END	**318**	**56.1%**
Content organization	56	
E-commerce	2	
User interface	76	
Media	53	
Mobile	5	
Translation	7	
User feature	119	
BACK-END	**134**	**23.6%**
Admin	72	
Analytics	13	
Performance	6	
Search engine	18	
Security	25	
INTEGRATION	**115**	**20.3%**
TOTAL	***567***	

Figure 2. Plugins Contributed to WordPress, by Type of Innovation

Table 2: Distribution of WordPress Plugins by Contributor Type and Innovation Type

	Front-End	Back-End	Integration
COMMERCIAL	110	65	65
QUASI-COMMERCIAL	66	30	18
NONCOMMERCIAL	127	33	30
Residual (WORDRESS and NOT AVAILABLE)	15	6	5

INTEGRATION contributions are even more biased in favor of commercial contributors. 53.9 percent of all INTEGRATION plugins were contributed by commercial innovators, versus only 26.1 percent by noncommercial members of the ecosystem.

V. DISCUSSION

Who Contributes to Innovation? How Commercial Are They?

Our investigation of the WordPress extensions ecosystem reveals a diversity of contributors to one of the most successful examples of open source software for business applications. It highlights a number of emerging roles in an open source business ecosystem that are relatively unexplored in existing research on user innovation and open source, particularly with respect to the range of commercial, or partly commercial, orientations that can be held by different innovators.

Small businesses acting as designers, developers, and consultants make up a surprisingly large part of the ecosystem, considering their lack of mention in the open source and democratized innovation literature to date. These innovators form a link between users and the product (WordPress) that helps bridge the misalignments of information and incentive at the heart of democratized innovation theory [von Hippel, 2005]. As customizers for hire, they lack the classic manufacturer disincentive of having to create products suitable only for larger markets, yet benefit as users by creating standard building blocks that they can deploy in solutions for multiple clients. This is an important commercial orientation toward open source business applications that differs from the complementary roles provided by larger companies such as Red Hat and IBM [von Hippel, 2007]. Considering how widely used WordPress is in Fortune 500 firms, it is interesting to note that not a single contribution was identified as coming from a large company.

Another surprisingly large part of the business ecosystem was made up by what we defined as quasi-commercial contributors: individuals asking for donations, or seeking advertising revenue on their Web pages. This is an important category of user innovators that may reflect the emergence of user-entrepreneurs. These partial entrepreneurs have not been distinguished from other individual contributors in the literature, despite their somewhat unique contribution behavior. The ease with which individuals can ask for donations or earn advertising revenue on the Internet opens up new possibilities for commercializing user innovation without the substantial effort required to become a manufacturer or start a firm (e.g., Shah and Tripsas, 2007).

A particularly interesting, though still somewhat minor role at less than 4 percent of all contributions, is played by the commercial firms who contribute a plugin not related to their core business (the "Commercial—Unrelated" subcategory). The WordPress ecosystem has examples of a real estate company contributing a search engine plugin, an online motorcycle community contributing a pdf creator, and a bunk bed store contributing a random posts plugin. Open source business applications would truly become a "generative system" [Zittrain, 2008] with a much higher innovation rate, if the businesses using applications could easily combine their efforts and, in essence, become their own software providers. The relatively few unrelated businesses who do contribute user innovations might not be able to create sophisticated business applications on their own, but by adding their efforts to a rich ecosystem such as WordPress can help create viable open source business software.

What Types of Innovations Do Different Contributors Bring to the Ecosystem?

If different types of contributors bring different kinds of benefits, then an open source community begins to display the variety and complexity of a true business ecosystem, with different parties fulfilling different roles. Our finding is that commercial and noncommercial innovators play different roles, in a way that is consistent with the simple model presented in democratized innovation theory [von Hippel, 2005]. Noncommercial contributors, most closely matching the classic definition of user-innovator in the literature, tend to contribute new functionality for end users. Commercial contributors fill in the important role of contributing a disproportionate number of behind-the-scenes features such as administration, performance, and security. We extend this democratized innovation literature by identify a new type, quasi-commercial, that falls in between these two extremes.

Having commercial contributors as part of the business ecosystem is especially important for back-end plugins that end users tend to lack the information and incentive to create. In the WordPress extensions ecosystem, commercial players contributed four out of six "Performance" plugins, twelve out of eighteen "Search engine" plugins, and three out of four "Mobile" plugins. "Personal" innovators contributed fewer "Admin" plugins (19.4 percent) than expected, given their size of contributions.

The business ecosystem is strengthened and made more valuable for all, by harnessing the diverse incentives of different small businesses to contribute. For example, the "Small Developers" subcategory contributed nine out of eighteen (50 percent) "Search engine" plugins, perhaps reflecting the rise of small consulting firms dedicated to the currently hot topic of search engine optimization. In a highly competitive and time-sensitive market, the promotion benefits of freely revealing innovations could be much higher than in the normal "steady state" of open source developers building their reputation. In another example of diverse incentives, the "Commercial—Related" subcategory contributed a large number of INTEGRATION plugins (20 percent) relative to their size. Many of these companies are promoting an outside service and have a natural incentive to do the "dirty work" of integrating WordPress with their software.

Comparing Extensions with Contributions to the Core

Is there a greater diversity of user contributors to extensions, rather than to the core of WordPress software code? Answering this question in a rigorous way is difficult, because of the lack of author information for code contributions, but data from the WordPress code repository offers a suggestive comparison point.

The SVN repository log file contained 11,902 total code commits, made by nineteen developers. 8,410 of the code contributions, or 70.6 percent, were made by employees of Automattic, the for-profit company closely associated with WordPress. In open source projects, the person that has the authority to commit the code is not necessarily the author of the code (e.g., Crowston and Howison, 2005). The WordPress developer community does have a standard practice of thanking the author of the code in a comment line. 947 of the code commits made by Automattic employees had a "thanks" or "props" acknowledging the original author of the code, leaving 7,463, or 60.7 percent of code commits, as contributions by Automattic employees with no acknowledgement of outside authorship.

A New Kind of Business Ecosystem for Co-creating IT Value

The open innovation literature, both inside and outside of IS research, has demonstrated the significance and the effectiveness of user innovation communities. "Any scale of community is more efficient than design search by

innovators acting in isolation" [Baldwin et al, 2006]. The literature on democratized innovation has studied open source software extensively (e.g., von Hippel and von Krogh, 2003), but has focused on the classic examples of individual volunteer developers combining their efforts, with perhaps the involvement of a few complementary firms such as IBM. For business applications, where developers are no longer the "lead users," the theory is unclear as to how a user innovation community can operate successfully. More recent literature on firm involvement in open source still has many open questions about whether commercial and volunteer contributions could be successfully combined, especially when a business application is released as a platform.

The WordPress business ecosystem is important because it shows that vibrant ecosystems—a key prerequisite for business application success, according to the business ecosystem literature—can form around open source software mostly intended for nonprogrammer business users. The ecosystem for WordPress extensions highlights the important roles that small business and individuals taking on aspects of small businesses can play in creating IT value and IT innovation. The concept of business ecosystems has gained popularity in academic research (e.g., Basole, 2009; Moore, 2006, Iansiti and Levien, 2004), but to date has focused its attention on relationships between firms and on the emergence of large "hub" or "keystone" companies that come to dominate industries by making themselves the center of a thriving ecosystem. User innovation has been excluded from the discussions of business ecosystems to date. This study of business ecosystems for open source business applications highlights the essential roles of user-innovators, whether volunteer or quasi-commercial, and small businesses. This is a new and different kind of model for business ecosystems that deserves exploration.

VI. CONCLUSION

We argue that our main contribution to the open source literature and the literature on business ecosystems is demonstrating the diverse roles that small businesses and users can play in democratized business software innovation. In the ecosystem for WordPress extensions, we found a surprising presence of small businesses, particularly consulting and small Web development companies, contributing a disproportionate amount of plugins that improved existing functionality not directly touched by the end user. We discovered small businesses offering integration plugins to make their services work with WordPress, businesses in unrelated areas contributing plugins, and many individuals becoming "lightweight entrepreneurs" by asking for donations or seeking advertising revenue using low-cost online tools. Small businesses act as customizers, making the platform more valuable for all users. The WordPress extensions ecosystem demonstrates how small business can be at the heart of an IT-based open innovation network. While we identify new commercial and semi-commercial roles in these innovation networks, we add support to the existing theoretical insight that commercial and noncommercial actors tend to contribute different kinds of innovations.

Our other main contribution, we argue, is to show that open source projects can create viable communities for business applications [Fitzgerald, 2006]. The existing literature on democratized innovation would predict a significant lack of "lead users" for business applications among traditional open source developers, leading to a lack of user innovation. The WordPress community has been able to overcome these challenges by supporting the contribution of stand-alone extensions and by allowing a business ecosystem with specialized roles to form. The amount of extensions code is now arguably larger than WordPress itself and makes a significant contribution to the business value of WordPress for potential users. The case of the WordPress ecosystem can serve as a baseline and comparison point for the continuing study of open source business applications emerging in other domains, such as enterprise resource planning or customer relationship management, that may not have experienced the same level of acceptance as content management systems.

Some of the most important limitations of this work come from the focus on one innovation community that is both unique and rapidly changing. As a contribution to democratized innovation theory and as an existence proof of open source projects for business applications, our focus on a single case is appropriate. But any implied generalization of the specific empirical findings to other forms of user innovation can be seen only as suggestive and an invitation to future research. Few open source business applications have reached the point of having a substantial number of user-contributed extensions, so the structure of these business ecosystems is very much subject to change. The WordPress platform itself is constantly changing, and the reported results here are already out of date. Our data source, the official WordPress extensions website, may not contain all the extensions available and is filtered by the administrators of the site. This selection process could add a systematic bias to the results. The decision to focus on plugins with greater than 10,000 downloads was an arbitrary cut-off point to ensure that each included plugin had an actual user base. The majority of WordPress plugins fall under this cut-off and still remain unexplored. The decision rules for categorizing plugins can be criticized for not operationalizing the main theoretical distinctions from the literature (type of innovator and type of innovation) adequately. The conceptualizations used in the study might be oversimplified, given that research on commercial involvement in open source is still at an early stage (e.g., Crowston et al., 2012).

Co-creation between commercial producers and their customers is one of those rare topics that attracts both practical attention in industry (e.g., Tapscott and Williams, 2006) and research attention across business disciplines (e.g., Chesbrough, 2003; Gossmann, 2006; Enkel et al, 2009). Open source software was one of the original inspirations for this work. As open source takes on new forms, and becomes routine in organizations, we will find new varieties of open innovation that go well beyond the classic examples of open source software development. As IS researchers, we will have privileged access to the most complicated and important examples of co-creation across competing firms, government agencies, and volunteer communities. There is no major technology company now that does not have a complex, important relationship to open source and user innovation. We hope to have added a useful example of user innovation and co-creation to the discussion by illustrating the different varieties of commercial and noncommercial contributors that can find ways to work together, and the distinctive value creation that each party brings to their business ecosystem.

REFERENCES

Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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Allen, J.P. (2009) "Community Building for Open Source Business Applications: The Core–Extensions–Themes Pattern," *Proceedings of the First International Workshop on Building Sustainable Open Source Communities (OSCOMM 2009)*, http://tutopen.cs.tut.fi/oscomm09/papers/cr7.pdf (current Apr. 13, 2010).

Ayanso, A., K. Lertwachara, and N. Thongpapanl (2010) "Technology-Enabled Retail Services and Online Sales Performance," *Journal of Computer Information Systems*, Spring, pp. 102–111.

Bach, P.M., and J.M. Carroll (2010) "Characterizing the Dynamics of Open User Experience Design: The Cases of Firefox and OpenOffice.org," *Journal of the Association for Information Systems* (11)12, pp. 902–925.

Baldwin, C., C. Hienerth, and E. von Hippel (2006) "How User Innovations Become Commercial Products: A Theoretical Investigation and Case Study," *Research Policy* (35)9, pp. 1291–1313.

Baldwin, C.Y., and K.B. Clark (2006) "The Architecture of Participation: Does Code Architecture Mitigate Free Riding in the Open Source Development Model?" *Management Science* (52)7, pp. 1116–1127.

Basole, R.C. (2009) "Visualization of Interfirm Relations in a Converging Mobile Ecosystem," *Journal of Information Technology* (24)2, pp. 144–159.

Bonaccorsi, A., and C. Rossi (2004) "Altruistic Individuals, Selfish Firms? The Structure of Motivation in Open Source Software," *First Monday* (9)1.

Boudreau, K. (2010) "Open Platform Strategies and Innovation: Granting Access versus Devolving Control," *Management Science* (56)10, pp. 1849–1872.

Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Cambridge, MA: Harvard Business School Press.

Chesbrough, H. (2006) *Open Business Models: How to Thrive in the New Innovation Landscape*, Cambridge, MA: Harvard Business School Press.

Crowston, K., H. Annabi, and J. Howison (2003) "Defining Open Source Project Success," *Proceedings of the International Conference on Information Systems*, Seattle, WA, Dec. 14–17.

Crowston, K., and J. Howison (2005) "The Social Structure of Free and Open Source Software Development," *First Monday* (10)2, http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1207/1127 (current June 18, 2012)

Crowston, K., K. Wei, J. Howison, and A. Wiggins (2012) "Free/Libre Open Source Software Development: What We Know and What We Do Not Know," *ACM Computing Surveys* (44)2, pp. 1–35.

Dhar, V., and A. Sundararajan (2007) "Information Technologies in Business: A Blueprint for Education and Research," *Information Systems Research* (18)2, pp. 125–141.

Enkel, E., O. Gassmann and H. Chesbrough (2009) "Open R&D and Open Innovation: Exploring the Phenomenon," *R&D Management* (39)4, pp. 311–316.

Fitzgerald, B. (2006) "The Transformation of Open Source Software," *MIS Quarterly* (30)3, pp. 587–598.

Flick, U. (2009) *An Introduction to Qualitative Research*, Thousand Oaks, CA: Sage Publications.

Iansiti, M., and R. Levien (2004) "Strategy as Ecology," *Harvard Business Review* (82)3, pp. 68–78.

Jacobides, M., T. Knudsen, and M. Augier (2006) "Benefiting from Innovation: Value Creation, Value Appropriation and the Role of Industry Architectures," *Research Policy* (35)8, pp. 1200–1221.

Johnston, D., M. Wade, and R. McClean (2007) "Does e-Business Matter to SMEs? A Comparison of the Financial Impacts of Internet Business Solutions on European and North American SMEs," *Journal of Small Business Management* (45)3, pp. 354–361.

Jupp, V. (2006) *The Sage Dictionary of Social Science Research Methods*, Thousand Oaks, CA: Sage Publications.

Kohli, R., and V. Grover (2008) "Business Value of IT: An Essay on Expanding Research Directions to Keep Up with the Times," *Journal of the Association for Information Systems* (9)1, pp. 23–39.

Langlois, R.N., and G. Garzarelli (2008) "Of Hackers and Hairdressers: Modularity and the Organizational Economics of Open-Source Collaboration," *Industry & Innovation* (15)2, pp. 125–143.

MacCormack, A., J. Rusnak, and C.Y. Baldwin (2006) "Exploring the Structure of Complex Software Designs: An Empirical Study of Open Source and Proprietary Code," *Management Science* (52)7, pp. 1015–1030.

McKeever, S. (2003) "Understanding Web Content Management Systems: Evolution, Lifecycle and Market," *Industrial Management & Data Systems* (103)9, 686–692.

Moore, J.F. (2006) "Business Ecosystems and the View from the Firm," *Antitrust Bulletin* (51)1, pp. 1–58.

packtpub.com (2009) "Open Source CMS Award," http://www.packtpub.com/award (current Apr. 13, 2010).

Prior, L. (2003) *Using Documents in Social Research*, Thousand Oaks, CA: Sage Publications.

Raymond, E.S. (2001) *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*, Sebastopol, CA: O'Reilly.

Schreier, M., and R. Prügl (2008) "Extending Lead User Theory: Antecedents and Consequences of Consumers' Lead Userness," *Journal of Product Innovation Management* (25)4, pp. 331–346.

Scott, J. (1990) *A Matter of Record: Documentary Sources in Social Research*, Cambridge, UK: Polity Press.

Shah, S.K., and M. Tripsas (2007) "The Accidental Entrepreneur: The Emergent and Collective Process of User Entrepreneurship," *Strategic Entrepreneurship Journal* (1)1–2, pp. 123–140.

Sharaf, C., S. Landgon, and S. Gosain (2007) "IS Application Capabilities and Relational Value in Interfirm Partnerships," *Information Systems Research* (18)3, pp. 320–339.

Tapscott, D., and A. Williams (2006) *Wikinomics: How Mass Collaboration Changes Everything*, New York, NY: Portfolio.

Tee, R., and A. Gawer. (2009) "Industry Architecture as a Determinant of Successful Platform Strategies: A Case Study of the i-mode Mobile Internet Service," *European Management Review* (6)4, 217–232.

Vitari, C., and A. Ravarini (2009) "A Longitudinal Analysis of Trajectory Changes in the Software Industry: The Case of the Content Management Application Segment," *European Journal of Information Systems* (18)3, pp. 249–263.

von Hippel, E. (2007) "Horizontal Innovation Networks—By and for Users," *Industrial and Corporate Change* (16)2, pp. 293–315.

von Hippel, E. (1986) "Lead Users: A Source of Novel Product Concepts," *Management Science* (32)7, pp. 791–805.

von Hippel, E., and G. von Krogh (2003) "Open Source Software and the 'Private-Collective' Model: Issues for Organization Science," *Organization Science* (14)2, pp. 209–223.

von Hippel, E. (2005) *Democratizing Innovation*, Cambridge, MA: MIT Press.

Wagstrom, P., A. Mockus, J.D. Herbsleb, and R.E. Kraut (2010) "The Impact of Commercial Organizations on Volunteer Participation in an Online Community," *Proceedings of the 2010 Academy of Management Annual Meeting*, Montreal, Canada.

wordpress.com (2009) “About WordPress,” http://wordpress.org/about/ (current Oct. 2, 2009).

w3techs.com (2011) “Usage of Content Management Systems for Websites,” http://w3techs.com/technologies/overview/content_management/all (current June 1, 2011).

Zittrain, J. (2008) *The Future of the Internet–And How to Stop It*, New Haven, CT: Yale University Press.

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