

## OPEN INSTITUTIONAL STRUCTURE

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**ABSTRACT:** By examining several different types of open institutions including open source software, open science and open square, this paper presents a general analysis of open institutional structure that is complementary to traditional proprietary mode. We argue that open institutions are essentially about decentralized production of a collective good that relies on voluntary collaboration of highly variable human-related input that is difficult to identify *ex ante*. In addition to providing a general definition of open institutional structure, we submit that there are at least two necessary conditions. The first is the integration of consumers into production that provides various non-monetary incentives for the participants. The second condition is *ex post* voluntary participation that precludes the hold-up problem and transforms the transaction cost problem into a production model. In this sense, open institutions represent a positive approach towards externality and uncertainty.

**KEYWORDS:** open institutions, collective goods, open source software, open science, open square

**JEL CLASSIFICATION:** D23, H41, L31

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## INTRODUCTION

Today “open society,” “open access,” “open source software,” “open space,” and so on are all popular terms in our daily life and in academic writings. People are using these terms in a more or less positive sense. However, what does “open” exactly mean? Can we identify a common institutional structure across different open institutional forms?<sup>1</sup>

The conventional wisdom in property rights or even institutional theories is that when the costs of delineating or defining property rights are higher than the benefits, it is then beneficial to leave a good in the public domain or the “open” form of institutions. This could be called a “residual theory” for open institutions that simply equates “public” to “open.” In other words, only when a private property rights arrangement cannot solve the problem (through internalization of externalities, Coasian transactions, and so on) do we resort to open institutions. Contrarians naturally ask whether open institutions must be in the public domain.

A seemingly different view is held by many people who more or less regard open institutions as decentralized private ordering. This view is probably shared by many commentators on the IT industry, especially open source software. For example, Benkler studied the phenomenon of “commons-based peer production” that is characterized by “large-scale collaboration in many information production fields... in the digitally networked environment without reliance either on markets or managerial hierarchy” (Benkler, 2002, p. 374). His survey includes NASA Clickworkers, Google’s rating of web sites, Napster, and many others. No doubt these different forms of production in the IT industry represent different degrees of open institutions that have been emerging due to the development of information technology. A fundamental question is: are open institutions just decentralized private ordering? How can we reconcile this view with the “residual” theory of the public domain?

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<sup>1</sup> Following North, Wallis and Weingast (2006), I distinguish institutional structure from organizations. Institutional structure is what is common across many seemingly different organizations in a society. In this sense, institutional structure is more fundamental than the general term of institutions in defining the rule of games.

The view of decentralized private ordering also excludes most political institutions, even in a democratic country, from open institutions. There are obviously many challenges to this view. For example, in a recent paper by North, Wallis and Weingast (2006), “open” means unfettered competition in both economic and political arenas. By regarding open institutions as the fundamental structure for the latest stage of human society, their definition of open institutions not only includes democratic political institutions, but also suggests a positive view of open institutions that casts doubt on the traditional wisdom.

In the literature on urban property rights and institutions, one main type of institutional structure is the integration of property owners and collective goods providers in the form of political or economic organizations (Foldvary, 1994; Beito, Gordon and Tabarrok, 2002; Deng, 2003), such as homeowners associations, shopping malls (McCallum, 1970), and even suburban local governments (Fischel, 2001). On the other hand, diversity and externality’s positive role has been emphasized in the urban literature (Jacobs, 1961), albeit rather separately from most formal theories. One question arises: do open institutions represent another fundamental institutional structure in urban areas, or more generally, in our society?

In this paper, we explore the following research questions about open institutions. First, what characterizes the so-called open institutions? In other words, we want to identify an institutional structure that is common across the different forms of open institutions. Our goal is to explore a definition of open institutional structure that could be used to assess the openness of institutions. Second, what are the economic advantages of open institutions? The answer to this question can help us better understand where and when we need to have open institutions rather than traditional proprietary institutions. We focus on three different fields in order to draw some general conclusions about this fundamental institutional structure. Open source software (OSS) is the best known example of open institutional format in industrial production, especially in the IT industry. Open science is about creation and evaluation of more general human knowledge. Open squares present an example of the physical arrangement of social activities in a built-up environment. Despite the breadth of our coverage, this

paper does not attempt to be a comprehensive survey of the related fields in the literature. Instead, we are interested in exploring the common features of open institutions in different fields.

We first submit a general definition of open institutional structure. In contrast to conventional institutional and property rights theories that focus on transaction and contract, we argue that open institutional structure is really about production. In particular, we argue that what is produced by open institutions is a collective good, with no clear direction for the final product, and relying on highly variable human-related input that is difficult to identify *ex ante*. Integration of consumers into production is a necessary condition for motivating people to participate in the open production process. A defining feature of open institutions is *ex post* voluntary participation, which precludes the hold-up problem and effectively transforms the transaction cost problem into a production model.

The next section presents a brief review of the three different types of open institutions, namely, open source software, open science, and open squares. The third section explains why open institutions are really about production. Then, a common definition of open structure is summarized in the fourth section. The fifth section includes several theses we develop in order to understand the economic rationale for open institutions. The last section includes the conclusion and additional discussion.

## CASES OF OPEN INSTITUTIONS

In this section we briefly examine several major types of open institutions including open source software, open science, and open (urban) squares. Our focus is on the elements of their basic institutional structures that are common across these different fields.

### Open Source Software

Open source software (OSS) is one of the most important developments in industrial organization in recent decades and the most widely studied among our examples of open institutions. The most famous examples include the Apache web server and the Linux

operating system. The fundamental concept of OSS is that there should be unrestricted access to the source codes, so that anyone can modify the codes and circulate them without being restricted as in the traditional proprietary system.<sup>2</sup>

Although OSS has a long history, its first important milestone was the establishment of the Free Software Foundation by Richard Stallman in 1983. An important institutional innovation that was first introduced by the Free Software Foundation is a formal licensing procedure (General Public License, GPL). In 1995, Debian, an organization set up to disseminate Linux, developed the "Debian Social Contract" that evolved into what is now known as "Open Source Definition." This licensing arrangement allows greater flexibility, including the right to bundle open source software with proprietary code.

Lerner and Tirole (2000) suggest that many OSS phenomena can be explained by simple labor economics. In particular, they argue that OSS participants may be motivated by the following rewards: (1) fixing bugs or customizing programs for their own benefit; (2) lowering cost to programmers due to the "Alumni effect;" (3) career concern incentives; (4) ego gratification incentives. In general, the literature largely agree that in OSS performance measurement is better and easier and the performance is more informative of talent; OSS programmers take full responsibility while their performance within a firm depends on others; capital formed in OSS is also less firm-specific but rather more human-specific. The evidence for these arguments includes the importance of user benefits, accrediting programmers and reputation to developers in open source projects.<sup>3</sup>

Existing studies on OSS often focus on its different aspects. For example, Kuan (2001) is probably the first to formally model open-source software as a make-or-buy problem that results in the integration of consumers and producers. When users organize to

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<sup>2</sup> OSS is different from shareware or free software. Shareware is only freely available in the binary form and its underlying source code is not openly accessible. Freeware (or public-domain software) has no restrictions placed on subsequent users of the source code.

<sup>3</sup> For a recent review and a collection of studies on OSS, see von Krogh and von Hippel (2006).

produce a good for themselves, its quality will be higher than closed source software. Kuan's approach somehow simplifies the institutional structure of OSS by ignoring the facts that 1) the good is a collective good, and that 2) its production requires the collaboration of many people. In a different approach, Benkler (2002) emphasizes "commons-based peer production" in OSS, which is regarded as a distinct mode from market and the firm. In the same way as many other authors, Benkler's approach focuses on the information economy brought about by OSS. In spite of the well-known advantages of the Internet in information exchanges and flows, people can also communicate efficiently by talking to each other. That is one reason why workers and assets are often concentrated inside one physical building. Of course, there is no doubt that the Internet has some unmatched advantages in facilitating intra-production collaboration, but this factor is not fundamental to the structure of open institutions, especially in fields that do not produce information. In this sense, open institutional structure itself is not directly related to the recent development of information technology, which is obviously the most important factor to many studies on OSS.

Langlois and Garzarelli (2008) analyze the spontaneously coordinated mental division of labor within OSS. They argue that open source collaboration ultimately depends on the institutions of modularity. Division of labor by modules can lower the coordination cost. This perspective emphasizes the importance of some pre-existing structure of possible tasks from which the participants choose. In this sense, the unpredictability of final product in OSS is a matter of degrees.

## Open Science

Many researchers have noted the similarity between OSS and modern science, which is also called "open science," "public science," or even "the Republic of Science" (Polanyi, 1962) in contrast to the proprietary mode of developing knowledge (David, 1998). Much scientific research is now carried on by universities or public institutes and supported by state funding.<sup>4</sup> It is characterized by free

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<sup>4</sup> No doubt that scientists working in the private sector also contribute to the scientific enterprise. Given the purpose of this paper, we focus on those in the public sector rather than proprietary institutions.

and wide communication of research results, peer evaluation, and voluntary participation, in the sense that there is no constraint on the direction of research.<sup>5</sup> Research findings are protected by either copyright law or patent law.

Largely from the perspective of externality, Nelson (1959) explains why few private firms, except a few with large technological bases, would be expected to invest in basic scientific research. By examining the emergence of open science from an institutional and historical perspective, David (1998) argues that the informational problem faced by the patrons in a new age of science led to the modern institutional form of open science. In particular, he argues that scientific research was first made possible by the old system of aristocratic patronage. But later on, with the development of the new mathematical form of “mechanical philosophy,” evaluation of scientific products became difficult and various principal-agent problems ensued. The competition among noble patrons for prestigious clients gave rise to the institutional form of open science, which features the norms of cooperation and information disclosure within the community of scientists and their institutionalization through formal scientific organizations.<sup>6</sup> It is necessary to point out that peer evaluation was not only important to the patrons several hundred years ago but also is an important part of the “production” process of scientific knowledge. Scientists are both consumers and producers of research discoveries.

An interesting issue emerged in recent years after many governments encouraged universities to patent their discoveries, especially in the biomedical field. The privatization of research has certainly strengthened the incentives of scientists, but Heller & Eisenberg (1998) pointed out that privatizing “up-stream” research in the biomedical field may result in anti-commons problem that is socially inefficient. Again, we see the delicate balance between proprietary mode and the open structure in scientific research.

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<sup>5</sup> Again, as in OSS, academic research is partly shaped by earlier models and approaches. It is also influenced by politics inside the academic world. It is a matter of degrees how unpredictable the direction of research is.

<sup>6</sup> Given the importance of religion in European history, no doubt it also played an important role in the development of modern institutions of scientific research (Su 2000).

## Open Squares

Cities have many public squares, some of which are owned by local governments while others are built by private property owners. An intriguing question is why squares are open to the public. This seemingly inane question becomes important when we consider two cases. First, some private communities also have “private” squares in the sense that they are only accessible to residents within those communities. Second, some squares built by private parties are designed to be open to the public. One example is the SONY Square in Berlin.<sup>7</sup> It was built by a private company, but designed to be open to the public, and most visitors are people who visit a nearby movie museum instead of those who work in the surrounding office buildings owned by the company. A seemingly more reasonable approach is to have a private square that serves only people who work in the office buildings. From the perspective of property rights, it seems strange for a property owner to intentionally open up part of his property, giving everybody a right of “trespassing” on that property. Designers’ justifications usually include the fact that an open city square is livable and is, therefore, an amenity to office buildings. In other words, an open square in the case of SONY Square is more valuable to the whole project than a private square. For our purposes, what is more important is a theoretical understanding of the “livable” nature of public squares.

Interestingly, when Fennell discussed the tragedy of commons, she also used an example of people shopping in a downtown Main Street instead of cheaper suburban shopping centers (Fennell, 2004, p. 924). Obviously, the busy, warm and livable urban atmosphere in the Main Street, just as described in Jacobs (1961), provides consumers a sense of enjoyment that might be offset by the higher prices. In addition to shop owners and vendors, consumers are also an important part of the livable atmosphere of the Main Street. The same applies to public squares, where physical design is only part of the landscape. Visitors and vendors who come and go are always the living soul of a square. Of course, there is a degree of difference across different types of public squares. Visitors are less

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<sup>7</sup> I thank Tianxin Zhang for providing this example.

important (or even counter-productive) to some squares that focus more on a natural landscape, where it is less pleasant to enjoy the view with more visitors.

With the rapid development of shopping malls and shopping centers, many “private” squares inside these places also gradually become a gathering place for young people, perhaps not shoppers. Nevertheless, most visitors to these “private” squares are consumers who are shopping in the malls. This is very different from a real open square in the city, where visitors may go for many different purposes and where no restriction is imposed on their accessibility. Of course, nothing is black and white; many squares may not be fully open but with managed access by the public.

## **OPEN INSTITUTIONS ARE REALLY ABOUT PRODUCTION**

These three cases are representative of open institutions in industry, social institutions, and a built-up environment, respectively. They can give us some general understanding of open institutions that is applicable beyond their particular institutional forms. Our first argument is that open institutions are really about production rather than transactions.

Conventional theories of property rights are almost all about transactions. Although different property rights arrangements may have different implications for production, such as owner A being better at using the property than owner B, they do not directly determine or affect the mode of production. In contrast, open institutions are directly about production. For example, OSS is not about free access to the source code, which by itself is nothing different from free copying of compiled binary codes, the final format of commercial software products. The essence of OSS is how different people can fix, improve or build upon the source codes so that a big software “project” can be achieved in a voluntary, free access environment. Kogut and Metiu (2001) pointed out that an important dimension of OSS is a production model.<sup>8</sup> It can be characterized as decentralized decisionmaking

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<sup>8</sup> Another dimension that they refer to is public ownership of intellectual property.

(regarding who, how, and when to improve on the source codes), albeit under some voluntary governance structure, and decentralized collaboration and production. In contrast, a conventional production mode is characterized by centralized decisionmaking and centralized production (in terms of people, time and space).

Although the case of public squares is less obvious, its essence is still about production. What SONY wants in the design of the square is a social or “livable” square that includes not only the physical square but also different types of people and the random combinations of their activities in the square. In this sense, all people who visit the square also contribute to the production of this “livable” square. The product of this unintended collaboration of different people at different times is an ever-changing picture of the square.<sup>9</sup> In a word, the case of public squares tells us that the random nature or no clear direction of the final product is a core condition for open institutional arrangement. Otherwise, we could always arrange for some fixed patterns of squares in a more efficient way by private ownership and management.

In this sense, peer collaboration *per se* is not the distinctive feature of open institutions. For example, Microsoft employees collaborate both formally and informally (such as by talk and other social activities) in their work places. This collaboration is based on (labor) market transactions that rely on employment contracts. Outsourcing can also be a form of collaboration that depends on commercial contracts. In the case of Linux, on the contrary, people cooperate in production not because of any contract, but because of so-called “common interest” or “commons.” So, it is the voluntary and decentralized type of peer collaboration that distinguishes open institutions.

Open science is also about production. Although peer evaluation and open distribution of research findings follow individual research, the nature of scientific research dictates that they all be intermediary goods in the production process. They are the media

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<sup>9</sup> A plausible argument is that the square might be due to consumption or preference externality, in which one person’s ability to have his own preferences satisfied depends on the number of other people in the same area who share the same preference. However, the problem with this approach is that it is too rigid to explain a livable square that keeps changing. People may simply like to consume a changing picture of the square instead of some fixed number of people present.

for collaboration of “anonymous” scientists all over the world. Even if a patron-client relationship might be important in the emergence of modern science (David 1998), it was just part of the old incentive mechanism for scientists. The real effect of open science vis-à-vis the patron-client model is the change of collaboration from in-house production under one noble patron to decentralized production by numerous “anonymous” scientists. The advantages of decentralized research are well known; central planning can never guarantee a groundbreaking discovery in science and technology. As an example of social institutions, open science is still about production.

## THE OPEN STRUCTURE

Conventional wisdom often equates open institutions with open access. This may be misleading if it is only understood to be free access to a resource. For example, “open space” is a planning concept that emphasizes access to a wide area of farmland or forest for its scenic view or for wildlife preservation. It is based on the physical attributes of land use instead of a particular institutional arrangement. Open space can be in the form of private property rights (McLeod, Woirhaye et al., 1998), public ownership, or a mixture of the two. In this sense, it is a planning objective rather than an institutional arrangement. Therefore, we do not regard “open space” as a type of open institution. This example also tells us that two major dimensions are necessary to describe open institutions: first, what to access; second, how to access.

Open institutions are about production of a collective good.<sup>10</sup> What is open is access to the production process. In spite of some arguments for the importance of production (see, for example, Langlois and Foss, 1997), most existing studies on organizations and institutions focus on transactions. The typical approach is transaction cost minimization, as studied by Coase (1991), Williamson (1985), Hart (1995) and many others. The recent growth of OSS certainly points to the importance of production in understanding open institutions. Many researchers have noted that OSS is a

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<sup>10</sup> A private good such as software can become a collective good once its content can be freely copied. In that case, the content is the collective good while the media where the content is stored remains a private good.

production model that exploits the distributed human capital and relies on their collaboration (Kogut and Metiu, 2001; Benkler, 2002). Although our understanding of market, hierarchy, and the firm can be synthesized in a transaction cost framework in the vein of Coase (1991), open institutions clearly develop along a completely different dimension. They are contrary to transactions.<sup>11</sup>

In open institutions, access should be open and free. Therefore, they are contrary to property rights in the sense that they are not directly dependent on any proprietary mode of production or transaction. "Open-source development exists because, once property rights are removed from consideration, in-house production is often revealed as less efficient" (Kogut and Metiu, 2001, p. 249). The removal of property rights as a mechanism for the coordination of many people in the production process does not necessarily imply that property rights should be absent from all aspects of open institutions. For example, some form of property rights may be needed to protect the continuous existence of open institutions itself. Many OSS projects survive from individual's privatization of the source code by copy-righting all of its code and then licensing it on the condition that all improvements and adaptations of the code be openly distributed. Even open squares need to require that no visitor is allowed to occupy its space for a long time. Squatters could effectively change the open square into *de facto* private property.

One issue merits clarification. Open institutions do not necessarily imply fragmentation of property because there are no property rights at all.<sup>12</sup> Hence, many traditional discussions on externality, which arise due to fragmented property rights and could potentially be mitigated by various property rights arrangements (Coase,

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<sup>11</sup> The distinction between production and transaction may not be as clear as it sounds. For example, collaboration in the production process could also be analyzed as transaction (Alchian and Demsetz 1972). We treat collaboration as part of the production process. Obviously there is an overlapping area between the two concepts.

<sup>12</sup> Fennell (2004) has a good discussion of the reasons and consequences of property fragmentation. She identified some positive reasons for fragmentation: (1) fragmentation may be important for people to relinquish power over the resource without actually transferring the power or property; (2) it might be a way to temporarily force the negotiation to spread over people or generations, during which more information can be collected and information asymmetry could be avoided.

1960)), are not very helpful here because externality is not regarded as a problem but rather an important source of productivity in the open structure.

No doubt property rights are the main source of motivation for people to participate in transaction and production in a proprietary world. Open institutions not only change people's incentive structure, but also depend on people's non-monetary motivation for its continuous production. If property interest is still people's main source of motivation, all efficiency features of open institutions collapse.

However, open institutions' need for protection from individual privatization (or occupation) suggests one way we can reconcile the two seemingly different views, namely, the "residual" theory in the public domain, and the one that regards open institutions as only a form of decentralized private ordering. Continuous development of decentralized private ordering needs the legal protection of public domain in order to push back any individual's privatization effort, which may reduce decentralized private ordering to individual private property. And *vice versa*, whenever a proprietary mode of production becomes infeasible or inefficient, an open structure becomes the alternative "residual" mode that has to be protected by public ownership.

Open institutions are also contrary to contract, which is used to facilitate transactions in a world of property rights. There is no doubt of the importance of contract in modern market economy. The research question is of course why and when we need an institutional arrangement that does not rely on contract.

Many have noted that a key feature of open institutions is voluntary participation. However, it seems difficult to apply this point to political institutions. In the sense of North, Wallis and Weingast (2006), open institutional structure should be applicable to both economic and political institutions. No doubt there are parallel aspects between an open structure and the proprietary mode. For example, many researchers have noticed the similarity between corporate voting and political voting in a democratic society (see, for example, Fischel, 2001; Dunlavy, 2006). But, as many point out (such as Rodrigues, 2006), there are fundamental differences between participation in a corporation and participation in a nation.

It remains an important question what is the similarity between economic and political institutions with regard to open structure.

The following is a categorization of institutions along the two dimensions of open versus non-open and economic versus political institutions.

	Economic	Political
Open Structure	OSS, etc. ( <i>ex ante</i> and <i>ex post</i> voluntary participation)	Political institutions in democracy ( <i>ex post</i> voluntary participation)
Non-Open Forms	Corporate voting ( <i>ex ante</i> voluntary participation)	Non-democratic process (no or limited participation)

It is easy to see that the main similarity between open economic institutions and open political institutions is *ex post* voluntary participation. Open political institutions, given their pre-defined spatial or social boundaries, often only allow *ex post* voluntary participation, while both *ex ante* and *ex post* voluntary participation are possible for open economic institutions (except in slavery or other forms of forced labor).<sup>13</sup> From this perspective, one defining property of open structure across both economic and political institutions is *ex post* voluntary participation.<sup>14</sup>

The Definition of Open Structure

In light of the above discussion, an open institutional structure should include the following elements:

- 1. Open access to the production process of a collective good.

<sup>13</sup> If given Tieboutian mobility, *ex ante* voluntary choice is possible for local political institutions. But in reality it is often difficult to achieve mobility purely for the purpose of political participation. People move for many other reasons.

<sup>14</sup> Of course, there are also other fundamental differences between economic institutions and political institutions. For example, Rodrigues (2008) notes that in the corporate world investors are not looking for democratic experience, value choices, or membership in a collective commitment; instead, they are looking for profit and monetary value.

2. No property rights and contract are involved in peer collaboration.
3. *Ex post* voluntary participation.
4. Consumers are also producers, i.e., the integration of consumer and producer.

Among the properties of open institutional structure listed above, the first one is the foundation of open institutions. The second one is a necessary condition that effectively excludes proprietary structure. Once property rights and contract are involved in the production process, individual's "privatization" effort will inevitably lead to the proprietary mode of in-house production and the open structure will collapse. The third property defines the nature of open access that is applicable to both economic and political institutions. The fourth property provides the incentives for people to participate in the open production.

According to this definition, can "freeware" be regarded as a type of open institutional arrangement? Can the so-called "flexible production" be counted as an open institution? The answers to these two questions are probably both negative. Freeware is only open in the transaction process because users can only download the binary codes and cannot get involved in its production. Although flexible production allows submission of customized orders, it is also only open in the transaction process and directly relies on contract and property rights.

## WHY "OPEN"?

Understanding why open institutions exist is equivalent to understanding under what conditions they are more efficient than the proprietary mode of production. We focus on three basic aspects of open institutions: (1) what is produced? (2) Why are people motivated to participate in the open institutions? (3) How do people deal with the hold-up problem?

## Collective Goods

It is almost common sense that open institutions are related to collective goods as the term "commons" is often used in

related research.<sup>15</sup> Given the wide variety of institutional forms in providing collective goods, especially the private provision of collective goods, a natural question is what type of collective good should be provided by open institutions.

**Thesis 1:** *The product of open institutions must be a collective good, which a) has no clear direction ex ante, b) has decentralized production relying on highly variable human-related input that requires high motivation from at least some individuals, who are difficult to identify ex ante, and c) does not rely on large investment of physical capital.*

The best example to illustrate the central role of collective good for open institutions is GPL, the formal licensing procedure which requires that all subsequent modifications and development of open source software must also remain open. Information products are special because they are bundles of private goods and collective goods. In the case of software, the private good is the medium such as the CD or hard disk; the collective good is the content such as the source code or binary code. Since the source code can be easily modified or improved, GPL effectively prevents the software program from becoming a private good, which could be used by its owner for private benefits. In other words, when the product is a private good, the incentive structure for open institutions collapses. This also shows an important reason why the production process of open institutions cannot be based on property rights.

It might be argued that since GPL itself is based on property rights, OSS cannot be said to be without property rights. However, we need to distinguish between the production process and boundary protection. GPL is basically the legal tool in a proprietary world that is borrowed by OSS to protect its non-property-rights regime from becoming prey to possible invaders who are motivated by a property interest. Its production process is not based on GPL. In the face of private predation, GPL defines the boundary of OSS by defending its public status in a proprietary world.

The final product of open institutions should have no clear *ex ante* direction, roadmap or design. There are several possible

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<sup>15</sup> In this paper we use the term “collective good” instead of “public good” because the latter has a narrower definition (non-excludability and non-rivalry in consumption) and is often associated with public institutions.

reasons for this. First, the nature of some products may directly depend on the randomness or variability of its final format. Open squares are a case in point. What we desire is a livable square that changes every minute and cannot be accurately predicted (in terms of people and activities inside it). If we know in advance whom we are going to meet and what we are going to see in a square, that is an uninteresting place without any attraction. Second, and more importantly, what open institutions reap from their open structure are the productive or positive effects of externality. Clear direction for the final product precludes the necessity of utilizing externality. Third, the final form of the collective good, if it exists at all, may simply be unpredictable given the limit of human knowledge. This point is most obvious in the case of open science. Fourth, if the final product has clear direction then it will be easier and probably more efficient to organize the production through contract and traditional governance structure in a proprietary world.

Of course, it is in a matter of degrees that the final product of open institutions has no clear direction *ex ante*. As Langlois and Garzarelli (2008) argue, open source collaboration may need to rely on institutions of modularity, which in turn requires some pre-existing structure. Those pre-existing structures can provide some direction for the final product, but many details remain to be determined. Here there appears to be a tradeoff between the need for no clear direction for the final product and the need for modularity.

The unpredictability or variability of the final product implies that production in open institutions must be highly human specific and decentralized. The causal link also goes in the other direction. For information products and especially their variability (which is the primary source of efficiency gains for OSS), many researchers have noted the central role of human capital in its production (Benkler, 2002). The highly variable nature of human capital is the source of innovation and creativity. Whenever the variation of human-related input to the production is not high, the proprietary mode may become more efficient.

If large investment of physical capital is needed and if human input is relatively standard in the form of large-scale teamwork, then the proprietary mode may be more efficient than open institutions. Open squares require little physical capital other than the presence of human beings. The same is true for the software

industry. “[I]n many industries, the development of individual components requires large-scale teamwork and substantial capital costs, as opposed to (for some software programs) individual contributions and no capital investment (besides the computer the programmer already has)” (Lerner and Tirole, 2005, p. 115). In other words, a large physical capital investment makes it economical to concentrate workers together and standardize their inputs.

Given its nature of open access and voluntary participation, the success of open institutions depends crucially on the high motivation of at least some of the members. These core members cannot be identified *ex ante* because, otherwise, a firm can be set up to recruit only those high-powered people. Besides, *ex ante* identification of most active members runs against the core efficiency source of open structure: the productive power of uncertainty and externality. Members’ motivation is also where open institutional structure connects to theories on collective good and organization. For example, given the almost unlimited size of open institutions, Olson’s (1965) argument implies that, on the one hand, direct material incentives from the collective good must be trivial, though on the other hand, there must be significant private benefits to some core members who are highly motivated. The latter condition is necessary because conveying significant benefits to all members in an open institution is certainly impossible and the high mobility rate also makes it infeasible. Then, the question becomes: in what format do these private benefits appear within an open structure?

## Consumers and Production

Many researchers have observed that most participants in OSS are also its users. In open science, consumers of scientific discoveries are also researchers who share their findings through peer review and open publications. In the case of open urban squares, the presence of visitors directly contributes to the creation of a livable square. Then, why do open institutions feature the integration of consumer into production?

**Thesis 2:** *Integration of consumers into production, to different degrees, is a necessary condition for the incentive structure and efficiency of open institutions.*

There are several possible reasons for the integration of consumer into production in open institutional structures. First, the final product of some open institutional arrangements is directly dependent on the consumers. The best example is the open square. Visitors (consumers) are simultaneously part of the final product—the livable urban square—and its producers.

Second, integration of consumers into production can guarantee that there are some private benefits to at least those consumers of high performance. Given the absence of monetary incentives within an open structure, the integration of consumers and producers can help to provide some direct non-monetary incentives, such as fixing bugs and customizing programs. Lerner and Tirole (2000) listed some private rewards to OSS participants that fit into simple labor economics. In their empirical studies on the factors that determine the scope of open source licensing, they found that restrictive licenses are more common for applications geared toward end-users and less likely for those oriented toward developers (Lerner and Tirole, 2005).<sup>16</sup> In other words, open source licensing tends to be more open and less commercial when the consumers are more integrated into production.

Third, the integration of consumers and producers is to some extent similar to “user-driven innovation” in some industries such as machine tool instruments and scientific instruments (von Hippel, 1988). This shows the importance of highly variable human capital and its creativity to open institutions.<sup>17</sup> Human capital is certainly accumulated through consumers’ experiences with the product. In OSS, users are more familiar with the features and problems of the software and, hence, are better at designing and improving the software. For example, Kogut and Metiu (2001) noted that an efficiency gain from the OSS model is concurrent debugging and design. Kuan’s (2001) empirical study also points to the efficiency of OSS in debugging code.

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<sup>16</sup> In Lerner and Tirole’s 2005 study, the authors classify licensing into two types: restrictive ones that require modification of the program must make the source code available; highly restrictive ones that prohibit modification of the open source program from mingling with other non-open source software.

<sup>17</sup> This point also affirms Hayek’s argument that decentralized local knowledge makes spontaneous private ordering more efficient than central planning.

Some may argue that, as Tirole and Lerner (2000) pointed out, many participants in OSS write codes to advance career concerns. They do not sound like consumers. Here we can distinguish two types of consumers. The first type is comprised of those who use the final binary codes. The second type is similar to scientists in working in open science. They read and improve the source codes of OSS; they “consume” the source codes for further development and improvement without necessarily using the binary codes for other production purposes. In this sense, they are still consumers of OSS products.

### ***Ex Post Voluntary Participation***

The hold-up problem due to relationship-specific investment has been the central issue for modern studies on the firm and property rights (see, for example, Klein, Crawford, and Alchian, 1978; Williamson, 1985; Hart, 1995). Why has it seldom been mentioned in the literature on open institutions? The key is *ex post* voluntary participation. Although voluntarism is often regarded as the foundation for open institutions from a moral perspective, it is also an important efficiency property for the open structure.

*Ex post* voluntary participation in the open structure means that any individual can exit at any time in any way without significant cost. This, on the one hand, implies the absence of firm specificity of human capital and, on the other hand, implies the disappearance of the hold-up problem. Individuals may choose to contribute to human capital that is specific to a particular open product, such as Linux, but since their rewards or the values of their investment are measured by non-monetary terms, such as fame and reputation, those rewards cannot be taken away if the individual chooses to leave the project. A scientist whose research on a university-specific project (say a highly local project) results in high quality publications is not affected by moving to another university, because he has built up his reputation in the field. Of course, the open institution might be said to suffer from the loss of one or more high-power participants. But, who knows what new people may bring into the open institution? The departure of a beautiful actress from an urban square might leave all people regretful, but the entry of a clown may make them even happier. That is the real life of an urban square. Again, we see

the crucial role of uncertainty and externality in the creativity and productivity of open institutions.

The classic transaction cost approach posits that a firm's willingness to invest in human capital is determined by how specific it is to the firm. An individual's willingness to contribute to the human capital depends upon factors such as search costs and adverse selection, which ultimately affect their salaries. The usual solution in a proprietary world is to internalize these problems within an institution, where there is the problem of shirking and monitoring. The costs of shirking and monitoring are especially high when human capital is highly varied and difficult to assess *ex ante*. Do open institutions also internalize all those problems (such as the hold-up problem) within a particular organization?

The answer is negative. Internalization is no longer an appropriate term here since it often reminds people of what goes on inside a firm. How do open institutions deal with the problem of shirking and monitoring? Or more accurately, do they exist inside an open institution? For political institutions, this problem does not exist at all because shirking and lack of monitoring means the loss of voice in the decision process. There is no participation, no voice, and no reward. For economic institutions such as OSS, shirking also means loss of influence in the direction or development of the project. In other words, the uncertainty of the final product (the collective good) makes shirking (and consequent loss of influence on the production) itself a punishment or loss of reward. In this sense, the incentive structure of open institutions is closely integrated with its governance structure. Seniority or fame becomes the direct and (possibly) primary reward. In contrast, money is often the most important form of reward inside a firm. Although money helps to create labor-market competition (otherwise, it is difficult for people to compare jobs in different firms), it makes the incentive structure loosely connected to the governance structure.

In a word, *ex post* voluntary participation precludes the hold-up problem but loss of efficiency due to relationship specific investment from either the institution or individuals may still exist, albeit at a smaller magnitude. This is, in our view, an important difference between a production-oriented approach

(such as open institutions) and transaction-oriented approach (such as firms).

**Thesis 3:** *With ex post voluntary participation, a defining feature of open institutions, the hold-up problem disappears, and efficiency loss from relationship-specific investment is reduced. The close integration of the incentive structure with the governance structure makes shirking and monitoring a non-problem in open institutions.*

The above discussion also suggests some downsides of open institutions or cases in which they may not be able to prevail. First, the institution will be less likely to invest in physical capital, let alone firm-specific human capital. Investment in physical capital increases the firm specificity of human capital, which in turn might lead to greater loss to the institution if the individual who uses the physical capital leaves. This is a real possibility in spite of the fact that newcomers may bring in other sources of productivity.

Second, given its close integration of incentive structure and governance structure, open institutions may not be so good at facilitating labor market competition as the firm. Reputation, seniority, and fame are all more specific to a particular institution than salary. Money can better lubricate the labor market as a single and objective measure.

Let us look at the case of the SONY square. Assume that SONY built the square in a non-open, commercial and proprietary way. SONY can even hire (or contract out) many people to perform different types of social activities in the square. In that case, consumers are still integrated into production, albeit in a way specified *ex ante*, and there is no *ex post* voluntary participation. However, one or a group of those employees or service firms may some day refuse to participate in the “production” process by holding up on some specific (human) capital that could not be replaced immediately. In the presence of the hold-up problem, the final product will not be complete, let alone its non-randomness that is detrimental to a livable square. It is interesting to note that this kind of “private” square does exist in many theme parks or tourist sites. But, in that case, tourists keep changing every day, and the square is always new to tourists who come on a particular day. The opposite is true for an urban square: people keep coming to the same square.

## DISCUSSION AND CONCLUSION

This paper presents an exploration of a general understanding of open institutional structure that lies behind many different forms of open institutions. By analyzing open source software, open science, and open squares, we argue that the essence of open institutions is about production. This is in contrast to traditional studies on institutions and organization that focus on transaction, which is based on proprietary structure.

The open institutional structure is defined by open access to the production process, no property rights or contract in peer collaboration, *ex post* voluntary participation, and the integration of consumers and producers.

Open institutions produce a collective good without a clear design for the final product, relying on highly variable human-related inputs that are difficult to identify *ex ante*. Integration of consumers into production provides various non-monetary incentives for participation in open institutions. Through *ex post* voluntary participation, the hold-up problem from relationship-specific investment disappears in open institutions. In this way, a transaction cost problem of intra- and inter-firm collaboration is transformed into a production model based on open structure. Uncertainty and externality then become the source of creativity and efficiency.

Although our focus is on the defining features of open institutions, it does not mean that open institutional structure does not have its problems. Some problems, such as the tragedy of commons, are well-known and some, such as the costs embedded in its governance structure, are less well-known. Open institutions are complementary to the proprietary structure in the sense that the open structure may only be able to thrive in some particular circumstances, while the proprietary structure prevails in others. Furthermore, there are many benefits, including social benefits, from private property rights. Personal motivations of individuals can generate great outcomes, just as the “invisible hand” shows us. Nevertheless, a comprehensive comparison between the open institutional structure and the proprietary structure is beyond the scope of this paper. That will be an important topic for further research.

Many studies (see, for example, Williamson, 1985; Barzel, 1989; Coase, 1991; North, 1991; Hart, 1995) have shown that institutional

arrangements based on the proprietary structure evolve to deal with various problems from uncertainty. In that tradition, uncertainty is often regarded as a negative factor and, hence, needs to be controlled. But, our analysis shows that open institutions' production efficiency lies in exactly the uncertainty and unpredictability brought about by highly variable and creative human capital. In other words, open structure responds to the need to harvest the positive value of uncertainty.

Besides, open institutions can mitigate the negative effects of uncertainty by resorting to the law of large numbers. For example, if a programmer decides to quit from an OSS project, then his vacancy could easily be filled by another voluntary programmer from the large number of volunteers in OSS. In this sense, institutions respond to both negative and positive sides of uncertainty. Open institutions represent an approach to capture the positive effects of human creativity while controlling its negative effects in an open way.

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