

A glowing lightbulb is the central visual element. The bulb is illuminated from within, casting a bright green glow. A butterfly with translucent wings, showing green and yellow patterns, is perched on the top rim of the bulb. Inside the bulb, a glowing caterpillar is visible, positioned as if about to emerge from the top. The background is dark, making the glowing elements stand out.

# INTERNATIONAL STANDARDIZATION AS A STRATEGIC TOOL

**Measuring the performance  
of standard setting organizations**

**By Timothy S. Simcoe, lead author;  
Marc Rysman, co-author**

**The Joseph L. Rotman  
School of Management –  
University of Toronto, Canada**



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Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
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## About the authors



### **Timothy S. Simcoe**, lead author

*Timothy S. Simcoe is Assistant Professor of Strategic Management at the Joseph L. Rotman School of Management, University of Toronto. Tim teaches courses in Strategic Management and Entrepreneurship and has published articles on technology management, firm strategy, health care, and industrial organization. His current research focuses on the organizational impact of IT adoption, the political economy of voluntary standard setting, and the impact of compatibility standards on economic and technological change.*

*Tim earned his MA in Economics and his PhD in Business Administration from the University of California, at Berkeley in 2005. Prior to that, he worked as a consultant in the economic and information technology practices of Ernst & Young LLP, and as a research assistant for the U.S. Council of Economic Advisers.*



### **Marc Rysman**, co-author

*Marc Rysman is an Associate Professor in the Economics Department at Boston University. He received his PhD in Economics from the University of Wisconsin at Madison in 1999. Marc's research focuses on industrial organization and competition, and the related issues concerning antitrust and regulation, in particular network effects, two-sided markets, standardization and compatibility. He has studied a variety of fields, such as modems, Yellow Pages, payment cards and consumer electronics. His research is primarily empirical, ranging from studies that are heavily motivated by theory to work that is primarily descriptive. He teaches industrial organization, econometrics, antitrust and regulation.*



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# Measuring the performance of standard setting organizations

Timothy Simcoe  
The Joseph L. Rotman School of Management  
University of Toronto

Marc Rysman  
Boston University

## Summary

*This paper proposes a new method for evaluating the performance of standard setting organizations (SSOs) using patent citations. We use a sample of patents obtained from the publicly available intellectual property disclosure records of 14 SSOs to illustrate the proposed approach. Our method has two major advantages. First, citations are easily measured and compared across different standards and SSOs; and, second, it is possible to examine both average citation rates and changes in patent citation rates following disclosure. Average citation rates provide a measure of SSOs' ability to identify important technologies, while changes provide a measure of their ability to influence a particular technology's economic or technological significance.*

*Our results show that SSO patents are cited far more frequently than an average patent from the same vintage and technology class, and that disclosure is followed by a statistically significant increase in the citation rate. These findings suggest that SSOs not only identify and endorse important technologies, but also influence their future significance. We also use our method to compare the relative size of these "selection" and "endorsement" effects at formal Standards Developing Organizations (SDOs) versus less formal consortia. In our sample, the selection effect is significantly larger for consortia, but the evidence of a disclosure effect is stronger for SDOs.*

## 1 Introduction

Voluntary Standard Setting Organizations (SSOs) promote industry-wide coordination on technical standards, providing an important alternative to standardization through market competition or government regulation. These groups are found wherever firms or consumers value interoperability, and come in a variety of shapes and sizes—from large international bodies to small informal industry consortia.

SSOs encourage coordination by sponsoring collaborative R&D, compatibility testing, and product certification. However, they mainly serve as a forum where experts can evaluate alternative technologies and endorse one as the industry standard. Since SSOs generally lack the power to enforce these recommendations, they often work to create a consensus that can serve as a focal point for industry coordination or lead to a bandwagon process among potential adopters.

It is not obvious how to measure the performance of SSOs.<sup>1</sup> In particular, there are two major obstacles. First, it is hard to find reliable metrics that can be systematically collected and compared across a wide range of technologies. And second, even with perfect measures, it would be hard to

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<sup>1</sup> While several authors have documented the substantial resources devoted to voluntary standard setting (e.g. David and Greenstein 1990; Shapiro and Varian 1998; Simcoe and Farrell 2006), there is relatively little research on SSO performance. (See Bibliography.)

identify the impact of an SSO on the overall significance of a particular technology. This is because SSOs strive to identify and endorse the best technologies (i.e. those most likely to become important on their own) making it hard to argue that any particular benchmark provides an accurate measure of the counter-factual value of a technology had it not become a standard.

This paper proposes new methods for addressing the performance measurement problem for SSOs.<sup>2</sup> We begin by arguing that *patent citations* provide a useful measure of SSO performance. There is a growing body of research showing that patent citations are correlated with the economic and technological significance of an invention.<sup>3</sup> Moreover, when standardized technology can be linked to specific patents, citation counts provide a simple metric that can be compared across multiple standards or SSOs.

We link patents to standards by examining the publicly available intellectual property disclosure records of 13 SSOs. This search identified 1,376 US patents, which we merged with the NBER US patent database to obtain citation counts, and to construct a sample of “control” patents from the same application year and technology class. A simple comparison of cumulative citation counts reveals that SSO patents receive more than twice as many citations as those in our control sample.

The high citation rate of SSO patents suggests a substantial *selection effect*, whereby SSOs identify important technologies. While this is an important finding that reflects one dimension of SSO performance, it does not tell us very much about the *impact* of an SSO. In particular, does SSO endorsement enhance the value of the standardized technology? To address this question, we examine how patent citation rates change following the patent’s disclosure to an SSO. To the extent that disclosures correspond to the formal endorsement of a new standard, the difference between pre- and post-disclosure citation rates provides a novel measure of the SSO’s influence on the value of a technology.

We use a simple regression to separate the selection effect from “SSO impact” (which we call the “disclosure effect”). This regression controls for a number of other factors including the age and vintage of the SSO and control patents, and changes over time in the average citation propensity.<sup>4</sup> Our results show a large selection effect—SSO patents receive 133 % more citations than an “average” patent—and a smaller but still statistically significant disclosure effect. On average, SSO patent citations increase by 16 % following disclosure.

Finally, we examine differences in the size of the selection and disclosure effects at different types of SSO. In particular, we divide our sample of SSOs into a set of formal Standards Developing Organizations (SDOs) and a set of less formal consortia. The SDOs include ISO, IEC, and ITU, while the consortia include the IETF, Open Mobile Alliance, and VESA.<sup>5</sup> We find a larger selection effect at the informal consortia (i.e. their patents receive more citations on average). However, the statistical evidence of a post-disclosure “citation bump” is stronger for the established SDOs.

Our analysis provides new evidence on the performance of SSOs, and an initial look at patents disclosed in the standard setting process. The results suggest that SSOs not only select important technologies, but also play a role in establishing their significance. Finally, our findings highlight potential differences in the relative size of these effects at SDOs and consortia.

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<sup>2</sup> There is a reasonably large economics literature on standard setting. However, most of this literature sidesteps the performance measurement problem by focusing on case studies of individual standards (e.g. Bekkers 2002; Shapiro and Varian 1998; Weiss and Toyofuku 1996). (See Bibliography.)

<sup>3</sup> For example, Hall, Jaffe and Trajtenberg (2005) [6] show that the average citations per patent in a firm’s patent portfolio is correlated with a firm’s market value.

<sup>4</sup> Our statistical methods are developed in Rysman and Simcoe (2006) [10] and Mehta, Rysman, and Simcoe (2006) [9]. These papers provide an extensive discussion of the strengths and weaknesses of the regression model. However, they focus exclusively on SDOs, whereas the present study uses additional data to compare the performance of SDOs and less formal consortia.

<sup>5</sup> See Table 2 for a complete list of the SSOs in our sample.

## 2 Patents and the standard setting process

### 2.1 The Economics of SSOs

SSOs provide a forum where firms work to solve collective action problems. In this study, we focus on SSOs that create compatibility standards, where the collective action problem is related to the collective benefits of adopting a common technology platform. These benefits are often called network effects.<sup>6</sup>

Economists have studied a number of mechanisms that create network effects. There are direct benefits, such as the ability to communicate with other users. There are also indirect benefits, such as the increased supply of complementary goods and services that accompanies a larger installed base. The ability to “mix and match” components are a third source of network effects (e.g. when a consumer buys a computer from one company and a monitor from another). Finally, there are scale economies and learning effects that lead to lower industry average costs when firms adopt the same technology.

All of these forces are pervasive in the information technology (IT) and telecommunications industries, where there has been a dramatic increase in standard setting activity over the last twenty years. This increase reflects sustained industry growth, the emergence of new general purpose technologies such as the internet, and the growing inability of large incumbents’ such as IBM and AT&T to act as *de facto* standard setters. (Table 1 shows that the 944 US patents used in this study are heavily weighted towards IT and telecommunications.)

While SSOs are very common whenever network effects are present, they are not always necessary to achieve coordination. Indeed, much of the economic literature on network effects has focused on “standards wars” such as the battle between Betamax and VHS. In a standards war, technical coordination emerges from a competition between the sponsors of rival technologies. When vendors believe the market is likely to “lock in” on a particular technology, this competition can be quite fierce.

Farrell and Saloner (1988) [3]<sup>7</sup> studied the relative performance of “markets and committees” using a formal model of the standard-setting process. Their analysis suggests that while committees (i.e. SSOs) are more likely to achieve coordination, markets produce a faster result. In their model, the benefits associated with increased coordination through using an SSO are dissipated by long delays, which are caused by competing vendors’ reluctance to concede in order to reach a consensus. Farrell and Simcoe (2006) [4] subsequently examined a number of SSO policies designed to reduce these delays.

This paper is concerned with a slightly different question. Given the large amount of voluntary standard setting that takes place in many industries, we ask whether there is any evidence that SSOs have an impact on the significance of the technologies they endorse. In other words, we seek to measure SSO performance.

We consider two dimensions of SSO performance. The first dimension is associated with the *selection problem*—i.e. an SSO’s efforts to identify and endorse the best solution for a given problem. The second dimension is associated with the *coordination problem*, or the SSO’s impact on the final outcome of the technology adoption process.

Interactions between these two dimensions of SSO performance create significant difficulties for any researcher hoping to isolate either one of them. In particular, if SSOs are successful at *identifying* the best solution to a given problem, it is hard to see why their *endorsement* should make any difference—particularly when they lack formal enforcement powers. After all, efficient markets will provide strong incentives to coordinate on the best technology once it has been

<sup>6</sup> A more precise definition of network effects would highlight the idea of “increasing returns” to the adopters of a common standard—i.e. everyone benefits from the existence of a large installed base.

<sup>7</sup> Figures in square brackets refer to the Bibliography.

identified. In other words, the impact of formal SSOs on the process of technical coordination may be little more than what is already achieved through the widely remarked process of market-mediated *de facto* standardization.

This paper suggests one way around this measurement problem, and presents some evidence suggesting that SSOs do influence the economic and technological significance of standardized technology. However, before describing our methods for identifying the selection and coordination effects, the following paragraph describes our basic performance measure.

## 2.2 Citations and technological significance

We use citations as a measure of the economic and technological significance of a cited patent. In practice, inventors and patent attorneys use citations to acknowledge the existence of “prior art” and to clarify the novel features of an invention. Since prior art limits the value of a patent, applicants have an incentive to cite sparingly—making citation counts a reasonably proxy for the overall significance of a patent. While it is hard to attach a dollar value to citations, the estimates in Hall, Jaffe and Trajtenberg (2005) [6], and Harhoff *et al.* (1999) [7] suggest that it could be substantial.

Patent citations have several advantages as a measure of SSO performance. One advantage is that they are not subjective. Patent citations are easy to quantify, and allow for systematic comparisons across different standards and SSOs. A second advantage (at least in principle) is that patents are linked to specific technologies. Citations can therefore be used to study the difference between proposals that are accepted or rejected by an SSO.

The major problem with patent citations as an SSO performance measure is that they are hard to interpret. While some researchers use patent citations as a measure of economic value, others interpret them as an indicator of knowledge flows. For this paper, it is not important to defend any particular interpretation of the meaning of a patent citation—as long as they contain some information about the significance of the cited invention, we can use them to learn about the impact of SSOs.

A second problem with patent citations as a measure of SSO performance is that the links between patents, technologies, and standards are often ambiguous. A single technology often spans multiple patents, and a single standard often contains many technologies. In principle, this problem can be overcome with careful data collection. However, an extensive patent search designed to identify all relevant patents for every proposal evaluated by an SSO would be an extremely expensive and time-consuming task. In the following paragraph, we describe an alternative approach, which relies on intellectual property disclosures made by individual firms in the course of the standard setting process.

## 2.3 Intellectual property disclosures

Most SSOs have rules that require firms to disclose any intellectual property rights (IPR) they believe might be infringed by a proposed standard. These disclosure requirements are usually accompanied by licensing rules, the most common being a promise to license on “reasonable and non-discriminatory” (RAND) terms.<sup>8</sup> IPR disclosures are usually letters indicating that a firm owns potentially relevant IPRs—generally patents or patent applications—and providing the necessary assurances with respect to licensing.

To create a link between standards and patents, we collected a large number of IPR disclosures from 13 different SSOs. We read these documents and created a list of US patents disclosed in the standard setting process. Our disclosure data begins in 1971 and continues through 2005. Figure 1

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<sup>8</sup> See Lemley (2002) [8] for an extended discussion of SSO licensing and disclosure rules, and Updegrave (2006) for an overview of recent policy developments in this area.

illustrates the growth in IPR disclosures over time, and Table 2 provides information on the number of disclosures and patents obtained from individual SSOs.<sup>9</sup>

While these patents provide a unique window into the standard setting process, they also have several weaknesses. One problem is that many firms do not provide specific patent or application numbers—preferring to use “blanket” disclosures that indicate their willingness to offer RAND licenses without disclosing any IPR. In some cases, firms may try to completely avoid disclosure requirements.<sup>10</sup> A second problem is that some disclosed patents cover technologies that are never incorporated into a standard. This is not a major concern, however, since these patents probably lead us to underestimate SSOs’ impact on standardized technology. Finally, our method of identifying the impact of an SSO endorsement requires that disclosures occur around the same time as endorsements. Many of these problems are mitigated by the tendency of firms to wait until the end of the standard-setting process before disclosing—whether to preserve secrecy or because patent searches become less costly as the details of a standard emerge.

For our purposes, IPR disclosures simply provide a list of patents corresponding to standardized technology. It is very unlikely that these patents will provide a representative look at the output of an SSO—they are more likely to be concentrated among the most important and commercially relevant standards.<sup>11</sup> Nevertheless, these data are sufficient to take an initial look at SSO performance that highlights the difference between selection and disclosure and contrasts the performance of SDOs and consortia.

## 2.4 SDOs versus consortia

Many SSOs have a long history of working to promote coordination on technical matters. For example, the International Telecommunications Union (ITU) was founded in 1865—before the invention of the telephone, and the International Electrotechnical Commission (IEC) was founded in 1906. These well-established organizations, which we refer to as Standards Developing Organizations (SDOs), are international in scope, and have evolved detailed procedures for certifying new international standards.

Recently, however, the number of smaller and more specialized SSOs has grown rapidly. This partly reflects the lengthy delays associated with SDOs’ formal procedures. It also reflects the increasing size and variety of the information technology landscape, and some firms’ desire to exert more control over the standard setting process. In any case, we refer to these new forums collectively as consortia.

Table 2 shows that we collected data from six SDOs (ANSI, IEEE, ITU, TIA, ISO, IEC) and seven consortia (ATIS, ATM Forum, IETF, DSL Forum, Multiservice Switching Forum, Open Mobile Alliance, and VESA).<sup>12</sup> The table also shows that the SDOs in our sample disclosed almost 50 % more US patents than the consortia. This reflects the broader scope of SDOs, and the fact that they have had formal IPR policies in place for a longer period of time. After describing our data and methods, we compare the size of the selection and disclosure effects for SDOs and consortia—offering the first systematic look at performance differences between these two types of SSO.

<sup>9</sup> We use common abbreviations for the SSOs, whose full names are: American National Standards Institute (ANSI); Alliance for Telecommunications Industry Solutions (ATIS); ATM Forum; Institute for Electrical and Electronics Engineers (IEEE); Internet Engineering Task Force (IETF); International Telecommunications Union (ITU); Telecommunications Industry Association (TIA); DSL Forum; International Organization for Standardization (ISO); International Electrotechnical Commission (IEC); Multiservice Switching Forum (MSSF); Open Mobile Alliance (OMA); and the Video Electronics Standards Association (VESA). ANSI is actually an umbrella organization that certifies US SSOs (including IEEE and TIA) and their disclosure letters come from a number of different sources. JTC-1 is a joint venture of ISO and IEC that focuses on international IT and telecom standards.

<sup>10</sup> The FTC has initiated antitrust actions against both Dell and Rambus for attempting to license essential IPR that was not disclosed. For a discussion of these cases, and the complicated antitrust issues they raise, see Teece and Sherry (2003) [12] or Farrell *et al* (2004).

<sup>11</sup> However, as firms contemplate changes to their IPR policies in the wake of the Rambus case, there is some reason to hope that data from IPR disclosures will become both more widespread and more thorough.

<sup>12</sup> We called any established international organization or ANSI certified standards developer an SDO. While our classification scheme is necessarily ad-hoc, we feel that it is a reasonable way of dividing the sample.

### 3 Methods

#### 3.1 Data construction

We compiled a list of US patents and their disclosure dates by reviewing publicly available IPR disclosure records. We then merged this list with the NBER US patent database (Hall, Jaffe and Trajtenberg 2001) to obtain information on the patents' application and grant years, the identity of owners, and the number of citations made and received. Our primary dependent variable is a simple count of the citations received by a patent in a particular year. We eliminate "self-citations" (i.e. cites from the same parent firm), although this does not have a major impact on the results.

We also used the NBER database to construct two "control" samples. The first set of controls consists of a single undisclosed patent from the same application-year and three-digit technology class as each SSO patent. For the second set of controls, we randomly selected a single undisclosed patent from the same application-year, technology class that was owned by the same parent firm as each SSO patent. Neither of these groups are true "controls" in the sense of a randomized trial—i.e. a sample that is statistically indistinguishable from the pre-disclosure SSO patents. However, by matching on timing, technology, and ownership, we control for several obvious sources of potential heterogeneity. These control samples allow for a straightforward comparison of cumulative citation counts. However, we turn to the more general regression framework described in the following paragraph to separately identify the selection and disclosure effects.

#### 3.2 Regression model

This paragraph briefly describes a simple regression that is described at length in Simcoe and Rysman (2006) [10]. Our model takes the following form: where  $SSO_i$  is an indicator variable that equals one for any patent disclosed to a standard setting organization,  $Disc_{it}$  is an indicator for the post-disclosure period, and  $X_{it}$  is a vector of control variables that includes a full set of patent-age effects, citing-year effects, application-year effects, and technology-class effects.<sup>13</sup>

$$E[C_{it}] = \exp(SSO_i * \beta_1 + Disc_{it} * \beta_2 + X_{it} * \beta_3) \quad (1)$$

The coefficients in this specification can be interpreted as percentage changes.<sup>14</sup> We are primarily interested in the coefficients on the SSO and Disclosure variables. The SSO coefficient ( $\beta_1$ ) measures the difference in the average citation rate between disclosed and undisclosed patents from the same technology class, with the same age, in the same citing-year. The disclosure coefficient ( $\beta_2$ ) measures the change in the average citation rate of disclosed patents following disclosure.

In this regression we do not use either of the random "control samples" described above, but rather include any patent from the same three-digit technology class as an SSO patent. Our measure of the "selection effect" therefore captures the difference in citation rates between a disclosed patent and an "average" patent from the same technology class at the same age. Because control patents vastly outnumber SSO patents, this model essentially uses the age distribution of control patent citations to identify the counter-factual citation rate of a post-disclosure SSO patent, and hence the "coordination effect". While it is impossible to test this assumption, Simcoe and Rysman (2006) [10] discuss it at length and find that alternative estimation strategies yield similar results.

<sup>13</sup> It may appear that there we introduce a co-linearity problem by including age, citing-year and application-year as control variables. However, since we define age in terms of the grant-year rather than the application-year this is not the case. Mehta, Simcoe and Rysman (2006) discuss the identification of age effects in this type of a model, which essentially relies on random noise in the lag between application and grant associated with the USPTO review process.

<sup>14</sup> The advantage of estimating the model as a Poisson regression (with robust standard errors), rather than in its log-linear form, is that the Poisson specification handles the large number of observations with zero citations in a straightforward manner.

## 4 Results

### 4.1 Cumulative citations

Our initial results are based on a comparison of the cumulative citations received by SSO patents and the two “control” samples. By matching each SSO patent to a single control from the same application-year, we ensure that the SSO and control patents have the same age distribution. (This is important, since older patents naturally receive more citations and we are computing an average across patents with different ages.) Our main result is illustrated in Figure 2, with additional statistics provided in Table 3.

Figure 2 shows that SSO patents are cited two to three times as often as the random controls and roughly 50 % more than undisclosed patents owned by the same firm. Moreover, this is true for both SDO and consortia. Table 3 shows that these differences in average cumulative citation counts are statistically significant.

While Figure 2 appears to show that consortia patents are cited more frequently than SDO patents, this could be an artefact of differences in the age distributions. Moreover, while this analysis clearly highlights the significance of SSO patents, it does not reveal whether this is primarily a selection effect, a disclosure effect, or some combination of the two. We turn to these issues in the following paragraph.

### 4.2 Selection and disclosure effects

To compare the size of the selection and disclosure effects, we estimate equation (1) and examine the coefficients of the SSO and disclosure indicator variables. The estimation sample includes all SSO patents, as well as every US patent with the same application-year and three-digit technology class as any SSO patent.

Figure 3 summarizes the results by comparing the pre- and post-disclosure citation rate of an “average” SSO patent to a hypothetical control patent that receives one citation per year.<sup>15</sup> (Coefficient estimates are provided in Table 4.) Prior to disclosure, the hypothetical SSO patent receives 2.33 citations per year—more than twice as many as an “average” patent from the same technology class and application year. After disclosure, the citation rate of the SSO patent grows to 2.7 cites per year—an increase of 16 %. This suggests that 80 % of the difference between an “average” patent and an SSO patent is based on selection, while 20 % is based on the impact of the SSO.

It is important to recognize that our use of an “average” patent as the baseline leads to a large selection effect. The relative size of the disclosure effect would be much larger if our baseline consisted of a sample of highly cited patents, such as other patents “at risk” for disclosure. Nevertheless, these results provide some of the first systematic evidence that SSOs not only identify important technologies, but also have an impact on the economic and technological significance of the technologies they endorse.

### 4.3 SDOs versus Consortia

In the following paragraphs, we compare the “selection” and “disclosure” effects for patents disclosed at SDOs and consortia. Once again, our results are based on the model in equation (1). However, we include separate SSO and Disclosure variables for the SDO and consortia patents. Figure 4 summarizes the results, and coefficient estimates are provided in Table 5.

Figure 4 shows that the selection effect is much larger for consortia than for SDOs. In particular, compared to a hypothetical rate of one citation per year, a pre-disclosure SDO patent would receive 2.0 cites, while a pre-disclosure consortia patent would receive 3.3 cites per year. This difference in pre-disclosure citation rates is statistically significant. Moreover, it is not explained

<sup>15</sup> In reality, the controls receive far fewer than one cite per year on average, and the expected number of cites depends strongly on the age of the patent.

by observable differences in the patent age distribution or types of technology evaluated at different SSOs, since we control for these factors in the regression.

One interpretation of this finding is that consortia are more focused than SDOs. If a consortium's primary objective is to promote a particular technology (which might be fairly well-developed), we would expect only the most important related patents to be disclosed. Another interpretation is that SDOs have more stringent IPR disclosure rules, leading to the disclosure of patents that are less important on average.

The second result illustrated in Figure 4 is the disclosure effect, which appears quite similar for the SDO and consortia patents. In fact, post-disclosure citations increase by 0.53 per year for SDO patents and 0.57 per year for consortia. However, these numbers are somewhat misleading, as it is more accurate to express these results in percentage terms. Table 5 shows that the disclosure effect was 26 % for SDO patents and 17 % for consortia (because of the consortium's higher baseline citation rate). While the post-disclosure increase for SDO patents is statistically significant at conventional levels, this is not true for consortia. Overall, these results provide strong evidence for a disclosure effect at SDOs, and inconclusive results for consortia.

The statistically insignificant consortia disclosure effect implies that we do not have enough data to make a precise comparison. (Indeed, the difference between the two disclosure coefficients is also not statistically different from zero). Nevertheless, the somewhat larger and "stronger" SDO disclosure effect hints at differences in the objectives of different SSOs. In particular, to the extent that SDOs identify and endorse technologies, while consortia merely promote them, we might expect a larger post-disclosure "citation bump" for the SDO patents.

## 5 Conclusions

This paper describes a new method for measuring SSO performance using patent citation counts. We analyzed 944 US patents disclosed in the standard setting process to address two important questions. First, what is the relative size of the "selection" and "coordination" components of SSO performance? And second, how does the performance of well-established SDOs compare to newer and less formal standards consortia?

Our results shows that the SSO patent citation rate is roughly twice that of an average patent, and that citations increase by 15 % to 20 % following disclosure. In other words, SSOs not only identify and endorse important technologies, but also influence their future significance. Finally, we show that the selection effect is significantly larger for consortia, while there is more evidence of a disclosure effect at established SDOs.

These findings suggest a number of directions for future research. With better data, one might refine our estimates of the selection and disclosure effects by identifying proposals to an SSO that were seriously considered but not endorsed; or standards that were endorsed but never widely accepted. It would also be interesting to refine our crude categorization of SDOs and consortia using observable features of the SSO. Finally, there is a great deal of work to be done on the larger issue of standards and intellectual property strategy.

**Table 1 – Technology classification of US patents disclosed to SSOs**

<i>Technology Classification</i>	<b>SDO</b>	<b>Consortia</b>	<b>Total</b>
Computers - Communications	270	157	427
Computers – Hardware/Software	245	105	350
Information storage	18	4	22
Electrical devices	13	0	13
Electrical and electronic (miscellaneous)	59	4	63
Optics	18	0	18
All others	41	10	51
<b>Total</b>	<b>664</b>	<b>280</b>	<b>944</b>

**Table 2 – IPR Disclosure summary statistics**

	<b>First Disclosure</b>	<b>Total Disclosures</b>	<b>Patents Disclosed</b>	<b>US Patents Disclosed</b>
ANSI	May-71	278	222	194
ATIS	Dec-86	58	39	39
ATM Forum	Feb-95	25	80	51
IEEE	May-83	390	588	425
IETF	Jun-95	353	169	151
ITU	Apr-83	643	532	337
TIA	Oct-89	126	22	22
DSL Forum	Jul-00	8	1	1
ISO	Feb-80	24	44	16
ISO/IEC JTC-1	Jul-92	217	61	36
MSSF	Nov-99	13	6	4
OMA	Jul-99	44	129	87
VESA	May-95	55	14	13
<b>Total SDO</b>		<b>1,678</b>	<b>1,469</b>	<b>1,030</b>
<b>Total consortia</b>		<b>556</b>	<b>438</b>	<b>346</b>

**Table 3 – Cumulative citations for SSO and control samples**

	<b>Mean</b>	<b>S.E. Mean</b>	<b>T-stat</b>	
SDO Patents	21.62	1.25		
Random controls	9.08	0.56	9.18	***
Same-firm Controls	16.36	1.08	3.15	***
Consortia patents	28.94	2.26		
Random controls	10.13	0.99	7.61	***
Same-firm Controls	20.97	2.09	2.58	**

\*\* Significant at 5%;

\*\*\* Significant at 1%.

NOTE T-test is for a difference in the means of the SSO and control samples.

**Table 4 – Selection versus Disclosure**

SSO (Selection)	0.847	***
	(0.046)	
Disclosure (Coordination)	0.147	**
	(0.068)	
Total obs.	3,527,433	
SSO patent obs.	8,270	

\*\* Significant at 5%;

\*\*\* Significant at 1%. Robust standard errors are in parentheses.

NOTE The results are based on the specification in Equation (1). The model includes a full set of application-year, citing-year, patent-age, and technology-class fixed effects (i.e. dummy variables).

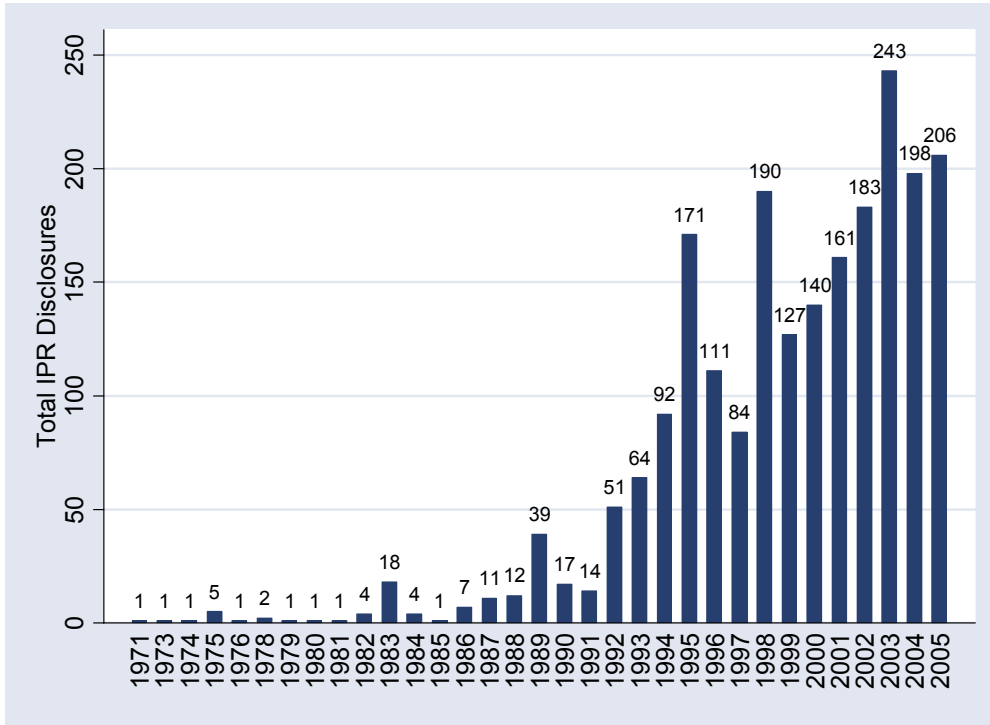
**Table 5 – SDOs versus Consortia**

SDO dummy	0.708	***
	(0.049)	
SDO* disclosure	0.230	***
	(0.074)	
Consortia dummy	1.181	***
	(0.089)	
Consortia*disclosure	0.161	
	(0.142)	
Observations	3,527,433	
SSO patent obs.	8,270	

\*\* Significant at 5%;

\*\*\* Significant at 1%. Robust standard errors are in parentheses.

NOTE The results are based on the specification in Equation (1). The model includes a full set of application-year, citing-year, patent-age, and technology-class fixed effects (i.e. dummy variables).



NOTE Counts based on all publicly available disclosures for the SSOs listed in Table 2.

Figure 1 – The increase in total IPR disclosures

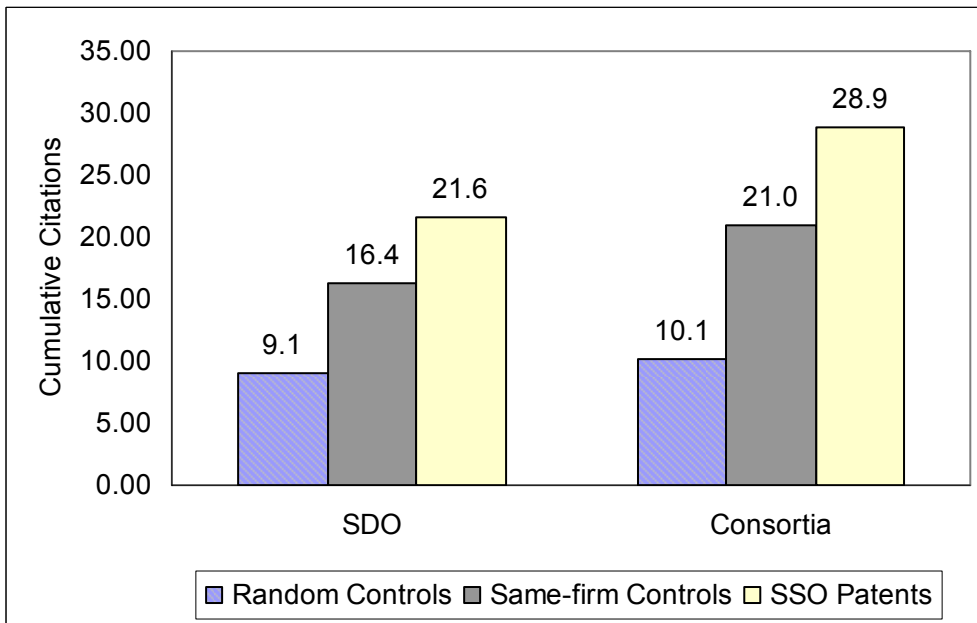


Figure 2 – Cumulative citation counts for SSO and control patents

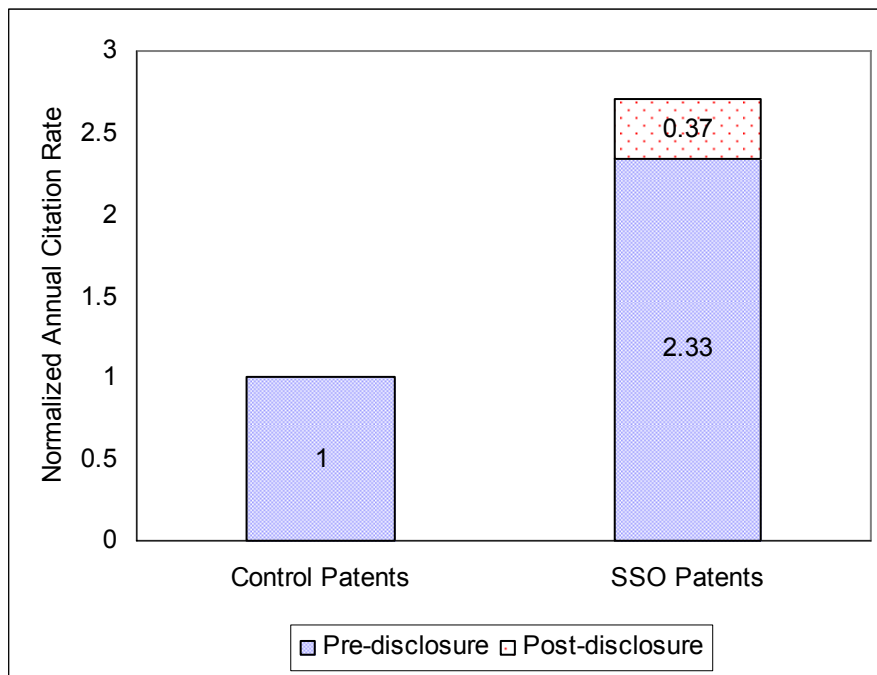


Figure 3 – Selection versus disclosure effects for SSO patents

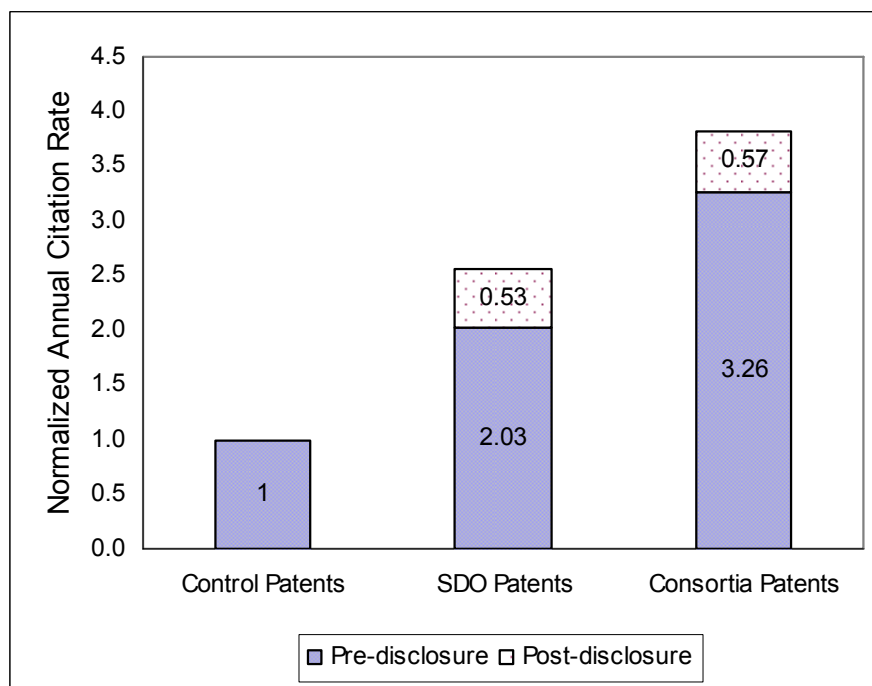


Figure 4 – Selection and disclosure effect at SDOs versus consortia

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