



Intellectual property reform in the laboratory

Ismaël Benslimane, Paolo Crosetto, Raul Magni Berton, Simon Varaine

► To cite this version:

Ismaël Benslimane, Paolo Crosetto, Raul Magni Berton, Simon Varaine. Intellectual property reform in the laboratory. 2020. hal-02794343

HAL Id: hal-02794343

<https://hal.science/hal-02794343>

Preprint submitted on 5 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

GAEL

Grenoble Applied Economic Laboratory

Consumption – Energy - Innovation

Intellectual property reform in the laboratory

**Benslimane, Ismaël
Crosetto, Paolo
Magni-Berton, Raul
Varaine, Simon**

May, 2020

JEL codes: O34,D90,D72

<https://gael.univ-grenoble-alpes.fr/accueil-gael>

contact : agnes.vertier@inrae.fr



Intellectual property reform in the laboratory

Ismaël Benslimane^{a,*}, Paolo Crosetto^b, Raul Magni-Berton^c and Simon Varaine^d

^aUniv. Grenoble Alpes, IPhIG, 38000 Grenoble, France

^bUniv. Grenoble Alpes, INRAE, CNRS, Grenoble INP, GAEL, 38000 Grenoble, France

^cUniv. Grenoble Alpes, Sciences Po Grenoble, PACTE and LIEPP, 38000 Grenoble, France

^dUniv. Grenoble Alpes, Sciences Po Grenoble, PACTE, 38000 Grenoble, France

ARTICLE INFO

Keywords:

Intellectual Property, Patents, Institutional Reform, Vote, Laboratory experiment, Innovation policy, Real effort task, Creativity

JEL codes:

O34, D9, D72

ABSTRACT

This study attempts to experimentally capture the effects of democratic reform of intellectual property (IP) and measure how a vote "against IP" can disappoint the most talented innovators and reduce their creativity. Contrary to expectations, the results show that such a vote increases overall creativity. Actually, the most talented innovators do not vote in favor of IP. Rather, those who vote in favor of IP are those who benefit relatively more from royalties. Surprisingly, no correlation is found between these two populations: the IP in our experiment seems not to reward the best players, but the players choosing an 'autarkic' strategy of relying on their own creations and forego cross-fertilization with other players. These are not particularly brilliant players that opt for a rent-seeking strategy that maximises gains *from* the IP system *itself*. There are plausible arguments to argue that this result is at least partly valid in the real world, especially for complex and highly sequential innovations where it has been proven that patent trolls and anti-competitive strategies are important. These findings lead us not to recommend IP constitutional protections, because there are no major "tyranny from the majority" concerns.

1. Introduction


Institutional change is difficult – even when the change is known to be beneficial. Changing the institutions by which a society works is likely to generate short term disruption, increase transaction cost, cause errors and inefficiencies. Moreover, there might be losers – people that do not benefit from the change, at all or in the short run. These losers could reduce their contributions to society due to their grievances against the winners and their feeling of relative deprivation, thus limiting or erasing the benefits of the institutional change.

Reforms of intellectual property (IP) rights, and in particular patents, are a case in point. Despite a large debate, the net effect of intellectual property on innovation and welfare is unclear. It is hence even more unclear whether a reform would be beneficial. Already back in 1955, the U.S. Senate Judiciary Committee commissioned several reports from experts such as Vannevar Bush and Fritz Machlup, on the effects of the patent system and the need to reform it. After surveying 200 years of economic theory on the patent system, Machlup (1958) concluded :

No economist, on the basis of present knowledge, could possibly state with certainty that the patent system, as it now operates, confers a net benefit or a net loss upon society. [...] If one does not know whether a system 'as a whole' [...] is good or bad, the safest "policy conclusion" is to "muddle through" – either with it, if one has long lived with it, or without it, if one has lived without it. If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.

According to Machlup, in the 1950s we did not know enough about the advantages and disadvantages of the patent system to take the risks involved in its demise. Despite decades of research, Machlup's conclusion still stands – we do not know enough about the effects of the patent system to be able to suggest a clear reform path. In the meantime, the stakes involved in taking action have steadily increased. In Machlup's time, less than 150.000 patents were filed worldwide in a given year. This number has increased 20-fold to over 3 million in 2018. Given the size and impact of the IP system today, are IP abolitionist like Boldrin and Levine (2008a) or IP reformists like Bessen and Meurer (2008)

*Corresponding author

 Ismael.Benslimane@univ-grenoble-alpes.fr (I. Benslimane)

and Stiglitz (2008) playing with fire by suggesting that we should abolish or strongly reform IP rights? IP is now long established and has attained global reach. The disruption risk is hence greater. Economic agents accustomed to the IP system could be destabilized, demotivated and, in the worst case, not compensated by the path opened by IP reforms.

In this paper, we conduct a laboratory experiment to test Machlup's fear of eliminating a system such as intellectual property, which has existed for a long time and whose effects are still not clearly understood. We exploit the possibility to build counterfactual situations in the laboratory to investigate the effects of *endogenous institutional change* on innovative activity. We observe subjects' behavior in a sequential innovation setting as they transition from a default system with IP to a system without IP.

We adopt the experimental design of Crosetto (2010); Brüggemann et al. (2016) and create a sequential innovation setting in the laboratory by using a *Scrabble*-like word-creation task. Subjects invest in letters and can use them to create words that yield them a direct payoff as in *Scrabble*. Moreover, subjects can produce new words by extending other subjects' words, after the payment of a royalty to the original innovator. This design allows us to easily and intuitively build a sequential innovation setting in the laboratory, and to study institutional change by abolishing the royalties dues for extending other subjects' words. Moreover, this design was proven to yield *better* outcomes *without* intellectual property. This feature allows us to focus on how the institutional setting and details of the *transition* impact behavior and welfare even if we know that the change is for the better.

Within this setting, we focus on the political nature of the transition and its potential effects. We introduce a vote, and we manipulate the information subjects get about the outcomes of different intellectual property systems in a similar laboratory game.

First, we let subjects vote. In the *Vote* condition, subjects play once in a context with IP, and then face a vote to decide whether to abolish or keep IP in a second, unannounced round. The default policy is the abolition of IP; this can be overturned by an unanimous vote to keep IP in place. This default+veto voting rule allows us to maximise the observations in which we can study institutional change and, crucially, to create many losers whose behavior interests us the most.

Second, we provide subjects with information before voting about the results of the Brüggemann et al. (2016) paper. In that paper, playing a similar *Scrabble*-like game, groups with noIP consistently and sizeably outperformed groups with IP. The idea of conveying scientific information about the relative performance of the two systems mimics an information campaign that might accompany the institutional change.

As control, we run treatments where subjects are not allowed to vote and just play once in the context of IP and once, unannounced, without IP. Since there is no vote, subjects have no way to act upon any information we might give them. Still, to generate the cleanest possible counterfactual, in the off-chance that the information had a *direct* effect on play in the second period, this control is split between groups that receive information about the results of the Brüggemann et al. (2016) paper and groups that don't.

In a publicly pre-registered analysis plan (details on OSF: <https://osf.io/nzq4f>) we hypothesized that the democratic nature of the transition would paradoxically *lower* the beneficial impact of abolishing intellectual property.

Proving that one system is better than another doesn't tell us much about the effect of moving from one system to the other. The hallmark of public policy change is that subjects can compare different systems and, as a result, experience relative deprivation in adopting one system over another. Even if *in vitro* the after-reform system is shown to yield a positive impact on social welfare, a coalition of losers from the institutional change could try to block the change, and, upon losing the battle, adopt boycotting behavior that would make the switch not cost-effective. There is ample evidence, e.g. in ultimatum games, that people do pay an individual price to send a message, enforce a moral or social norm, or show their anger.

In the context of intellectual property in democratic societies that we study here, an institutional change towards the abolition of IP could occur following a democratic procedure (e.g. a general election), and innovators could feel victims of "tyranny from the majority" that want to expropriate them.

Assuming that the main losers of an IP ban are the more talented innovators, because they are those who benefit more from IP, we hypothesized that banning IP produces grievances among the most productive group, leading them to reduce their effort. We hence expected the beneficial effect of the abolition of noIP to be higher when players do not vote, and lower in presence of a vote.

We further hypothesized that providing information about the likely outcome of the policy change might ease the transition. Even losers would be less inclined to boycott the change if they know from a trusted external source that the transition will bring in net benefits. We hence expected the problem identified above to be less harsh in presence of information.

Testing these hypotheses has consequences on the procedure by which IP should be amended. When majority preferences oppose the preferences of the best innovators, the social welfare could be reduced. This is one of the arguments to constitutionalize IP so that the “procedures for change require a lengthy ratification process or something more than simple majority approval” (Anderson and Hill, 1988).

Results show that we were wrong.

We replicate – with a lower significance – the positive effect on innovation of abolishing IP found in Brüggemann et al. (2016). Removing IP is beneficial to all players, irrespective of their previous productivity and their status as losers or winners in the IP system. The few groups that unanimously voted to keep IP perform worse than groups having abandoned intellectual property.

However, contrary to our expectations, introducing a vote *increases* the positive effect of abolishing IP. This is due to an unexpected finding: the subjects voting to keep the IP system are not the most talented innovators, but those who have earned more from royalties. Surprisingly, no correlation is found between these two populations: in our experiment, the patent system seems not to reward the best players, but the players choosing an ‘autarkic’ strategy of relying on their own creations and forego cross-fertilization with other players. These are not particularly brilliant players that opt for a rent-seeking strategy that maximises gains *from* the IP system *itself*.

Actually, providing subjects with vote is not a threat for the best players because their preferences are not homogeneous, and if there is tendency on their vote, is to lean slightly more *against* IP. As a consequence, groups voting unanimously to keep the IP are more likely to be composed by rent-seekers without particular skills, and fare relatively worse. Providing information has a large effect on the likelihood of voting to abolish IP, but has no effect on innovation and welfare, further showing that the mechanism we hypothesized – good players being squeezed out of their profits and retaliating by reducing their effort – did not materialize.

It is important to note that the hypothesis that failed is so widespread as to border common sense. One of, if not *the*, main argument of the proposers of intellectual property rights, is that they provide incentives to innovators, and absent those incentives, we would see less innovations and be all worse off. But, at least in our experimental setting, intellectual property does not benefit the most productive innovators, but those agents that are best at gaming the incentive scheme that it provides. Given the large evidence on patent trolling, the large and growing profits of legal firms providing patent services, and the widespread practice, by key innovators, to opt for trade secrets rather than using the intellectual property system, there are plausible arguments to advocate that our result is at least partly valid in the real world.

2. Related literature

The Patent and Copyright Clause of the United States (U.S.) Constitution states that “[the U.S. Congress shall have power] To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries”. The U.S. Supreme Court specified in *Mazer vs. Stein*, 1954 that the U.S. intellectual property protection stems from its utility in providing incentives:

The economic philosophy behind the clause empowering Congress to grant patents and copyrights is the conviction that encouragement of individual effort by personal gain is the best way to advance public welfare through the talents of authors and inventors in ‘Science and useful Arts.’ (Mazer v. Stein, 1954)

But is this *conviction* backed by actual results? Whether patents and intellectual property in general increase public welfare is a debated and not obvious question. Patents solve a dynamic inefficiency – anticipating being copied and exploited in the future, innovators do not devote effort – by legally creating a static inefficiency – granting a temporary monopoly on the invention. Their impact on R&D, innovation, and overall welfare is hence theoretically unclear and depends on the exact assumptions of each model (see, for the case of sequential innovation Scotchmer, 1991; Green and Scotchmer, 1995; Moschini and Yerokhin, 2008).

Empirical studies that investigate how R&D investments responded to patent protection strengthening show no measurable increase in domestic R&D (Sakakibara and Branstetter, 1999; Qian, 2007) and Sweet and Eterovic (2019) show no effect of IP on productivity in either developing or industrialized countries. These null results could be spurious, though, as the empirical studies of the effects of patent law changes face several limitations. Patent law changes may affect domestic R&D through channels that are difficult to track. For instance, through changes in foreign competition, changes in foreign R&D investments of non-domestic firms who sell products to domestic consumers

and, as noted by Budish et al. (2016), because technologies are developed for a global market, country-specific patent law changes in “small” economies may be a relatively small source of variation in global R&D incentives.

Historical comparative analysis cannot help, since there is just one recorded case of a country having abolished IP rights – the Netherlands from 1869 to 1912 – and only one country that has industrialized in the absence of IP – Switzerland from 1850 to 1907 (Schiff, 2015).

There is a growing literature in experimental innovation economics (for a review, see Buccafusco and Sprigman, 2019). While the experiments vary widely in scope and context, most papers develop tasks that mimic innovation as a search over some large, multidimensional space unknown to the subjects but controlled by the experimenter. Most of these studies (Buchanan and Wilson, 2014; Buccafusco and Sprigman, 2010; Erat and Gneezy, 2016; Eckartz et al., 2012) do not find any effect of IP on innovation or creativity, and some even find negative effects compared to other incentive mechanisms (Meloso et al., 2009; Charness and Grieco, 2014). Brüggemann et al. (2016) find that intellectual property rights in a scrabble-like sequential game significantly decrease innovation, because the introduction of IP leads to more rudimentary innovations, as subjects do not exploit the most promising sequential innovation pathways.

As pointed out by Sampat (2018) “while many of the studies [on IP] are relevant for thinking about the effects of patents on average, the relevant policy discussions are often marginal [...]. More research on these types of changes could also be useful”. Our study falls within this field of research and is the first study to our knowledge that looks at the effects of radical IP *reform* in the laboratory. To our knowledge, the only experiment that has tried to test an endogenous effect on an IP default rule was Sprigman et al. (2013) who designed an experiment to determine whether subjects’ valuation of attribution was stable against changes in the default rule governing the availability of attribution of a creative work (in that case, a painting).

3. Experimental design

We implement a *Scrabble*-like word creation game in the lab. The design replicates most features of the one employed in Brüggemann et al. (2016). The game is played in groups of three players, who are randomly matched. They are assigned letters, and then take turns in creating simple (three-, four-, five-letters long) words – that generate a payoff as in Scrabble, roughly determined by the inverse of a letter’s absolute number in the set – or extend existing words by adding one and only one letter in any position. Extensions generate a similar Scrabble-like payoff, and all the letters of the words are counted – hence making extensions more profitable than simple words. This game repeats for ten periods. In presence of intellectual property, subjects are asked to assign a royalty fee to each of their creations. This royalty fee is paid to the word creator by any other player that might wish to extend the given word, and is bound between zero and the value of the original word. In absence of intellectual property, subjects do not pay any fee when extending other subjects’ words.

Subjects play this game twice, with the same anonymous group. Each phase lasts for ten periods, for a total of twenty periods. Subjects start in a baseline setting with IP, and then move to a second unannounced phase in which intellectual property has been abolished. Treatments impact the information subjects have at their disposal when transitioning and whether subjects get to veto the institutional change by unanimous vote or not.

In the remainder of this section, the game and treatments are described in detail, and the main theoretical properties of the design are detailed. The English translation of the original French instructions is available on Appendix A. Two videos showing live play from our software interface are available [here](#) and [here](#).

3.1. Experimental task details

Preliminary control task

Before starting the main task, we ran a control task to measure the subjects’ word-creation skills. The control task is built on Eckartz et al. (2012). All subjects are endowed with the same alphabetically ordered set of 9 letters (AMADITERS), and have 3 min to build as many words as possible, using only letters from the set which they can reuse as many times as they wish. The words must be at least 3 letters long.

Initialization stage

To jump-start the creation process, in both repetitions of the game, subjects start the game with an endowment of five randomly drawn letters and two pre-created words. These words are associated with royalty fees of 50%. That is, each player starts the game as if they had already made two words and for which they were charging 50% royalty fees. We chose royalty fees of 50% by default because this was the average value obtained in the first five periods

in Brüggemann et al. (2016) (exactly 49%) in the IP treatment. This allows to speed up the game and to offer equal extension possibilities to everyone at the beginning. In the real world this corresponds to the public domain from where you can pick and that you can extend. The pre-selected words have been carefully chosen to have the same value and a set of similar extension possibilities. The same 6 words for the first part were given randomly to the 3 players (2 for each) and the same 6 words were given for the second part, so all groups faced the same game board in each treatment. In other words, the initial endowment is the same for all groups – though it may vary across individuals.

Creation stage

Like in Brüggemann et al. (2016), subjects play in turns. When it is their turn, subjects can choose one among three possible actions:

1. produce a three- to five-letter word (*root*), for instance, if a subject owns the letters a, e, i, m, g, p she can create the roots *age*, *page* or *image*;
2. extend an existing word (*extension*). A subject is only allowed to extend an existing word with one additional letter, which can be placed in any position of the existing word. For example, *agent* can be extended to *agents* or *argent*;
3. pass without taking action.

Subjects cannot recreate an already existing word. All produced words yield a payoff equal to the sum of the letter values (token), 1 token converts to €0.25. When extending a word, not only the one letter added but rather all letters of the new word generate payoff. For instance, extending *agent* (worth $1 + 2 + 1 + 1 + 1 = 6$ tokens) into *argent* with the letter *r* – which itself is worth 1 token – results in a payoff of 7 tokens. This implements increasing returns in the experiment – whereby each subsequent innovation is *more* valuable than its components.¹

A word is accepted when it is included in the French *Official Scrabble Dictionary 2018* implemented in the game. All forbidden actions are dynamically indicated to the player. If the word created or extended does not exist in the Scrabble dictionary or has already been created by another player, a pop-up message warns the subject that can hence correct her action in real time.

All the words and extensions created by every group member appear on the common board, as in Scrabble. For each word, the board shows its value, the amount of royalty fees to be paid to extend it and/or that are received in case another player extends it. A screenshot of the board is given in Figure 1.

Intellectual property stage

After having created a root or an extension, subjects have to set a royalty fee. A royalty fee for a root refers to all the added letters. A royalty fee for an extension only refers to the marginal contribution by the player – the one added letter. Royalty fees range from 0% to 100% in steps of 10%. The chosen royalty fee becomes public information and is fixed for the rest of the game. However, no one can be excluded from using the word altogether. By choosing higher royalty fees, subjects earn more when their word creations are extended by other subjects. Nevertheless, at the group level, royalty fees are merely a mechanism to redistribute income within the group as there are no transaction costs.

For example, subject A produces *agent* – worth 6 tokens – and chooses a royalty fee of 50%. Every subject who extends *agent* pays A 3 tokens. Consider subject B extending *agent* into *argent*, which is worth 7 tokens: 3 tokens are transferred to subject A, subject B earns 4 tokens and has to set a royalty fee for the letter *r*, worth 1 token. If she chooses 20%, the next subject adding a letter to the word *argent* will have to pay 3 tokens to subject A and 0.2 token (20% of 1 token, namely the value of the letter *r*) to subject B.

When subjects are not at turn, the main board of the game is shown, so that players can follow the game, but not active.

Theoretical properties of the design

The modified Scrabble task transposes in the laboratory a sequential, cumulative innovation setting inspired by the model of Bessen and Meurer (2008). In particular, the game induces strict sequentiality, since each extension is created from an existing word by adding one and only one letter. This transposes the concept of innovation in the laboratory by letting subjects be creative within a familiar space that is vast but intuitively searchable. This models the effort needed to invent in a natural way: generating complex ideas requires both effort and the ability to stand on

¹While this assumption does not represent the structure of all industrial sectors, it is a faithful representation, for instance, of the software industry. See Brüggemann et al. (2016) for a discussion of this assumption.

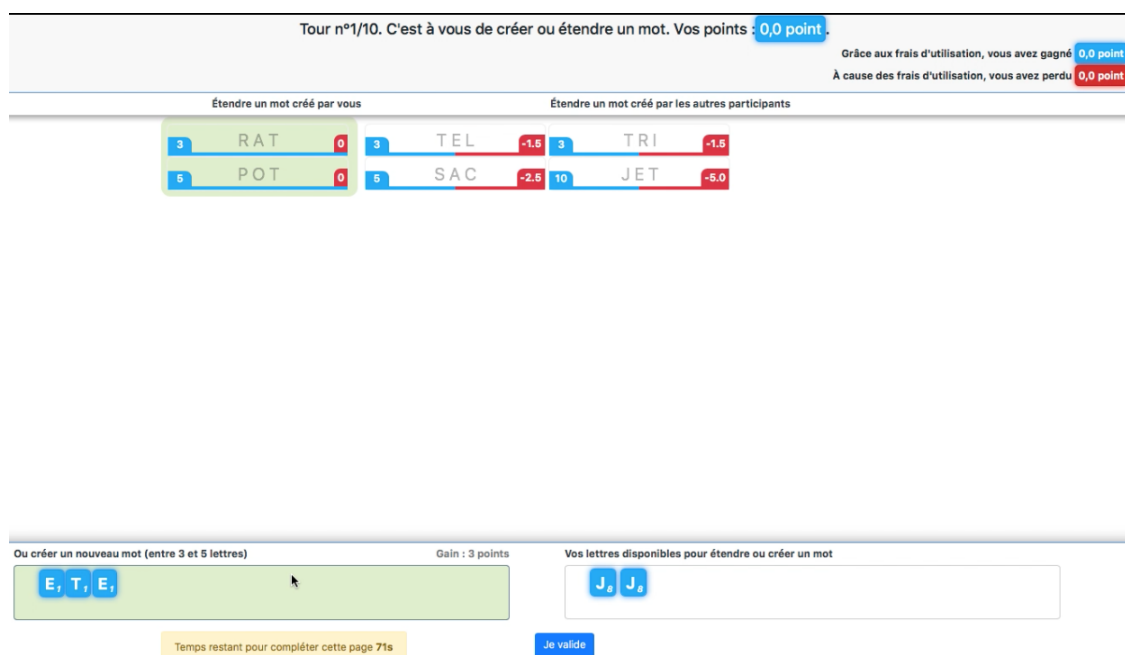


Figure 1: General view of the main board at the beginning of the game

the shoulders of giants. Moreover, the space is countable, as it resides totally within the chosen dictionary. We can compute the number and value of all possible extensions and have a precise and complete map of the innovation space facing our subjects. An extension is worth exactly its marginal contribution (the added letter) plus the value of the root it is using. *"This payoff structure best describes the situation of basic science – in which the first contributions lay down the foundations, allowing subsequent contributions to carry most of the value – or in the software industry – in which modern software technologies are built on thousands of algorithms, hardware, drivers, etc. that have been accumulated over the years."* (Brügemann et al., 2016).

3.2. Treatments

Treatments impact the *transition* from the first to the second repetition of the game, and focus on giving players the right to *veto* the institutional change through an unanimous vote and on the amount of information subjects have when voting.

First, we manipulate exogenously the presence or absence of vote. In the vote treatment, after the first part with IP, subjects are informed that they will have to vote to choose to stay in the condition where they can set royalty fees (IP regime) or vote to choose to abolish this rule, i.e. that there is no longer the possibility of setting royalty fees for the words created and all words are publicly available at no extra fee (noIP regime). It is a unanimous (veto) vote. The subjects will play a game with royalties if all the group participants vote to keep the royalties system. Otherwise, they will play a game without royalties. It only takes one person who supports the noIP for all 3 members of the group to play noIP. To have time to think, subjects have 20 seconds when they can't do anything before voting. The vote is anonymous and only the final result is known. At the end of the vote, subjects are informed whether they have won or lost the vote and in which IP regime the group is in the second part accordingly.

We choose a unanimous vote to maximize the number of losers (players who voted for IP but lost because of one or two players in the group that voted to abolish it) without manipulating the result. Besides, unanimous voting is natural enough not to raise suspicion. The vote procedure aims at implementing in the laboratory a democratic process where subject are forced to take a position and commit themselves to a clear choice. In addition, it simulates the disappointment that some would have if the abolition of IP were to result from a real political agenda. Most experiments rely on between-subjects designs, where each subjects experiences only one treatment. But policy changes in the real world never happen in a vacuum. Often people start off in a new environment by knowing the old environment, or people can experience only one system but know that another system is in place somewhere else. This frustration is

Treatment	Info	Vote	Participants	Groups
Control	No	No	75	25
Control with information	Yes	No	75	25
Vote without information	No	Yes	150	50
Vote with information	Yes	Yes	165	55
All			465	155

Table 1

Distribution of the subjects and groups across treatments.

illustrated, for instance, by the ultimatum game (Güth et al., 1982; Thaler, 1988) in which the difference between what subjects expect and what they get may lead individuals to retaliate against those that voted against their interest, even if this retaliation is costly. In our case, this could lead the losers to exert less effort when there are forced by the result of the vote to play in a regime without the intellectual property they favored.

Second, we manipulate the information given to the subjects after the first part. In the information treatment we inform just after the end of the first part that a previous experiment (Brüggemann et al., 2016) show that the noIP regime significantly increases the total gain of players (see instruction in appendix A).

The degree of information provided to a voter has a significant impact on the final choice (Luskin et al., 2002). With this treatment we want to simulate the effect of an informed vote versus a naive vote on the acceptance of the result of the vote by the losers. We can be disappointed for the wrong reasons, such as thinking that others voted against us, for their own selfish interest. But if the result of the vote follows the recommendations of experts who provide evidence that the vote serves the common good then disappointment should be lower.

We implement as control treatments a situation with no vote, with or without the information. A breakdown of subjects by treatment is given in Table 1.

3.3. Experimental procedures

Experiments were conducted in the GAEL experimental laboratory (Grenoble, France). The experimental software was written in python using the oTree framework (Chen et al., 2016). The source code is available [here](#). We recruited 465 participants from the GAEL subject pool, made in roughly equal parts by students and subjects issued from the general population. Subjects were allocated to 155 groups of 3 players. Instructions were read aloud and projected overhead. Clarification questions were answered collectively. Participants received a 10€ show-up fee, which was not at stake during the game. After the end of the experiment described in this paper the subjects proceeded for an unrelated second experiment. Gains from the current experiment were used as an endowment for the second experiment, whose aims and results are described in Varaine et al. (2019). Participants knew when playing the word task that a second experiment would take place, but were given no other detail. After that second experiment and after being notified their final payoff, participants were asked to complete a short questionnaire, including socio-demographic questions - age, gender, level of education and professional status. We also included two questions about whether participants found themselves and the other players cooperative during the game.

Participants were on average 26 years old (st.dev; 10.2) and 58.5% were female. Sessions lasted around 90 min. The 465 participants earned 22.8€ on average including a 10€ show-up fee, with a minimum payoff of 14.5€ and a maximum of 34.6€.

4. Results

4.1. Effects of abolishing intellectual property

Given our focus on the effects of the transition to a noIP regime for society as a whole, all the results we report in this section are generated from group-level data. Each group provides two observations, one per repetition. All results are robust to focusing on individual-level data.

Despite the differences in the details of our design (within- vs. between-subjects design, 3 vs. 4 group size, 10 vs. 25 period, French vs. German language, starting endowment of words, ...), we replicate the main result of Brüggemann et al. (2016): the transition from a regime with intellectual property to a regime without intellectual property has a positive effect on innovation.

	Points	
	All groups	Control only
Repetition 1	131.27 *** (10.04)	130.86 *** (9.96)
Kept IP	-4.11 (7.89)	
Transition to noIP	22.05 ** (7.92)	9.36 ° (5.53)
Word skills	0.58 *** (0.14)	0.64 * (0.26)
N	310	100
R2	0.16	0.08
logLik	-1438.54	-472.28
AIC	2887.08	952.57

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ° $p < 0.1$.

Table 2

OLS estimates of group points by repetition, IP transition, and vote treatment

The 11 groups playing twice under IP show a small and not significant improvement in the second period compared to the first (+6.73 points, +5.04%, t-test p-value = 0.553, cohen's $d = 0.27$), while the 144 groups experimenting the transition to a noIP setting, with or without voting, show a large and significant increase (+17.1 points, +11.6%, t-test p-value < 0.001, cohen's $d = 0.66$).

The above result though mixes together groups that transitioned to noIP by fiat and others that did so after a vote. The result might hence be confounded by selection effects. A cleaner test of the hypothesis is to restrict attention only to groups that did not go through a vote and had no possibility to veto the transition. Restricting the sample to the 50 groups in the no-vote control treatment (with and without information), there is a weakly significant positive effect (+9.36 points, + 6.1%, t-test p-value 0.0843, cohen's $d = 0.33$)

The effect survives when controlling for the average skills in the preliminary word task of the players of each group, with the same pattern: strong and highly significant for the whole data, and weakly significant for the control only. Results of a difference-in-differences OLS estimate of the group total points across repetition and IP regime are reported in Table 2, where the first column reports all groups and the second the control groups not having voted only.

These results hold true at the individual level. Transitioning to noIP significantly increases by 11.58% the individual earnings from 49.2 to 54.9 (+ 5.7 points, t-test p-value < 0.001), while sticking to IP results in a small 5.03% increase from 44.5 to 46.7 points (+2.24 points, t-test p-value = 0.598).

We hence replicate the general result of Brüggemann et al. (2016) of a positive effect of removing IP in a sequential innovation setting. Our results are overall weaker. This might be due to the way shorter length of the game (10 periods here, 25 in Brüggemann et al. (2016)) and to a different language (here French, there German), both factors limiting the sequences that could be generated by the players and hence the positive effect of the absence of IP on long sequences of innovations.

4.2. Effects of voting and information on the transition

In our pre-registered analysis plan, we argued that the democratic nature of the transition would reduce the positive effect of transitioning to noIP. We hypothesized that losers of the vote would feel acrimony towards the vote having deprived them of royalty income, and react by reducing their efforts. This was just a dynamic version of the standard arguments in defense of IP: remove incentives to innovators, and they would exert lower effort.

Our hypothesis is not supported by the data. Actually, the results show the opposite pattern: voting has a *strongly positive* effect on the transition to noIP. To test this hypothesis, we compare the points accumulated by groups having transitioned to noIP without a vote – i.e. all groups in the control treatments, irrespective of the amount of information

	Transition gains	
	Group data	Individual data
No vote	5.48 (10.89)	2.66 (2.59)
Vote	12.16 * (6.10)	3.99 * (2.02)
Word skills	0.11 (0.27)	0.01 (0.06)
N	144	432
R ²	0.03	0.01
logLik	-713.09	-1903.90
AIC	1434.18	3815.79

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ° $p < 0.1$.

Table 3

OLS estimate of transition gains for groups transitioning to noIP, by voting condition

received – to those groups having transitioned to noIP after a vote. We hence compare 50 groups in the controls to 94 groups in the vote condition, irrespective of information received.

After a vote, groups transitioning to noIP significantly and substantially increase their points (+21.23 points, +14.7%, t-test p -value < 0.001 , cohen's $d = 0.87$). This increase is weakly significantly different from the increase in the control treatments (t-test, p -value = 0.0625). This difference reaches traditional levels of significance when controlling for group word creation skills, as done in Table 3, left column, that reports results of a regression of the difference in group points across repetition by vote treatment, controlling by group skills.²

This result is robust to running the same tests at the individual level. Players in the non-voting control treatment increase their score by 3.12 points, while subjects in the voting condition by 7.08 points. This difference is weakly significant in a direct test (t-test, p -value = 0.0566) and significant once controlling for skills (see Table 3, right column).

Overall, our pre-registered hypothesis was at odds with our results. This result makes a test of the effect of information on the behavior of the losers of the vote irrelevant, and we hence skip altogether the discussion of our pre-registered Hypothesis 3. Since information did have a negligible impact overall, in the remainder of the paper we pool together the two information treatments, signaling results only when they do (slightly at best) differ.

4.3. Determinants of the vote and the transition to noIP

Why did our hypothesis on the effects of voting fail? We argued that the best players would vote to keep IP, lose the vote, and react by reducing effort. This did not happen. To understand what happened, we venture here out of the pre-registered plan and investigate individual voting determinants and their correlation with performance.

Let us start with a few descriptive statistics about voting. Without information, a slight majority of subjects voted to keep IP (52%). Once given information about the results of Brüggemann et al. (2016), the majority favored a transition to noIP (64.8%). This difference is significant (Fisher exact test, p -value < 0.001).

Given that unanimity was needed to keep IP, the vote resulted in quite a number of losers – subjects voting to keep IP but being forced against their will into a game without IP. In groups without information there were 60 losers (out of 150 players) 20 groups had two losers and 20 had one; among groups with information, the number of losers decreased to 43 (out of 165), and 27 groups had one and 8 groups had two.

The reasoning behind Hypothesis 2 was simple. We assumed that subjects' performance would be a function of skills and incentives. This means that under IP the best players get to be rewarded for their production through royalties, hence exert high effort, resulting in increased productivity. The best players are the ones earning most royalties, and

²The regression here is carried out directly on the difference between the two repetitions rather than in diff-in-diff to make for a clearer reading.

hence will be the ones voting against the transition to noIP. They are consequently the subjects most likely to lose the vote, and feel robbed of a legitimate source of income. If they react by shirking, the overall performance will suffer.

This argument can be split in a chain of hypotheses that can be tested with our data, in order to shed light on why H2 failed. In particular, we will test whether a) skills in word creation correlate with output in the game; b) skills in word creation correlate with royalties earned; and c) royalties earned correlate with the likelihood of voting to keep the IP system in place.

We hypothesized that skills would correlate with performance and to royalty earnings. That is, that the best players would end up performing better and also being the winners of the IP system. This is indeed one of the reasons that proposers and defender of IP put forth to support the existing system.

We measure skills with the results of the preliminary word-hunt task. This measure of skills is fully exogenous, as subjects were not aware, when completing this task, of what they would be asked to do in the rest of the experiment.³

As expected, skills correlate significantly with the output (including net royalty gains) in the first repetition of the game ($r = 0.255$, $p.value < 0.001$), in the second repetition with noIP ($r = 0.362$, $p.value = 0.038$) and also when sticking to IP ($r = 0.245$, $p.value < 0.001$).

On the other hand, word-creation skills do not correlate with net royalty gains – the amount received thanks to royalties on created words minus the amount paid to access other participants' words. The correlation for the first repetition is small, negative in sign, and not significantly different from zero ($r = -0.05$, $p.value = 0.279$).

Turning to voting behavior, skills show a weakly significant *negative* relation with voting for IP. IP-voters had a mean skill of 107.99 points, while noIP-voters had a mean of 119.89 (t-test, $p.value = 0.073$, cohen's $d = 0.205$). Net royalty gains show instead a strong, significant and *positive* relation with voting to keep IP in place. IP-voters had on average a net royalty balance of 3.77 points – meaning that they got more royalties than they spent, while noIP-voters had a negative net royalty balance of -2.86 points (t-test, $p.value < 0.001$, cohen's $d = -0.75$).

The unexpected result of this analysis of the vote is hence that the best players did not tend to lean to keep the IP system in place. Rather, the players having benefited from the IP system did vote to defend it, and those were not the best players.

Yet, not only skills can affect the individual impact of an IP system. In our game there are at least four main drivers of net royalty earnings: skills, luck, greed and royalty aversion. High-skilled players can create complex and valuable words, and hence gain royalties on them. Lucky players can rip the benefits of a better initial set of letters: not all letters have the same potential, and the set of letters was randomly drawn for each individual. Greedy players can set high royalty fees on their words, hence potentially getting a larger stream of inbound royalties. Finally, if players are averse to spend on royalties, they can avoid extending other players' words and hence reduce the outbound royalties.

To make the analysis as easy to follow as possible, we create four variables spanning the same domain, one for each of the above-mentioned drivers of individual behavior.

For skills, we take the raw number of points generated in the preliminary word-creation task and rescale it so that the best player has a score of 100.

We measure luck as the potential number of points that could be generated in period 1 for each player. To do so, we generate all possible words and extensions that a player could create given the available words and the allotted letter endowment at the start of the game, compute the value of each one of them, and take the mean. This number indicates the raw potential at the starting block for each player, irrespective of skills. It does show enough variance to in principle bite on the performance in the rest of the game (mean 4.81 points, variance 1.07) – that is, despite our best effort in leveling the playing field, you could in our game get a lucky start. We take this indicator and rescale it so that the luckiest player has a score of 100.

We measure greed as the mean share of royalty fees asked by each participant for each of their contributions. This number spans from 0 to 100.

We measure royalty aversion as the complement to 100 of the mean royalty fee accepted by each participant for extensions. Suppose a participant extended only words originated from herself. She did not pay any royalty fee, so her royalty aversion is 100. Suppose instead a participant paid 50% royalties on one extension and 70% on a second one, nothing on a third one. Her mean paid royalty is of 40% and her royalty aversion is 60. This number spans from 0 to 100.

To shed light on the three steps of our argument above, we run OLS regressions of the points earned, the royalties received and spent and their balance using the four indicators described above, restricting attention to the first repetition

³Results are robust to using an endogenous measure of skills, i.e. the performance of each subject relative to the potential choices he could make at any point in time.

Intellectual property reform in the laboratory

	Points OLS	Royalties OUT	Royalties IN	Royalties BALANCE	Vote for IP	Vote for IP
constant	-10.214 (6.498)	36.003 *** (1.728)	-2.219 (3.047)	-38.222 *** (3.778)	0.117 (0.260)	-0.001 (0.764)
skill	0.207 *** (0.045)	0.041 *** (0.012)	-0.023 (0.021)	-0.063 * (0.026)		-0.005 (0.005)
luck	0.340 *** (0.078)	0.008 (0.021)	0.066 ° (0.036)	0.057 (0.045)		0.008 (0.008)
greed	0.070 ° (0.039)	0.018 ° (0.010)	0.036 ° (0.018)	0.018 (0.023)		0.008 ° (0.004)
royalty aversion	0.405 *** (0.061)	-0.378 *** (0.016)	0.075 ** (0.029)	0.453 *** (0.036)		-0.005 (0.008)
points					-0.006 (0.005)	-0.006 (0.006)
royalty balance					0.056 *** (0.009)	0.060 *** (0.011)
N	314	314	314	314	315	314
R2	0.230	0.642	0.044	0.352		
logLik	-1249.670	-833.689	-1011.865	-1079.350	-193.998	-189.651
AIC	2511.340	1679.378	2035.729	2170.699	393.997	393.303

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ° $p < 0.1$.

Table 4
Determinants of performance, royalty balance and voting

of the game, where subjects played under IP. Since all four variables span from 0 to 100, the coefficients can be easily interpreted as the impact that increasing the variable by 1/100 would have on the dependent variable. Results are shown in Table 4, columns 1 to 4.

The first column shows the impact of these four characteristics on the performance in the game, as measured by the number of points. Skills and luck contribute positively to success, which is intuitive. Royalty aversion has a similar positive role, because it reduces outbound royalties. Overall, hence, our predictors all contribute in the hypothesized direction to success in the game.

The second, third and fourth columns show the impact on royalty indicators (outbound, inbound, and balance). Signs go in the expected direction for greed (slightly increasing inbound royalties) and royalty aversion (mightily decreasing outbound royalties). We see no effect of luck across the board, and, surprisingly, no effect of skills. If at all, skills *increase* the *outbound* royalties. Overall, this means that the winners of the royalty system are not the best players, but the more 'autarkic' ones, those that restrict their attention to their own words only.

To shed light on the determinants of the vote, we gather all we have learned from the above analysis and we run a probit regression of voting for IP (Table 4, last two columns). First, we assess only the role of points – i.e., of bare performance – and of royalty balance – i.e., of performance at exploiting the IP system, dropping all other potential

drivers. Results clearly show that the royalty balance is strongly correlated with voting to keep the IP system, while performance is not. Then (last column) we add our individual controls – skills, luck, greed and royalty aversion. Again, the only strong predictor of voting for IP is to receive a net benefit from the IP system.

Our results show that while skilled players produce more points in the game, and royalties earned predict voting patterns, skills in the game do not predict royalty earnings. The redistribution given by royalties is surprisingly orthogonal to the players' output, and is even *negatively* correlated with skills in the game. Hence, subjects voting to keep IP in place and possibly grieving their loss were not the best players. The success in royalties is best predicted only by *royalty aversion*, an index capturing the tendency of a subject *not to pay* royalties and rely on own words instead.

The IP system does not benefit the best players, but the ones extracting a rent from the system. This explains both the failure of our pre-registered hypothesis and the dire performance of the groups having stuck with IP in repetition 2. Best players were not among the losers of the vote, not having a particular predilection for IP; and ending up in an IP group after the vote was a sign of adverse selection going on, as it meant ending up in a group of rent-seekers bent on reducing royalty expenditure at all cost.

Overall, we see that the IP system in our experiment does not reward the skills of the players, but is linked only with royalty aversion. As a consequence in our experiments the participants benefiting from the IP system and hence voting to keep it in place are the ones *contributing relatively less* to overall creativity. It is no surprise then that in period 2, those groups keeping IP underperformed relative to the noIP group. While these results could be artefactual to our game, we feel that they could also serve as a truthful description of the IP system in the real world.

5. Discussion

We expected that losing the vote would reduce innovators' motivation to create, but this was not the case. We highlight in the result section above that this is because the losers of the vote are not the most creative players. But there is also at least another competitive explanation: intrinsic motivation. The Scrabble-like task can be quite fun to play, and this might crowd out grievances, pushing even the disappointed losers to exert effort. To the extent that the act of inventing requires also more laborious and tedious tasks than in our study, the external validity of our findings will be somewhat limited.

We have reason to think that an intrinsically motivating task could be a good representation of several innovative sectors. Inventors often cite intrinsic motivations as their main driver. The *Time Invention Poll in Cooperation with Qualcomm* (2013), with 10,197 respondents worldwide, showed that "*the love of inventing*" is the main reason respondents give when asked "*What do you think mainly motivates people to invent?*" (but with great differences between countries, e.g. 38% in U.S., 65% in China, 34% in Germany, 53% in UK)⁴. Using survey data for over 2,000 academic scientists and engineers, Sauermann et al. (2010) found significant relationships between researchers motives and their patenting activities. Pecuniary motives predict patenting in the physical sciences, but the desire to contribute to society is the key motive predicting patenting in the life sciences. In engineering, patenting is predicted by the motives of challenge and advancement. While 74.5% of researchers rated "*applicability of research*" as highly important, only 11.1% rated "*seeking IP rights*" similarly.

Because of all these results, the fact that our Scrabble-like design game is fun is not a weakness, insofar as it can reproduce intrinsic motivations that are largely present in innovative sectors. However, it is true that the stakes are much higher in the real world and that the role played by intrinsic motivation differs widely between technology sectors. Thus, our experience can translate well the grievances that may occur in one sector and poorly those in another. For instance, the risk of stifling innovation with the abolition of IP could be high in technological areas where R&D investments are huge but copying costs are quite low (e.g. pharmaceuticals) while in the field of computer or web technologies this is much less the case. In future research it would be interesting to couple the innovative nature of the Scrabble-like game with a more tedious, real-effort task, to produce a stronger sense of grievance.

We wanted to test Machlup's point that institutional change in intellectual property might be costly, and we focused on what we thought was a likely backlash from the best innovators being deprived of their royalties by the reform. Our hypothesis felt natural and it is the one made by most if not all supporters of intellectual property: touch it, and we will lose genius inventors. Our results show instead that the best innovators are not the players who earned more royalties. This is because the best players do earn a lot royalties, but also spend a lot in royalties to others. This nullifies the beneficial effect of their creativity in an intellectual property regime. In our experiment, players focusing on gaming the system – collecting royalties while carefully avoiding paying them – are the only net winners of the system. Does

⁴The other items are: Social good, Making money, Necessity, Fame

this reflect reality? We think so. For publicly-traded United States firms, Bessen et al. (2018) found that private costs had exceeded private rents since 1999-2000 and that the trend in costs was sharply higher due to a surge in the number of patent trolls, which contributed to the increase in the gap. The huge costs of competing can be a disincentive to innovation in an area where the entry ticket is very high (Shapiro, 2000; Lemley and Shapiro, 2006). Torrisi et al. (2016) showed that 67% of patent applications were filed to block other patents. These studies show that patents are mainly used strategically to block competitors and not as a financial reward for an invention. Moreover, they found that most patents (38% in Europe, 36% in the U.S. and 46% in Japan) are never used, only about 6 patents every 100 are licensed, and only 4 out of a 100 sold. As in our game, inventors do not seem to be the most apt at commercializing their intellectual property and benefit from royalties, but rather keep it for themselves and try to avoid paying royalties to others.

Aghion et al. (2018) recently evaluated the wage spinoffs in Finnish companies for the period 1988-2012 when filing patents. They found that inventors received only 8% of the total private return, the rest was shared by entrepreneurs (44%), blue-collar (26%) and white-collar (22%). Inventors earned on average a wage premium of 5% post invention. Bell et al. (2017) showed that a patent application marks the peak of a successful career in innovation rather than an event producing high returns itself. Five years after a patent is granted, patent royalties account for less than 3% of income even for inventors with highly cited patents. The authors also found that an inventor's salary was little related to granting a patent, except for the top 5% of patents cited. So it seems that our game reproduces the real balance in which innovators do not obtain as much positive profits on average from royalties.

In our game the best players, who are not the ones who earn the most royalties, do not grant particular support to the patent system when voting. Is this the case in the real world? It seems so, insofar as the role played by the formal patent system is minor for inventors. Wajzman and García-Valero (2017), based on data from the Eurostat Community Innovation Survey 2012, found that trade secrets are used by 52.3% of innovative companies and patents only by 31.7% of them. This number is much higher for large companies: 69.1% use trade secrets and 52.8% use patents, compared to 51.2% and 30.4%, respectively, for SMEs. They conclude that the use of trade secrecy to protect innovation is more important than the use of patents, especially among small SMEs. Levine and Sichelman (2018) show that is also the case for startups.

For many companies, being the first to bring a product to the market and benefiting from that competitive advantage is better than patenting. This is the main idea behind the *competitive rent* models of Boldrin and Levine (2008b). As simply expressed by Leiponen and Byma (2009) : "If you cannot block, you better run". In addition to the first-mover incentive, there is also a wide range of market incentives (market segmentation, speed of technological change, complementary sales, service and manufacturing capabilities, knowledge imperfections, transactions cost, learning and switching costs and network effects), social norms and psychological factors that can explain "Intellectual Production without Intellectual Property" (Dreyfuss, 2010).

The literature on "negative space" – creative and innovative fields that, for historical, doctrinal, or other reasons, are not addressed by IP law (Raustiala and Sprigman, 2006) – is directly confronted with the widely held belief that copy protection is necessary for innovation incentive. Boldrin and Levine (2013) and Raustiala and Sprigman (2012) argue that in many industries, the first-mover advantage and the competitive rents it induces are substantial without patents. The indirect incentives found in the open-source movement are a typical example (Lerner and Tirole, 2005). Research on intrinsic and extrinsic motivations (Benabou and Tirole, 2003) may also suggest that many managerial and institutional solutions are possible to compensate for the incentive deficit that would result from the removal of temporary monopoly on inventions.

However, it should be noted that some technological areas would probably suffer more than others from the removal of IP rights. Particularly, the pharmaceutical and biotech industry would be strongly impacted (Sampat, 2018). Graham et al. (2009) asked through a large survey how important (or unimportant) the following seven items were to companies in securing competitive advantages from their technology innovations: first-mover advantage over competitors; secrecy; patents; copyrights; trademarks; difficulty of reverse engineering; and other production, implementation, or marketing capabilities. For medical device startups and venture-backed IT hardware companies, respondents ranked patenting second, behind "first-mover advantage" but for biotechnology, patenting was ranked as the most important means of capturing competitive advantage.

6. Conclusion

In this paper we focused on institutional change in the realm of intellectual property rights. By means of a Scrabble-like game we recreated in the lab a sequential innovation setting and investigated the role of vote and information on the transition from a setting with IP to one in which IP have been abolished. We found that, contrary to our expectations, the most creative players do not have a particularly tendency to vote to defend IP; rather, the subjects overwhelmingly voting to keep IP in place are those extracting a rent from the IP system. While not surprising *per se*, this finding is at odds with the traditional arguments put forth to keep IP in place, that all assume that the system obviously benefits the best innovators. This is not the case in our experiment.

This result is in line with the literature showing that patents are not the preferred incentive or protection system for innovators, except in pharmaceutical industries (Sampat, 2018). In our experiment, those who vote to keep the IP system in place are on average less skilled than those who vote to abolish it. According to the *Time Invention Poll*, it is likely that the same would happen in the real world: support for the patent system is widespread in the population, while at the same time the system is shunned, rarely used, and not really valued by many inventors. Among the general population worldwide, about 90% of the 10,197 respondents think that "patent protection promotes creativity and invention" and the same proportion think that "Patent systems are necessary to promote new invention and to guarantee that the inventor is given credit both intellectually and economically for his/her inventions". Only 10% think that it "hurts" creativity and invention, and similarly, in another question, 10% think that "Patent systems are harmful because inventors are worried about being accused of infringing on the patents of others".

This mismatch between popular support and actual use may explain why a patent system is maintained without strong proof of its benefits. Citizens only perceive some benefits (final products from motivated inventors) without the hidden costs paid by inventors. In addition, those who extract rents from the current IP protection system sometimes enjoy significant lobbying power. As an example, it is very well documented that Disney lobbied hard multiple times to extend the term of exclusivity offered by copyright when Mickey Mouse was about to enter the public domain (Landes and Posner, 2003).

As much as we believe in our results, we do not venture to provide direct policy advice. Motivational aspects are complex and it is impossible to distill from our clean counterfactual laboratory data simple rules that would allow us to dictate an incentive policy regarding creativity. A great deal of research has studied monetary incentives in general on creativity (Kaufman and Sternberg, 2019). But these studies provide mixed results, some finding positive effects (Eisenberger and Rhoades, 2001; Eisenberger and Shanock, 2003), others finding positive effects only on certain aspects such as quantity and quality but not originality (Charness and Grieco, 2014; Laske and Schroeder, 2017), others finding no particular effect (Eckartz et al., 2012) and still others finding negative effects of incentives (Ariely et al., 2009; Erat and Gneezy, 2016).

However, some general message can be distilled from our paper. First, we do not take a stance for or against IP. We do provide arguments against the idea that institutional change is, in itself, detrimental. Contrary to what Fritz Machlup put forward, reforming IP, in itself, is not costly neither for innovators, nor for the overall welfare. Democratically abolishing IP – at least in some specific areas – has a detrimental impact limited to rent-seekers who maximize gains from the IP system itself. Unlike innovators, rent-seekers are over-represented among people who vote in favor of IP. When they share the same market, they strongly contribute to make IP ineffective. For this reason, we do not recommend to constitutionally protect IP against a popular vote. Past scholarship has mainly defended IP constitutional protections against interest groups who over-represented rent-seekers' preferences (Nard and Morriss, 2006). However, these provisions generally produce qualified majorities that favor conservative minorities. These minorities – in the case of IP – are mostly made up of rent-seeking users of IP. Constitutional provisions are therefore likely to produce inefficiency.

The second recommendation that we can draw from our results is the need to focus on the most creative people. IP may be surprisingly badly designed for creative people, who seem not to benefit from the system much neither in our experiment nor in the real world. On the other hand, again both in our experiment and in the real world, the IP system seems to reward strategic, autarkic agents that can benefit from its existence. A reform would in this sense be welcome. Possibilities include making patent examination more stringent, to ensure that only patents that are valuable are granted, and more generally to reform IP to avoid patent trolls as much as possible. But there is a debate as to whether it is worth spending more money to encourage the patent office to put more effort on examination (Lemley, 2000; Frakes and Wasserman, 2019). Another way is to implement a mechanism that reduces the risk of "submarine torpedoes" as Boldrin and Levine (2008a) call it, that is, the fear of being attacked by an unsuspected patent-holder.

Increasing the use of compulsory licences or allowing independent invention claims could help in this case (Gallini and Scotchmer, 2002). Finally, more ambitious measures such as the Patent buyouts mechanism imagined by Kremer (1998) could also help create an IP system that, as advertised as highly as by the U.S. Constitution, exists to serve innovators and "*To promote the Progress of Science and useful Arts*".

Acknowledgment

Financial support from INNOVACS is gratefully acknowledged.

References

- Aghion, P., Akcigit, U., Hyttinen, A., Toivanen, O., 2018. On the returns to invention within firms: Evidence from finland, in: AEA Papers and Proceedings, pp. 208–12.
- Anderson, T., Hill, P.J., 1988. Constitutional constraints, entrepreneurship and the evolution of property rights. JD Gwartney and RE Wagner (1988), Public choice and constitutional economics , 207–208.
- Ariely, D., Gneezy, U., Loewenstein, G., Mazar, N., 2009. Large stakes and big mistakes. The Review of Economic Studies 76, 451–469.
- Bell, A., Chetty, R., Jaravel, X., Petkova, N., Van Reenen, J., 2017. Cep discussion paper no 1519 december 2017 who becomes an inventor in america? the importance of exposure to innovation .
- Benabou, R., Tirole, J., 2003. Intrinsic and extrinsic motivation. The review of economic studies 70, 489–520.
- Bessen, J., Meurer, M.J., 2008. Patent failure: How judges, bureaucrats, and lawyers put innovators at risk. Princeton University Press.
- Bessen, J., Neuhäusler, P., Turner, J.L., Williams, J., 2018. Trends in private patent costs and rents for publicly-traded united states firms. International Review of Law and Economics 56, 53–69.
- Boldrin, M., Levine, D.K., 2008a. Against intellectual monopoly. Cambridge University Press Cambridge.
- Boldrin, M., Levine, D.K., 2008b. Perfectly competitive innovation. Journal of Monetary Economics 55, 435–453.
- Boldrin, M., Levine, D.K., 2013. The case against patents. Journal of Economic Perspectives 27, 3–22.
- Brüggemann, J., Crosetto, P., Meub, L., Bizer, K., 2016. Intellectual property rights hinder sequential innovation. experimental evidence. Research Policy 45, 2054–2068.
- Buccafusco, C., Sprigman, C., 2010. Valuing intellectual property: an experiment. Cornell L. Rev. 96, 1.
- Buccafusco, C., Sprigman, C.J., 2019. Experiments in intellectual property, in: Research Handbook on the Economics of Intellectual Property Law. Edward Elgar Publishing.
- Buchanan, J.A., Wilson, B.J., 2014. An experiment on protecting intellectual property. Experimental Economics 17, 691–716.
- Budish, E., Roin, B.N., Williams, H., 2016. Patents and research investments: Assessing the empirical evidence. American Economic Review 106, 183–87.
- Charness, G., Grieco, D., 2014. Creativity and financial incentives. University of California, Santa Barbara, Working Paper .
- Chen, D.L., Schonger, M., Wickens, C., 2016. otree—an open-source platform for laboratory, online, and field experiments. Journal of Behavioral and Experimental Finance 9, 88–97.
- Crosetto, P., 2010. To patent or not to patent: A pilot experiment on incentives to copyright in a sequential innovation setting, in: IFIP International Conference on Open Source Systems, Springer. pp. 53–72.
- Dreyfuss, R.C., 2010. Does ip need ip-accommodating intellectual production outside the intellectual property paradigm. Cardozo L. Rev. 31, 1437.
- Eckartz, K., Kirchkamp, O., Schunk, D., 2012. How do incentives affect creativity? .
- Eisenberger, R., Rhoades, L., 2001. Incremental effects of reward on creativity. Journal of personality and social psychology 81, 728.
- Eisenberger, R., Shanock, L., 2003. Rewards, intrinsic motivation, and creativity: A case study of conceptual and methodological isolation. Creativity Research Journal 15, 121–130.
- Erat, S., Gneezy, U., 2016. Incentives for creativity. Experimental Economics 19, 269–280.
- Frakes, M.D., Wasserman, M.F., 2019. Irrational ignorance at the patent office. Vand. L. Rev. 72, 975.
- Gallini, N., Scotchmer, S., 2002. Intellectual property: when is it the best incentive system? Innovation policy and the economy 2, 51–77.
- Graham, S.J., Merges, R.P., Samuelson, P., Sichelman, T., 2009. High technology entrepreneurs and the patent system: Results of the 2008 berkeley patent survey. Berkeley Technology Law Journal 24, 1255.
- Green, J.R., Scotchmer, S., 1995. On the division of profit in sequential innovation. The RAND Journal of Economics , 20–33.
- Güth, W., Schmittberger, R., Schwarze, B., 1982. An experimental analysis of ultimatum bargaining. Journal of economic behavior & organization 3, 367–388.
- Kaufman, J.C., Sternberg, R.J., 2019. The Cambridge Handbook of Creativity. Cambridge University Press.
- Kremer, M., 1998. Patent buyouts: A mechanism for encouraging innovation. The Quarterly Journal of Economics 113, 1137–1167.
- Landes, W.M., Posner, R.A., 2003. Indefinitely renewable copyright. The University of Chicago Law Review 70, 471–518.
- Laske, K., Schroeder, M., 2017. Quantity, quality and originality: The effects of incentives on creativity .
- Leiponen, A., Byma, J., 2009. If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies. Research Policy 38, 1478–1488.
- Lemley, M.A., 2000. Rational ignorance at the patent office. Nw. UL Rev. 95, 1495.
- Lemley, M.A., Shapiro, C., 2006. Patent holdup and royalty stacking. Tex. L. Rev. 85, 1991.
- Lerner, J., Tirole, J., 2005. The economics of technology sharing: Open source and beyond. Journal of Economic Perspectives 19, 99–120.
- Levine, D.S., Sichelman, T., 2018. Why do startups use trade secrets. Notre Dame L. Rev. 94, 751.
- Luskin, R.C., Fishkin, J.S., Jowell, R., 2002. Considered opinions: Deliberative polling in britain. British Journal of Political Science 32, 455–487.

- Machlup, F., 1958. An Economic Review of the Patent System. 15, US Government Printing Office.
- Mazer v. Stein, 1954. 347 U.S. 201. U.S. Supreme Court.
- Meloso, D., Copic, J., Bossaerts, P., 2009. Promoting intellectual discovery: patents versus markets. *Science* 323, 1335–1339.
- Moschini, G., Yerokhin, O., 2008. Patents, research exemption, and the incentive for sequential innovation. *Journal of Economics & Management Strategy* 17, 379–412.
- Nard, C.A., Morriss, A.P., 2006. Constitutionalizing patents: from venice to philadelphia. *Review of Law & Economics* 2, 223–321.
- Qian, Y., 2007. Do national patent laws stimulate domestic innovation in a global patenting environment? a cross-country analysis of pharmaceutical patent protection, 1978–2002. *The Review of Economics and Statistics* 89, 436–453.
- Qualcomm, 2013. Time invention poll in cooperation with qualcomm. Time .
- Raustiala, K., Sprigman, C., 2006. The piracy and paradox: Innovation and intellectual property in fashion design. *Va. L. Rev.* 92, 1687.
- Raustiala, K., Sprigman, C., 2012. The knockoff economy: How imitation sparks innovation. Oxford University Press.
- Sakakibara, M., Branstetter, L., 1999. Do stronger patents induce more innovation? Evidence from the 1988 Japanese patent law reforms. Technical Report. National bureau of economic research.
- Sampat, B.N., 2018. A survey of empirical evidence on patents and innovation. Technical Report. National Bureau of Economic Research.
- Sauermann, H., Cohen, W., Stephan, P., 2010. Doing well or doing good? the motives, incentives and commercial activities of academic scientists and engineers, in: DRUID summer conference, pp. 16–18.
- Schiff, E., 2015. Industrialization without national patents: the Netherlands, 1869-1912; Switzerland, 1850-1907. Princeton University Press.
- Scotchmer, S., 1991. Standing on the shoulders of giants: cumulative research and the patent law. *Journal of economic perspectives* 5, 29–41.
- Shapiro, C., 2000. Navigating the patent thicket: Cross licenses, patent pools, and standard setting. *Innovation policy and the economy* 1, 119–150.
- Sprigman, C.J., Buccafusco, C., Burns, Z., 2013. What’s a name worth: Experimental tests of the value of attribution in intellectual property. *BUL Rev.* 93, 1389.
- Stiglitz, J.E., 2008. Economic foundations of intellectual property rights. *Duke LJ* 57, 1693.
- Sweet, C., Eterovic, D., 2019. Do patent rights matter? 40 years of innovation, complexity and productivity. *World Development* 115, 78–93.
- Thaler, R.H., 1988. Anomalies: The ultimatum game. *Journal of economic perspectives* 2, 195–206.
- Torrisi, S., Gambardella, A., Giuri, P., Harhoff, D., Hoisl, K., Mariani, M., 2016. Used, blocking and sleeping patents: Empirical evidence from a large-scale inventor survey. *Research policy* 45, 1374–1385.
- Varaine, S., Benslimane, I., Magni Berton, R., Crosetto, P., 2019. Attacking the weak or the strong? An experiment on the targets of parochial altruism. Preprint.
- Wajzman, N., García-Valero, F., 2017. Protecting innovation through trade secrets and patents: Determinants for european union firms. European Union Intellectual Property Office .

Appendix

A. Instructions for all treatments

The differences between treatments are indicated in square brackets. The original instructions were in French, participants also viewed screenshots and explanatory videos of the game. The original instructions are available from the authors upon request. The videos projected as a complement of the written instructions are available [here](#) and [here](#).

Individual Training

To begin, before playing the paid game, you will do individual training. During this training, your task is to form as many words as possible in 3 minutes as in a Scrabble game. To do this, you have 9 letters at your disposal, which you can reuse as many times as you want. The words you form must be at least 3 letters long. All French words and their different declinations and conjugations are accepted. On the other hand, proper nouns, foreign language words, abbreviations and compound words are not accepted. Each time you find a word, you must enter it using the keyboard and press the "Enter" key on the keyboard to validate. If there is an accent in the word you wish to enter, you must type the letter without the accent.

Game, first repetition

In this part, you will be randomly divided into groups of three participants. Each in turn, with the other two participants in your group, you will have to form words, just like in the training task. You will play over ten periods. Each period corresponds to one round of the game for each of the participants in your group. When it is your turn to play, you have two options:

- Create a new word.
- Extend an existing word to create a new one.

You have 40 seconds to make your decisions. If you have not created a new word by the end of the 40 seconds, you pass your turn. To begin, you have five letters at your disposal, as well as two words already formed. Then you will receive a new letter for each new round.

Word creation

The first option is to create a new word. To create a new word, you have to drag the letters at your disposal with your mouse from the frame at the bottom right to the "Create a new word" frame at the bottom left of the screen. Once the new word has been created, you must validate it by clicking on "I validate". Attention you must create words of at least three letters.

Word extension

The second option is to extend an existing word. You can extend the word of your choice, whether it is one of your words or a word from another participant. To extend a word, you must drag one of your letters with your mouse and add it to an existing word. You can place the letter anywhere in the word - at the beginning, middle or end of the word. However, you can't rearrange the other letters in the word. When you expand a word, you can only add one letter. Once you have added the letter, you must validate by clicking on "I validate". When you create or extend a word, the letters you have used are deleted from your stock. The game checks each word entered with a spell checker. If the word is incorrect, the word creation field turns red. There is no penalty for entering a word incorrectly, you simply have to enter a new word.

Payoff

As in the Scrabble game, each letter has a certain value in points. When you create or extend a word, you earn the sum of the points for the letters of the newly created word. For example, if you create the word $P_3O_1T_1$, you earn 5 points = 3 points for P, 1 point for O, 1 point for T. Then, if you expand the word $P_3O_1T_1$ into $P_3O_1R_1T_1$, you earn 6 points = 3 points for P, 1 point for O, 1 point for R and 1 point for T.

Royalties

One last rule that will determine your points: user fees. When you create or extend a word, you have to choose an amount of fees for the use of your letters by other players. This way, players who wish to extend your word will have to pay you a fee. When validating your word, you must choose the level of fees as a percentage of the value of the letters you contribute, from 0% to 100% depending on your choice. To use the example of $P_3O_1T_1$, if you choose a 50% user fee, then players who wish to extend the word will have to pay you 50% of the value of $P_3O_1T_1$, i.e. 2.5 points.

Earnings

So at the end of each period you earn points. You earn the value of the word you created and the fees received from other players, minus the points paid in fees to other players. At the end of the game, you will see the number of points you have accumulated as well as the total fees you have paid and received. Your final number of points will contribute to your final payment in Euros at the end of the session, at the conversion rate 1 POINT = 0.25 EUROS

Game, second repetition

Vote/noVote

Now that you've completed the first part of the word game, we'll move on to the second paid part.

[noVote condition: But unlike the first game, from now on you will play without word fees: you won't pay any more fees to use other players' contributions and you won't earn any more points when other participants use your contributions.]

[Vote condition: Before playing, we will ask you to vote with the other participants in your group on the rules you prefer for this second game. You must indicate your preference between these two options:

- Remove word fees from the rules of the game: you will no longer pay any fees to use other players' contributions and you will not earn any more points when other participants use your contributions.
- Keep the fees for using words: the same rules as the previous game will apply.

You will play a game with user fees if all participants in your group vote to keep the fees. Otherwise, you will play a game without user fees. Before voting, you will have 20 seconds to think about your choice.]

Information

[Info condition: For your information, a scientific study published in 2016 in the journal Research Policy analyzed the behavior of participants in a game similar to the one you are playing. The study compared the performance of participants in a game with the word user fee rule to a game without the user fee rule. The findings of the study clearly show that, overall, participants performed better in the game without a word user fee than in the game with a user fee. In a game without user fees, participants overall produced more word extension and more points. As a result, this resulted in higher payments for players in the no-cost game.]