

Intellectual Property Rights Hinder Sequential Innovation.

Experimental Evidence

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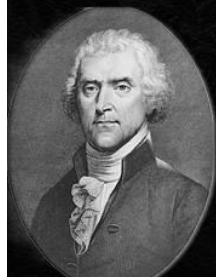
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Grenoble – February 19th, 2015

...ideas are public goods...

He who receives ideas from me,
receives instruction himself
without lessening mine; as he
who lights his taper at mine
receives light without darkening
me.



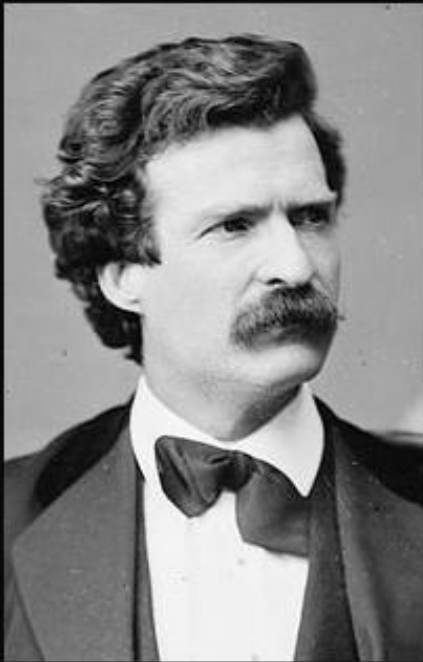
Thomas Jefferson
3rd U.S. President
(1743-1826)

QuoteHD.com

And if we have seen far, is by standing on the shoulders of giants
Isaac Newton



...on the other hand...



Only one thing is impossible for God: To find any sense in any copyright law on the planet.

(Mark Twain)

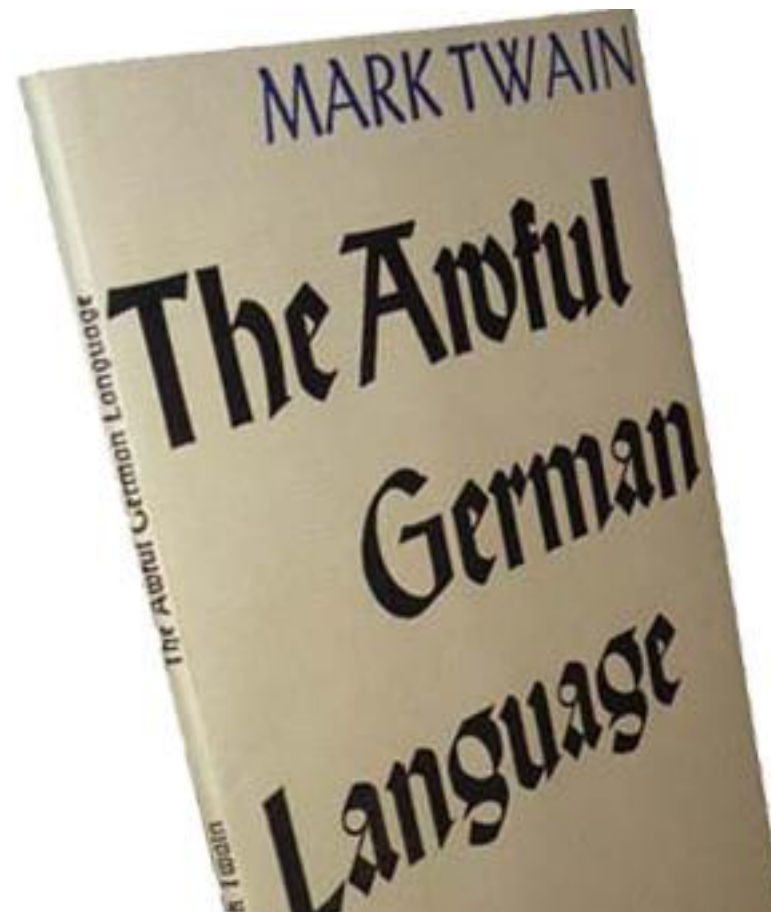
izquotes.com

The laws of England and America do take away property from the owner. They select out the people who create the literature of the land [...] and do what they can to crush it, discourage it, and put it out of existence.

Now that gentleman [...] asked me what I thought the limit of copyright ought to be. “Well,” I said, “perpetuity.”

Mark Twain, 1906

[this is the same guy who wrote this]



The IP Discussion in Economics

Arguments for and against intellectual property rights



monopoly rights as incentive for innovators:

- Protection from imitation
- receive part of the social surplus from subsequent innovators
- patents induce disclosure of new technologies
- knowledge diffusion

monopoly rights increase prices:

- inefficiencies
- welfare losses

for sequential innovation:

- patent races
- gridlock and anticommons issues

Some evidence

- Mixed evidence from theoretical and empirical studies
- empirical studies: positive influence (Ernst, 2001), „inverse u-relationship“ (Gallini, 1992), minor influence (Williams, 2013), negative influence (Qian, 2007)
- theoretical studies on sequential innovation: unclear effects (Scotchmer, 1991), welfare-reducing effect of patents (Bessen & Maskin, 2009), inverse u-relationship (Hunt, 2004)

Is there a need for experiments?

- mixed evidence from empirical and theoretical studies
- lack of natural experiments allowing to observe a counterfactual, non-existent patent-free world (Hall & Harhoff, 2012)
- our approach to contribute to the IP discussion: a laboratory experiment
- advantages
 - counterfactual situations can be build while retaining control over confounding factors
 - the effects of a patent regime can be compared to those of a patent-free regime
 - identification of impact factors on innovation activity possible
- limitations
 - external validity
 - trade-off between replicating a complex innovation environment and making the task manageable for an experimental session

This paper

- We deal with the evaluation of the *pros* and *cons* of Intellectual Property Rights in sequential innovation settings
- Theory & data do not settle the issue, so...
- ...we use an *experiment* to
 - build counterfactuals
 - cleanly identify casual relationships
- We find that, in our setting, introducing IP
 - reduces overall welfare
 - reduces the rate of innovation
 - results in increased ‘autarky’ – disruption of the creative process
- Introducing stronger social relationships (via a *chat* among subjects)
 - does not decrease the detrimental effects of IP
 - has little effect overall

Experimental Design

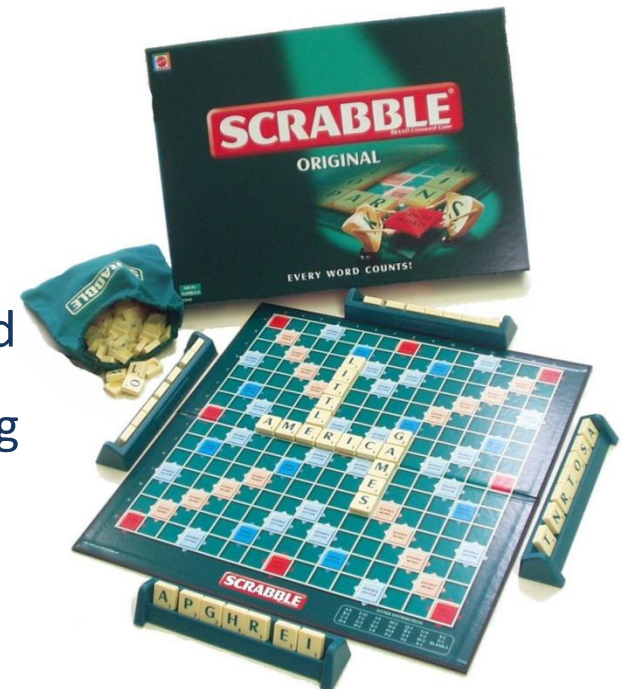
Existing Experimental Literature

Mimicking IP & R&D in the lab is a tricky task.
Need to introduce *dynamics, innovation, sense of authorship, ...*

- Innovation as R&D, R&D as simple investment with probabilistic return
 - E.g. Aghion et al. 2014
- search task: ‘best’ arbitrary set, random search
 - real-effort-task in a multidimensional space (Ederer & Manso, 2013)
 - trading self-created colors (searching task in a multidimensional space) or standard-products (Buchanan & Wilson, 2014)
- creativity task: no ‘best’ option, comparisons difficult
 - market for self-written poems (Buccafusco & Sprigman, 2010)
- creativity and search task: countable, comparable task in a creative space
 - Scrabble-like word-creation task (Crosetto, 2010)

Experimental Task: do you Scrabble?

- inspired by the board game “Scrabble”
- task: creating words (search + creativity)
- letters have a price ($<$ than expected value) – risky investment
- strict sequentiality in word creation:
 - two types of words: roots (3) and extensions (+1)
 - Two inventive steps, 3, +1
 - Possibility of opening alternative paths
- payoff: sum of the value of the letters in a word
- Great variance in the dynamics of value starting from the same raw letters.



18×	A ₁	4×	B ₃	4×	C ₃	8×	D ₂	24×	E ₁	4×	F ₄	6×	G ₂
4×	H ₄	18×	I ₁	2×	J ₈	2×	K ₅	8×	L ₁	4×	M ₃	12×	N ₁
16×	O ₁	4×	P ₃	2×	Q ₁₀	14×	R ₁	10×	S ₁	12×	T ₁		
8×	U ₁	4×	V ₄	4×	W ₄	2×	X ₈	4×	Y ₄	2×	Z ₁₀		

Example: potential extension paths of *cat*

root	extensions				
	+1	+2	+3	+4	+5
cat (5)		canst (7)	canton (8)		
	cant (6)	canto (7)	cantor (8)	cantons (9) cantors (9)	
		cants (7)	cantons (8)		
	capt (8)				
			carats (8)		
	cart (6)	carat (7) caret (7) carts (7)	carets (8) carpet (10) claret (8)	carpets (11) clarets (9)	
	cast (6) cats (6)	caste (7) casts (7)	caster (8) castes (8) castle (8)	casters (9) castled (10) castles (9) coaster (9)	coasters (10)
		chant (10)	chants (11)		
	chat (9)	chart (10) chats (10) cheat (10)	charts (11) chaste (11) cheats (11)	chasten (12) chastes (12)	chastens (13)
	coat (6)	coast (7) coats (7)	coasts (8)		
	scat (6)	scant (7) scats (7)	scants (8) scanty (11) secant (8)	scantly (12) secants (9)	scantly (13)

Introducing IP

- IP regulations introduced:
 - Every word created automatically 'copyrighted'
 - Enjoys a royalty of α value on the marginal contribution
 - e.g. *root*: $\alpha (0.5) * \text{cat} (5) = \text{royalty} (2.5)$
 - e.g. *extension*: $\alpha (0.8) * \text{cart} (+1) = \text{royalty} (0.8) [+2.5]$
 - e.g. *extension*: $\alpha (0.6) * \text{chat} (+4) = \text{royalty} (2.4) [+2.5]$
 - Alpha can be chosen
 - Royalties are automatically distributed to each marginal contributor
 - No one can re-create the same word
- IP protection lasts for ALL periods
- Limited IP breadth if *cart* comes from *cat*, no royalties paid to *car*.

Experimental Design - Screenshot

Rundenzeit

-4
Beeilung!

Spieler:

Verbleibende Buchstaben:

Guthaben

Guthaben:

Auszahlung in dieser Runde:

Lizenzgebühren

In dieser Runde eingenommen:

In dieser Runde bezahlt:

In gesamten Spiel eingenommen:

In gesamten Spiel bezahlt:

Rechtschreibprüfung

Wort eingeben

Wort überprüfen

Spellchecker

Bisherige Wörter aller Spieler

Wort	Lizenzgebühr	Spieler	Wert
Ⓢ tod	40%	Spieler 2	4
Ⓢ wal	20%	Spieler 3	6
Ⓢ wale	keine	Spieler 4	7
Ⓢ walen	100%	Spieler 1	8
Ⓢ wall	80%	Spieler 2	8
Ⓢ wald	10%	Spieler 3	7
Ⓢ wales	keine	Spieler 4	8
Ⓢ gib	60%	Spieler 1	6
Ⓢ walde	keine	Spieler 2	8
Ⓢ wahl	40%	Spieler 3	8

Public Words

Eigene Buchstaben

Bisheriger Spielverlauf

Spieler 4 leitet das Spiel an Spieler 1 weiter.

----- Beginn von Runde 3 -----

Spieler 1 kauft einen Buchstaben.
Spieler 1 hat das Wort gib gebildet. Es ist 6 Taler wert.
Die zu zahlende Lizenzabgabe wurde auf 60.0% festgesetzt.
Spieler 1 leitet das Spiel an Spieler 2 weiter.
Spieler 2 kauft einen Buchstaben.
Spieler 2 hat den Wortstamm wald zu walde erweitert. Das neue Wort ist 8 Taler wert.
Spieler 3 bekommt 1.3 Taler aufgrund der Nutzung des Wortstamms wald.
Die zu zahlende Lizenzabgabe wurde auf 0.0% festgesetzt.
Spieler 2 leitet das Spiel an Spieler 3 weiter.
Spieler 3 kauft einen Buchstaben.
Spieler 3 hat den Wortstamm wal zu wahl erweitert. Das neue Wort ist 8 Taler wert.
Die zu zahlende Lizenzabgabe wurde auf 40.0% festgesetzt.
Spieler 3 leitet das Spiel an Spieler 4 weiter.

Eigene Wörter

Wort	Wert	Einkünfte
Ⓢ wal	6	1.2

Your words

Eigene Erweiterungen

Wort	gezahlt	Einkünfte
Ⓢ wald	0	1.3
Ⓢ wahl	0	0

Your extensions

Chat

[**Spieler 3**] : wajfsohnioa
[**Spieler 3**] : hyoxhngvopashngf
[**Spieler 3**] : FAFafaGAGG
[**Spieler 3**] : GIVISAKOGOSGH
[**Spieler 1**] : fjaasnrvjoasvioxdkyghjaapwehfia
[**Spieler 1**] : v<aiomnfviwapngfoa
[**Spieler 1**] : vaioaoosdfhoquvthnagös
[**Spieler 1**] : anophgh
[**Spieler 2**] : naioospgrnuoprhn
[**Spieler 2**] : jagvisopgrhgusidf
[**Spieler 2**] : joavniasogruao jagiofhgio s ajjiohago ghacpas f ghaospgh oia hg
[**Spieler 3**] : bnjgbvBVl ag hdtfguib ghauspo ghpsfd g s gapb ifog hshg ago hfagoshtd goops gsdf gis

Chat box

Game log

Further details

- Sequential moves (as in board games)
- Course of a turn
 1. Buying phase (buy / not buy letter for a fixed price of 2 tokens)
 2. Production phase. Choice among:
 - a) Producing a root (3-letter-word)
 - b) Extending an existing word (+1)
 - c) Pass
 3. License phase. Choose royalty % (if word or extension produced)
- 4 players in a group
- 25 periods

Experimental Design - Treatments

What is the effect of IP rights on innovativeness and welfare?

- IP/noIP

What is the effect of stronger social interaction innovators?

- Chat/noChat

Experimental Design - Treatments

	no communication	communication
no IP	<i>noChat/noIP</i>	<i>chat/noIP</i>
IP – endogenous license fee	<i>noChat/IP</i>	<i>chat/IP</i>

- *Between-subjects* design: 192 subjects, 48 per cell
- 12 groups (independent observations) per treatment
- Sessions lasted around 90 minutes.
- Earnings: €16.19 on average, min €7.1 max €28.5.

Results: treatment effects

Overview of words and value created

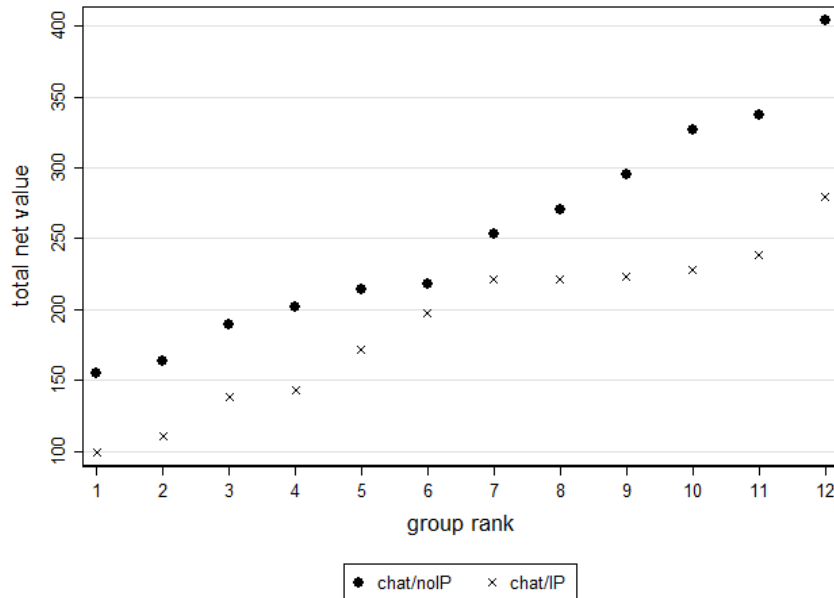
		<i>noChat/noIP</i>	<i>noChat/IP</i>	<i>chat/noIP</i>	<i>chat/IP</i>
letters bought	mean (sd)	85.5 (7.51)	84.3 (8.05)	80 (9.16)	81.42 (7.43)
total net value	mean (sd)	288.25 (44.21)	204.92 (46.23)	252.42 (76.51)	189.17 (56.26)
	median	295.5	210	235.5	209
	min	200	103	155	99
	max	350	274	404	280
word length	mean (sd)	4.97 (.3756)	4.49 (.3219)	4.84 (.4103)	4.37 (.3573)
word value	mean (sd)	4.59 (.5366)	3.74 (.5744)	4.12 (.8238)	3.52 (.6187)
no. extensions	mean (sd)	49.33 (5.76)	43.33 (6.21)	45.33 (8.11)	38.5 (7.54)
no. roots	mean (sd)	10.92 (1.98)	13 (2.22)	10.67 (2.61)	14.25 (2.60)

Overview of words and value created

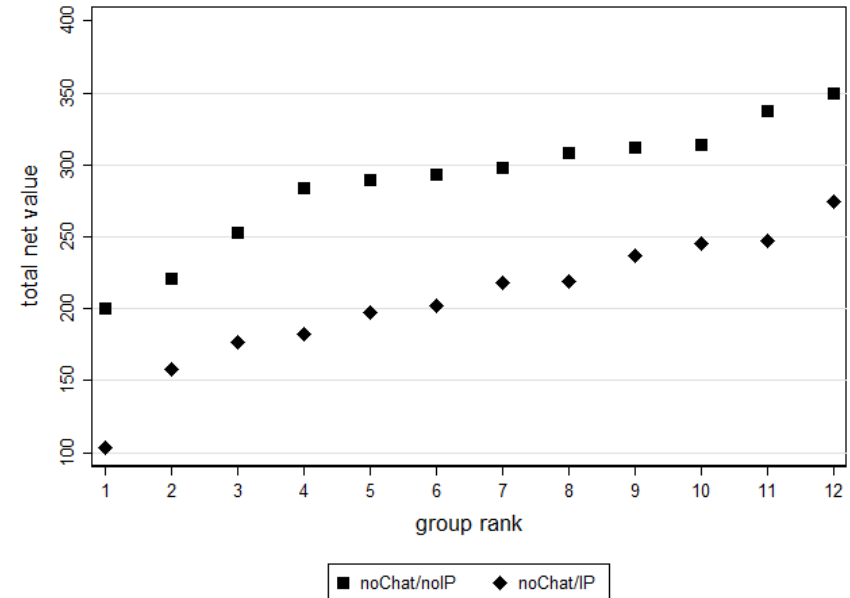
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Result 1: Introducing IP decreases welfare.

Chat



No chat



Total net value by treatment and group

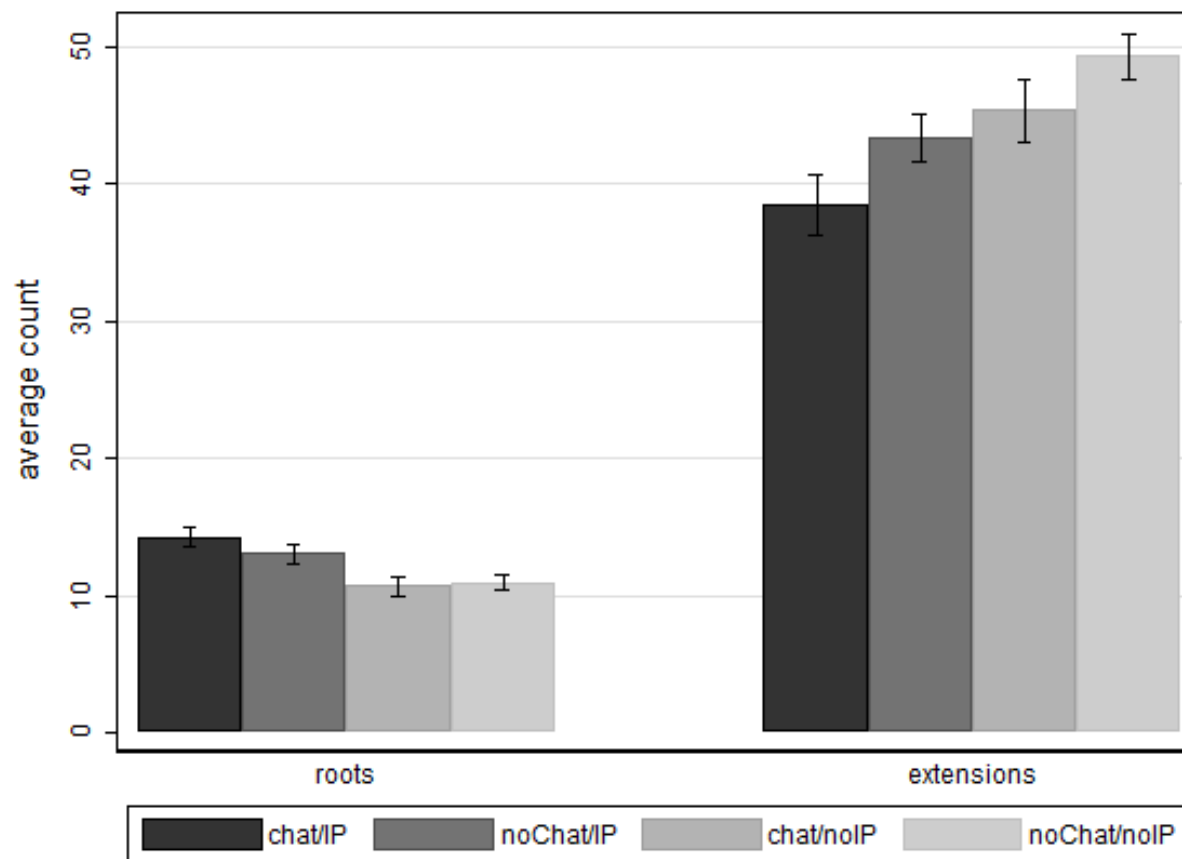
How? noIP -> longer, more valuable words

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How? noIP -> more extensions, less roots

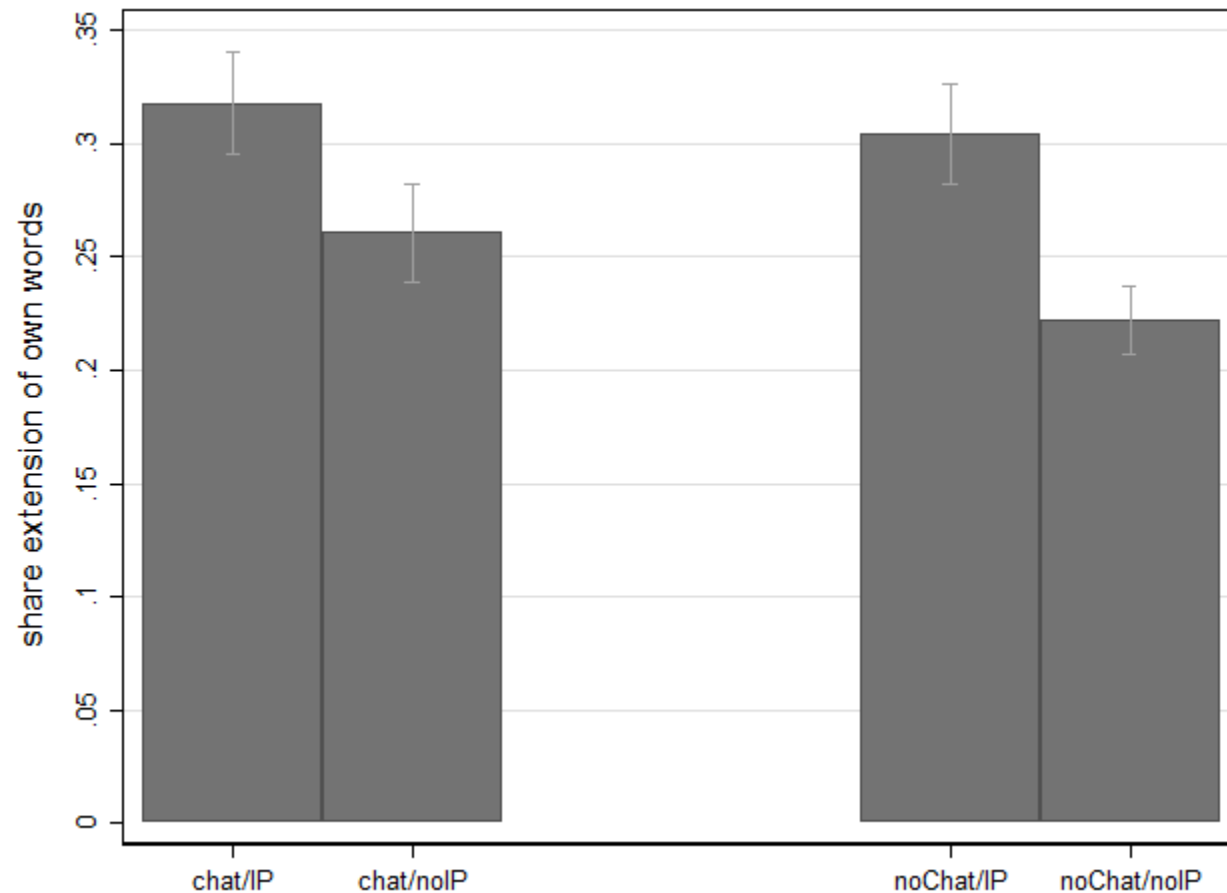
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How? noIP -> less roots, more extensions



Number of roots and extensions created

Why? Increased autarky



IP treatments: noIP -> better results

- Across IP treatments same number of letters bought...
 - Initial investment identical
- ...but higher net value (payoff- cost of letters) created
- Treatment effect significant across *chat* and *noChat* conditions
- The effect is large (30-40% more value) and persistent across all groups
- The effect is due to the creation of
 - Longer words
 - More valuable words
 - (the two are correlated by design)
- Share of extension per root significantly different by treatment

Chat treatments: small to no effect

- No average effects on welfare, word length, word value
- Not all groups *did use* the chat, though.
- Only 42% (66%) of the groups in *chat/IP (chat/noIP)* used the chat *meaningfully*
- These group had slightly (n.s.) better results
- Overall null results on this dimension

Results: taking path dependency seriously

The game is dynamic and path-dependent

- The average results in terms of value created might be biased
- By the path taken by subjects. Example: *ext* vs. *tex*

<i>Root</i>	<i>Extensions</i>			
	+1	+2	+3	+4
ext (10)	exit (11)	exist (12) exits (12)	exists (13) sexist (13)	sexiest (14) sexists (14)
	next (11)			
	text (11)	texts (12)		
tex (10)	text (11)	texts (12)		

Introducing the Relative Net Value (RNV)

- We build a relative indicator: how did subjects fare, *given their choice sets*?
- For each period, each choice, we compute all possible actions by each player
 - Given letters owned, all possible root
 - Given letters owned and public words, all possible extensions
- We compute 'myopic optimality' of choice w.r.t. max (M) and min (m) obtainable payoff

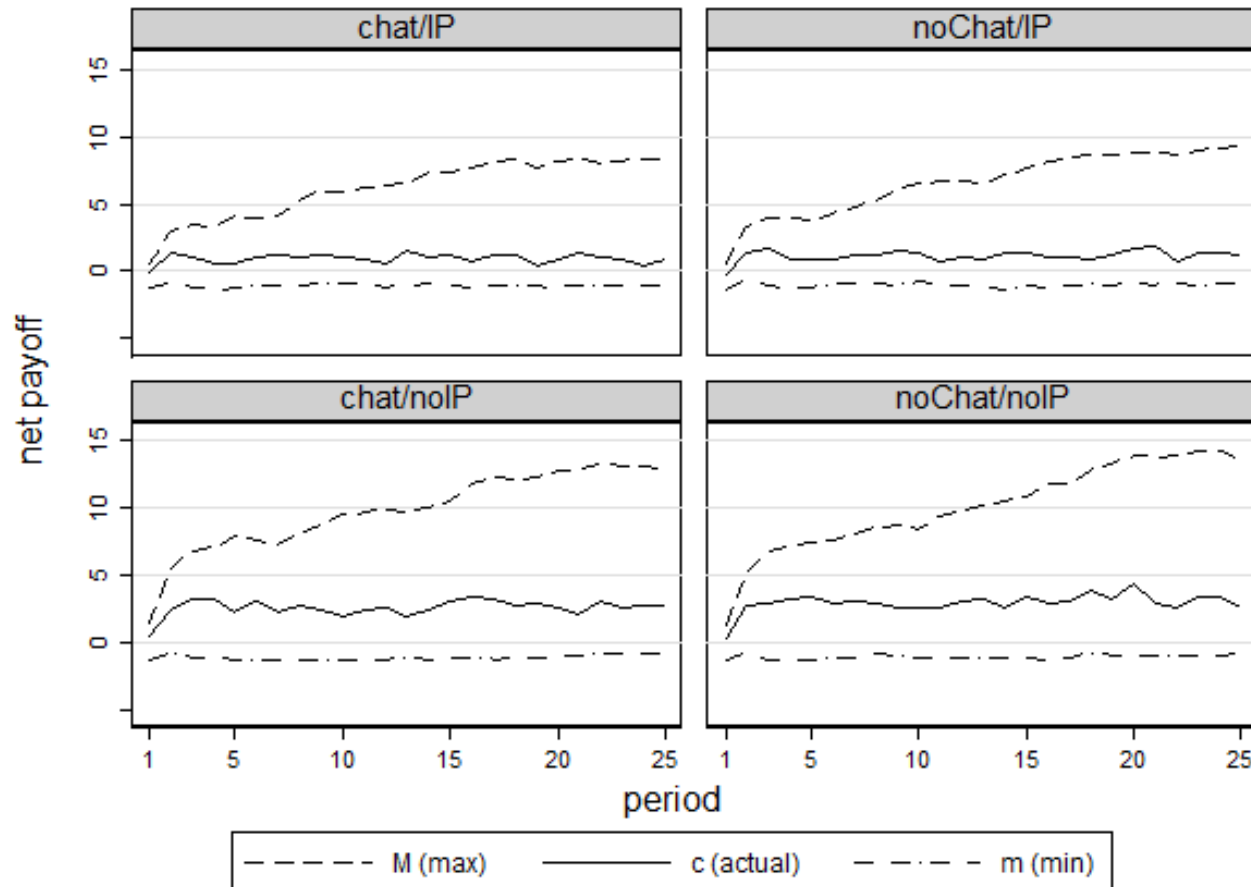
$$RNV_{it} \in (0, 1) = \frac{\pi_{it} - m_{it}}{M_{it} - m_{it}}$$

- This gives us for each period, for each subject, how the chosen action compares to the whole set of available actions in (myopic) payoff space
- The higher the RNV, the 'better' the choice for the subject

Summary statistics of the RNV by treatments

	average (sd)	median	min	max
<i>noChat/noIP</i>	.392 (.0313)	.387	.356	.450
<i>noChat/IP</i>	.317 (.0309)	.311	.274	.378
<i>chat/noIP</i>	.366 (.0569)	.358	.272	.461
<i>chat/IP</i>	.3233 (.0399)	.333	.253	.389

Evolution of minimum, maximum and actual payoffs by period and treatment



RNV: results

- Maximum payoff per period is an indicator of *opportunities*
- RNV is an indicator of how well these opportunities were *exploited*
- RNV is higher in noIP treatments
- RNV is decreasing in time: lots of opportunities, cognitive limits
- noIP treatments generate far more opportunities than IP treatments (significantly different slopes for M in the plots)

Results: individual and group-level analyses

Controlling for individual characteristics

- What if our groups differed in some observable characteristic?
- E.g. Education, gender, proficiency in German, ability in word riddles?
- Control task: all possible anagrams of a given 12-letter string, 3 minutes
- Questionnaire: demographics
- Controlling at the group & individual level by clustering standard errors

RNV	(individual level)	(group level)
chat	-0.0325	-0.0419
IP	-0.0839**	-0.0871***
chat_IP	0.0653	0.0794*
period	-0.0112***	-0.0118***
period_chat/IP	-0.00135	-0.00179
period_noChat/IP	0.000281	0.000601
period_chat/noIP	0.000649	0.000862
high in control task	0.0171	0.0145
low in control task	-0.0570***	-0.0102
female	-0.0259**	
age	-0.00491**	
proficiency	0.00238	
Constant	0.673***	0.552***
Observations	4603	1200

Collective action & the noIP results

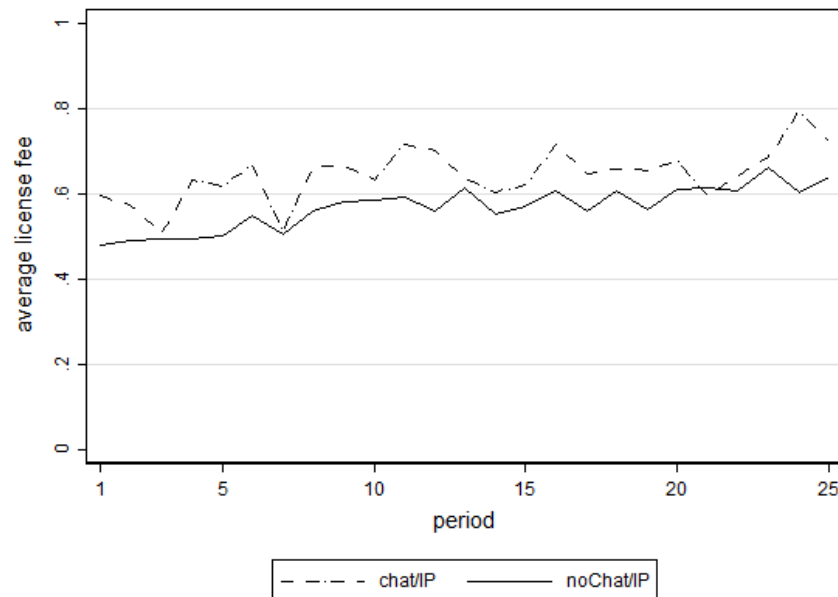
- In principle, in IP treatments subjects face a collective action problem, while in noIP treatments they do not
- That is: in noIP treatment individual and collective optimal coincide
- In IP treatments, not so. They might diverge. What is optimal for the group (i.e., the word generating the higher possible flow of extensions) is not necessarily optimal for the individual.
- Hence, individuals might *rationaly* generate negative externalities in IP treatment: they might go for the individually optimal but forego collective gains.
- The RNV regression allows us to *show* that this is not the case. The RNV is *lower* in IP treatments, meaning that subjects perform worse *relative to the choice they face*.

Results: royalty levels, time and welfare

Analyzing royalty levels

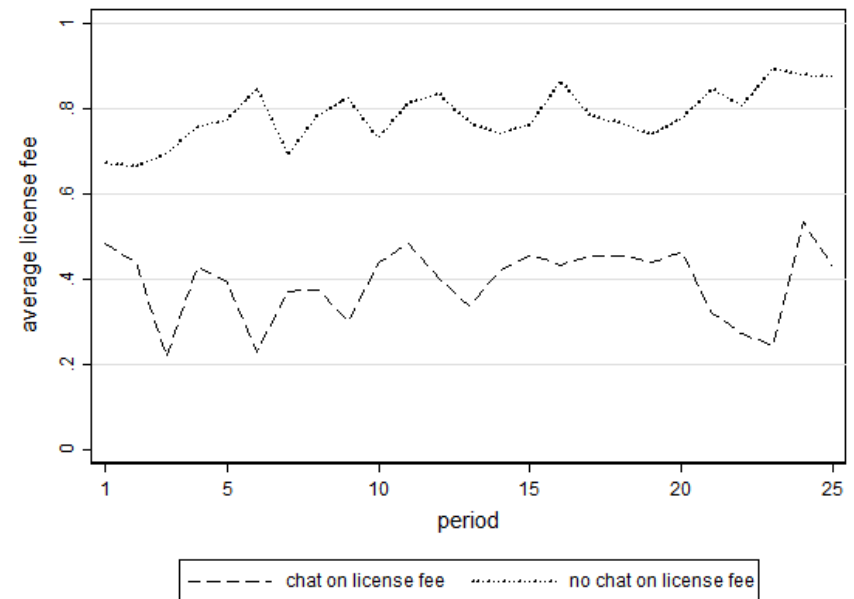
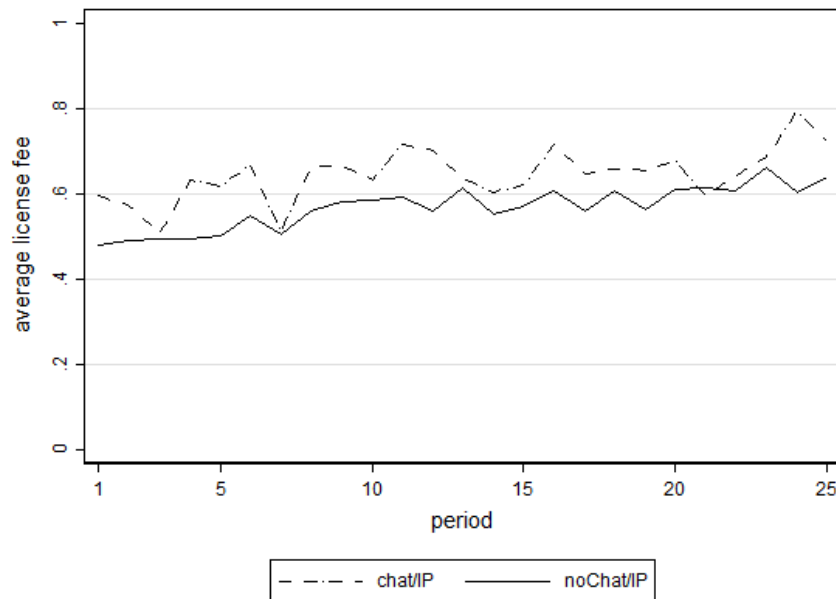
- Subjects in IP treatments could choose their royalty fees
- On a 0 to 100% scale, in 10% intervals.
- What happened to these royalty levels?

Royalty levels increase over time (PGG anyone?)



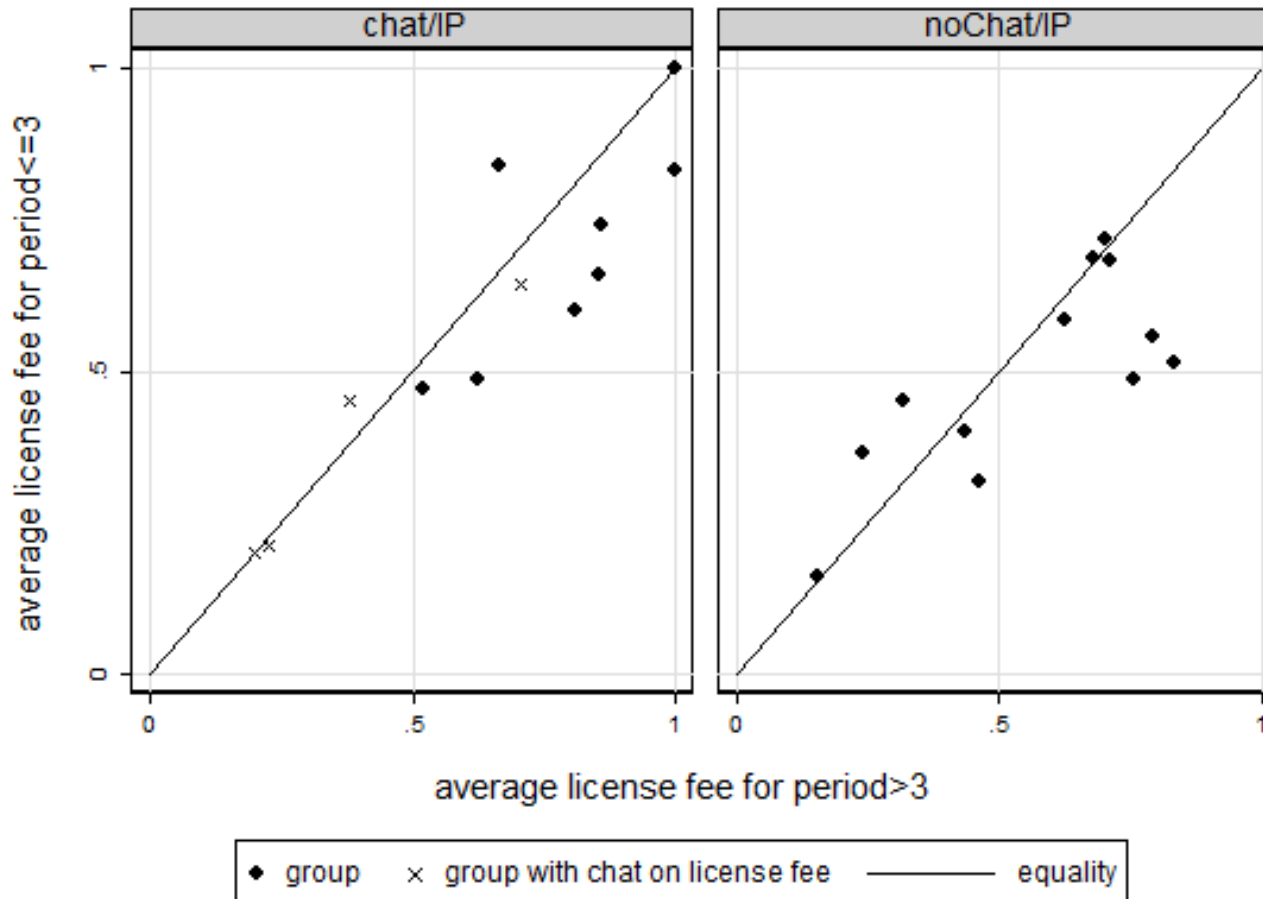
Average license fees over periods by treatment

Royalty levels increase over time (PGG anyone?)

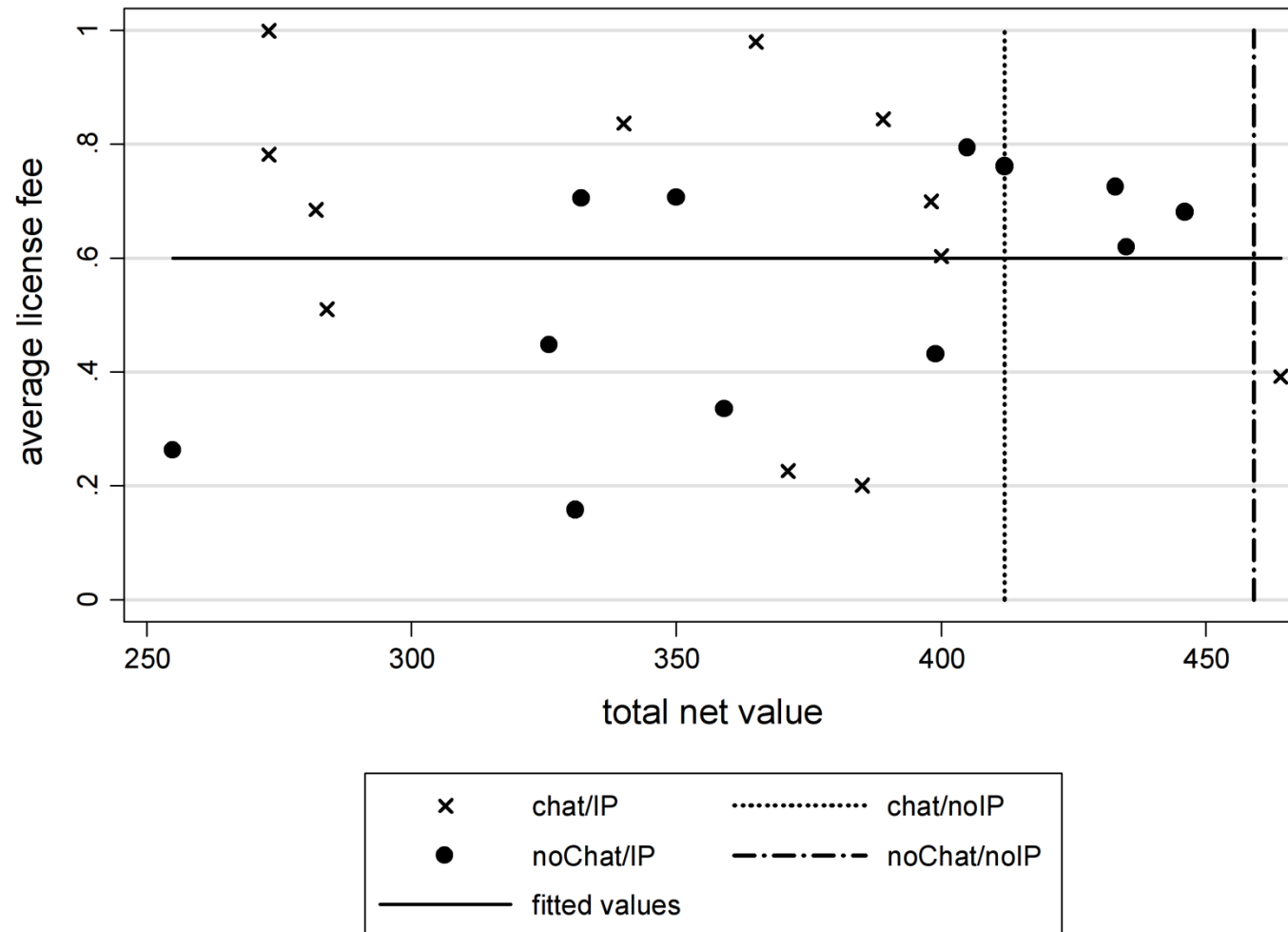


Average license fees over periods by treatment and within *chat/IP*

Best predictor for royalty at time T is royalty at time 3



But total value created is *independent* of royalty levels!



Conclusion

Conclusion

- We experimentally compare patenting regimes with and without endogenous license fees to test the welfare effect of intellectual property rights.
- We find subjects performing significantly better – up to 40 percent – in the regimes without IP.
- Communication among innovators is not able to change the detrimental effect of IP.
- As in public goods experiments we find path-dependency and decreasing cooperation over time.
- Our results imply that granting IP rights slows down the rate of innovation in sectors characterized by strong sequentiality, such as software or bioengineering, and therefore reduces welfare.

thanks

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