What patents are less likely to be granted?

Perspective from Patent Examiner and Disruptive Innovation

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Introduction

Designed by the government to protect innovative technologies (Meyer, 2000), **an important task for patent examiners is to identify innovative patent applications based on prior submissions** (Meyer, 2000). Serving as impartial third parties, **patent examiners are expected to offer comparatively objective assessments of the quality of patents.**

V.S.

Disruptive innovation faces many challenges in terms of its scientific impact and acceptance. Kuhn (1962) posits that innovation is a form of anomaly, and truly understanding such groundbreaking works, which challenge established paradigms, often demands a substantial amount of time. Noh and Lee (2020), in their analysis of patents within the telecommunications field, suggest that disruptive innovations often struggle to capture the attention of examiners due to their significant deviation from existing technologies.

Key Puzzlement: does scientific gatekeeping within the patent examination system promote or suppress disruptive innovation?

Introduction

Research gap

- The outcome of scientific gatekeeping, whether conducted by journal reviewers or patent examiners, hinges on the interplay between the scientific content and the gatekeeper.

- While the functioning of scientific gatekeeping has long intrigued the academic community, the review process for journal articles often remains opaque, resembling a black box. Consequently, most existing research primarily focuses on those accepted works (Alcácer et al., 2009; Chaffin et al., 2013; Picard & Van Pottelsberghe De La Potterie, 2013; Righi & Simcoe, 2019), with little attention given to the rejected ones.

- To fill this gap, our study compares granted patents with rejected ones, aiming to shed light on the scientific gatekeeping process within the patent examination.

Introduction

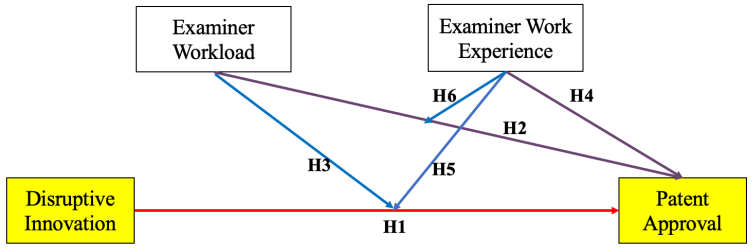
Research gap

- To explore the reasons behind limited disruptive innovation, scholars have analyzed factors like team size, discipline development, technical scope, geographic region, and component familiarity (Wu et al., 2019; Noh & Lee, 2020; Kemeny et al., 2022; Radnejad & Vredenburg, 2019).

- This study aims to further strengthen this line of research by uncovering the potential bias of scientific gatekeeping towards disruptive innovation.

Drawing on the theories of scientific gatekeeping and disruptive innovation, we analyze 4.5 million patent data (2004–2018) of the United States Patent and Trademark Office (USPTO). To explore the bias in the patent approval process, we focus on two key characteristics of patent examiners, namely workload and work experience.

Research Hypothesis



***H1*: Disruptive Innovation has a negative effect on patent approval.**

***H2*: Examiner workload has a positive effect on patent approval.**

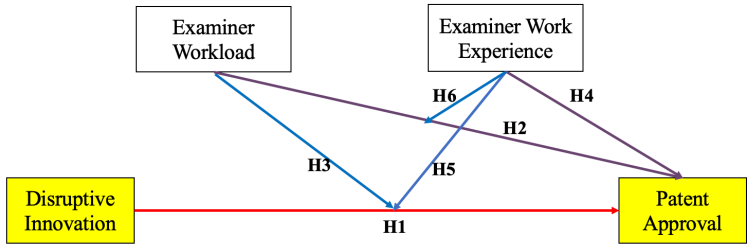
***H3*: Examiner workload can reduce the negative impact of disruptive innovation on patent approval.**

***H4*: Examiner work experience has a positive effect on patent approval.**

***H5*: Examiner work experience can reduce the negative impact of disruptive innovation on patent approval.**

***H6:* Examiner work experience can mitigate the positive effect of examiner workload on patent approval.**

Research Hypothesis

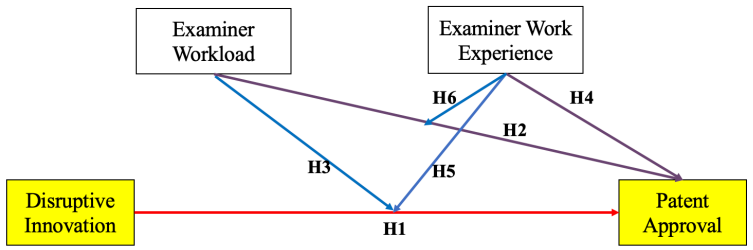


Disruptive Innovation and Patent Approval

- Normal science typically aims to explain existing problems and build upon traditional knowledge rather than disrupting existing knowledge. (Kuhn, 1962).
- Patent approval faces a similar dilemma, despite being utilized by the government to safeguard innovation.
  - A patent that introduces a groundbreaking and disruptive innovative idea may struggle to attract attention because it is significantly different from existing technologies (Noh & Lee, 2020).
  - Some patents with a high degree of disruptive innovation may be accompanied by technical boundary spanning (Noh & Lee, 2020), which requires the examiner to do more back-and-forth work with the patent office, increasing the difficulty of examination and adversely affecting the granting result (Whalen, 2018).

***H1*: Disruptive Innovation has a negative effect on patent approval.**

Research Hypothesis



Patent Examiner and Patent Approval

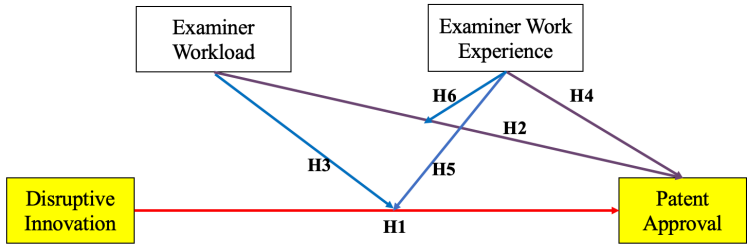
- Rejecting a patent demands more time compared to granting one (Langinier & Marcoul, 2020; Schuett, 2013). If examiners lack sufficient time to thoroughly examine all relevant prior art for each application, the likelihood of granting patents increases (Caillaud & Duchêne, 2011; Frakes & Wasserman, 2014).
- The mental burden caused by workload can also impact patent examination.

***H2*:** Examiner workload has a positive effect on patent approval.

- Rejecting disruptive patents demands additional time for identifying specific justifications. The time constraints resulting from workload make it considerably challenging for examiners to accomplish this task.

***H3*:** Examiner workload can reduce the negative impact of disruptive innovation on patent approval.

Research Hypothesis



Patent Examiner and Patent Approval

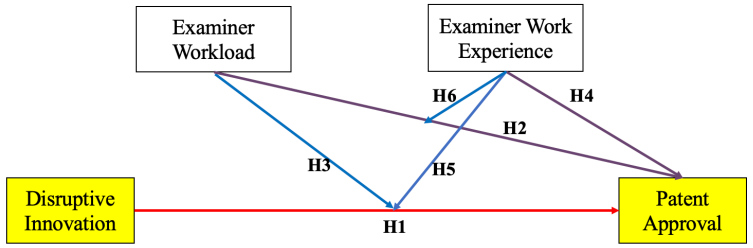
- Examiners with greater work experience tend to cite fewer instances of prior art and are more likely to grant patents without rejections (Lemley and Sampat, 2012).
- Mann (2013) argues that an increase in work experience may lead to a burnout effect, resulting in a higher rate of patent granting.

***H4*: Examiner work experience has a positive effect on patent approval.**

- Since experienced examiners pay less attention to existing technologies (Lemley & Sampat, 2012), they tend to provide a more lenient assessment of disruptive patents.
- Experienced examiners have a better connection and collaboration with specialized personnel across various domains within the patent office (Whalen, 2018).

***H5*: Examiner work experience can reduce the negative impact of disruptive innovation on patent approval.**

Research Hypothesis



- Accumulated work experience enables patent examiners to conduct examinations with greater efficacy and efficiency, empowering them to better manage time constraints (Shu et al., 2022).
- Less experienced examiners are more prone to relying heavily on prior patents in their patent examination process (Lemley & Sampat, 2012), which amplifies the positive effect of workload on grant approval.

H6: Examiner work experience can mitigate the positive effect of examiner workload on patent approval.

OLS Regression, Propensity Score Weighting (PSW), Mixed Effects Model

Data

- 4.5 million patents data (2004–2018) of the United States Patent and Trademark Office (USPTO)
- To calculate the work experience of examiners, we exclude examiners who appeared in the dataset in the two years prior. Further, to ensure the 5-year citation window, we select patents applied before 2013.

Measures

Dependent variables

Patent Approval. Patent approval is a dummy variable denoting whether a patent has been granted or not. This variable takes the value 1 if the patent is granted and 0 if it is rejected.

Patent Citations. Citations are the number of patents that cite the focal patent and we select the citation counts of the focal patent in a 5-year time window after its publication (Wang, Song, & Barabási, 2013). Since the distribution of citation counts is highly skewed, we transform it to its logarithmic form ($M = 1.47$, $SD = 0.80$).

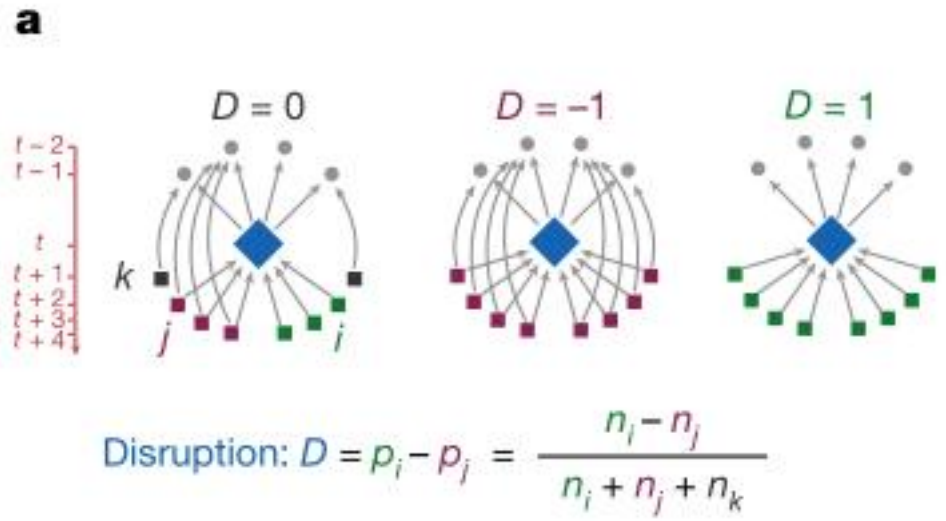
Method

Independent variables

Disruptive Innovation. Disruption innovation is a leap or break with traditional knowledge (Lin et al., 2022). Following the tradition of prior research (Funk & Owen-Smith, 2017; Wu et al., 2019), we calculate the *D-score* of disruption for each patent as follows:

$$D = \frac{n_i - n_j}{n_i + n_j + n_k}, \quad (1)$$

We calculate disruptive innovation based on citations of the focal paper over a 5-year time window (CD5). Because the distribution of disruption is also highly skewed, we convert it to its percentile score. Thus, in our analysis, we use the CD5 percentile ($M = 0.21$, $SD = 1.26$) to measure the disruptive innovation of the patent.



where n_i is the number of subsequent papers that cites the focal paper, n_j is the number of subsequent papers that cite both the focal paper and its references, and n_k is the number of subsequent papers that only cites the focal paper's references.

Measures

Independent variables

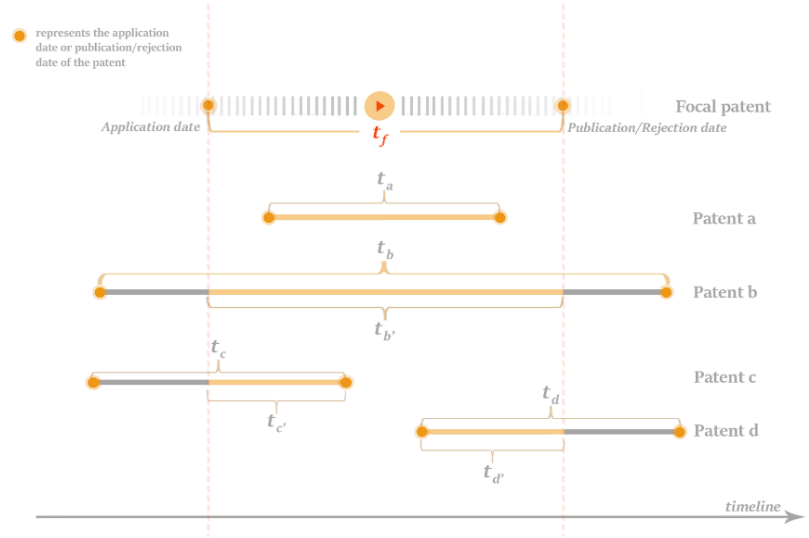
Examiner Workload. The variable of examiner workload quantifies the weighted number of other patents assigned to an examiner when she/he evaluates the focal patent.

We have considered all these four types of overlaps and calculated the weighted number of overlapping patents by considering the percentage of overlap time. The calculation formula is as follows:

$$W_f = \sum_{i=1}^{N_j} \frac{t_{fj}}{t_{ij}}, \quad (2)$$

where j is the type of patents, including patent *a, b, c, d,* N_j is the total number of type j patents. t_{fj} is the length of time that a patent of type j overlaps with a focal patent f *(i.e.,* ta, tb', tc', and td'). t_{ij} is the duration of the ith type j patent *(i.e.,* ta, tb, tc, and td).

Figure 1 *Patent Examiner workload*



Patent a: whose application date is after the focal patent and publication or rejection date is before the focal patent; patent b: whose application date is before the focal patent and publication or rejection date is after the focal patent; patent c: whose application date is before the focal patent and publication or rejection date is also before the focal patent; patent d: whose application date is after the focal patent and publication or rejection date is also after the focal patent.

Measures

Independent variables

Examiner Work Experience. Examiner work experience is the number of years the examiner has worked for USPTO. We exclude the examiner appearing in the first 2 years of the dataset to calculate more accurately ($M = 3.09$, $SD = 1.82$).

Control Variables

Team Size, References, IPCR Label, Number of Labels, Country/Region, Year

Results

Table 1 *The Correlation Matrix of Key Variables*

	Disruptive Innovation	Patent Approval	Patent Citations	Examiner Workload	Examiner Work Experience
Disruptive Innovation					
Patent Approval	-0.038***				
Patent Citations	-0.102***	0.035***			
Examiner Workload	-0.057***	0.229***	0.040***		
Examiner Work Experience	-0.049***	0.042***	-0.080***	0.205***	

Note: *p <0.05; **p<0.01; *** p <0.001

First, disruptive innovation has a negative correlation with patent approval. Second, examiner work experience and examiner workload have a positive correlation with patent approval. Thus, examiners with more extended experience or facing a larger workload are associated with an increased likelihood of granting a patent. Third, the patent approval has a positive relationship with patent citations.

Results

Table 2 *Mixed Effect Model and Interaction Effect on Patent Approval*

	Patent Approval				
	Model 1	Model 2	Model 3	Model 4	Model 5
Disruptive Innovation	-0.400*** (0.008)			-0.372*** (0.016)	-1.828*** (0.142)
Examiner Workload		1.150*** (0.006)		1.527*** (0.016)	1.232*** (0.032)
Examiner Work Experience			0.090*** (0.004)	0.083*** (0.004)	-0.068*** (0.032)
Disruptive Innovation *Examiner Workload					0.322*** (0.031)
Disruptive Innovation *Examiner Work Experience					-0.014 (0.009)
Examiner Workload *Examiner Work Experience					0.034*** (0.007)
Control variables					
Team Size	Yes	Yes	Yes	Yes	Yes
References	Yes	Yes	Yes	Yes	Yes
Number of Labels	Yes	Yes	Yes	Yes	Yes
IPCR Labels	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	No	No	No
Country	Yes	Yes	Yes	Yes	Yes
Random effect					
Examiner ID	Yes	Yes	Yes	Yes	Yes
Constant	0.188	-5.958***	-0.316***	-6.619***	-5.288***
ICC	0.540	0.439	0.470	0.505	0.503
Pseudo R^2	0.023	0.024	0.103	0.152	0.153

Note: * p <0.05; ** p<0.01; *** p <0.001

As **Table** 2 shows, there exists a negative influence of disruptive innovation on patent approval. According to the results of Model 2-4 in **Table** 2, both examiner work experience and examiner workload have a positive impact on patent approval. **Therefore, *H1*, *H2*, and *H4* are supported.**

Results

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	Model 1	Model 2	Model 3	Model 4	Model 5
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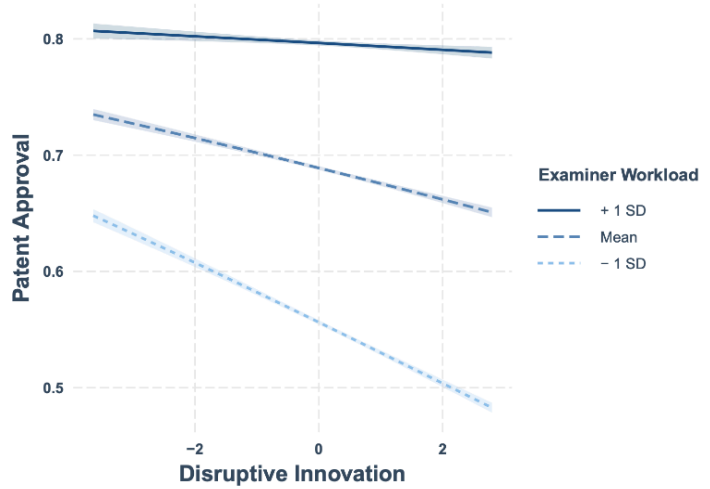
Figure 2 *The Moderation Effect of Examiner Workload on Disruptive Innovation and Patent Approval*



As model 5 shows in **Table** 2, examiner workload has a moderate effect on the relationship between disruptive innovation and patent approval. As shown in **Figure** 2, examiner workload can reduce the negative impact of disruptive innovation on the patent approval.

Therefore, ***H3* is supported.** In contrast, the moderation effect of examiner work experience is not significant. **Thus *H5* is rejected**.

Results

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	Patent Approval				
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Examiner Workload		1.150*** (0.006)		1.527*** (0.016)	1.232*** (0.032)
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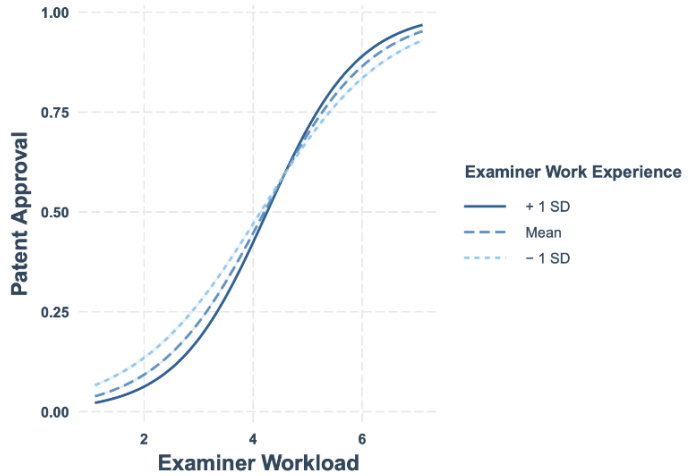
Team Size	Yes	Yes	Yes	Yes	Yes
References	Yes	Yes	Yes	Yes	Yes
Number of Labels	Yes	Yes	Yes	Yes	Yes
IPCR Labels	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	No	No	No
Country	Yes	Yes	Yes	Yes	Yes
Random effect					
Examiner ID	Yes	Yes	Yes	Yes	Yes
Constant	0.188	-5.958***	-0.316***	-6.619***	-5.288***
ICC	0.540	0.439	0.470	0.505	0.503
Pseudo R^2	0.023	0.024	0.103	0.152	0.153

Note: * p <0.05; ** p<0.01; *** p <0.001

Figure 3 *The Moderation Effect of Examiner Work Experience on Examiner Workload and Patent Approval*



According to Model 5 and **Figure** 3, there exists a critical point in the moderation effect. When the examiner workload is less than approximately 4.5, higher examiner work experience is associated with a lower probability of patent approval at the same workload level. However, when the workload exceeds around 4.5, higher examiner work experience is associated with a higher probability of patent approval at the same workload level. Therefore, **H6 is only partially supported.**

Results

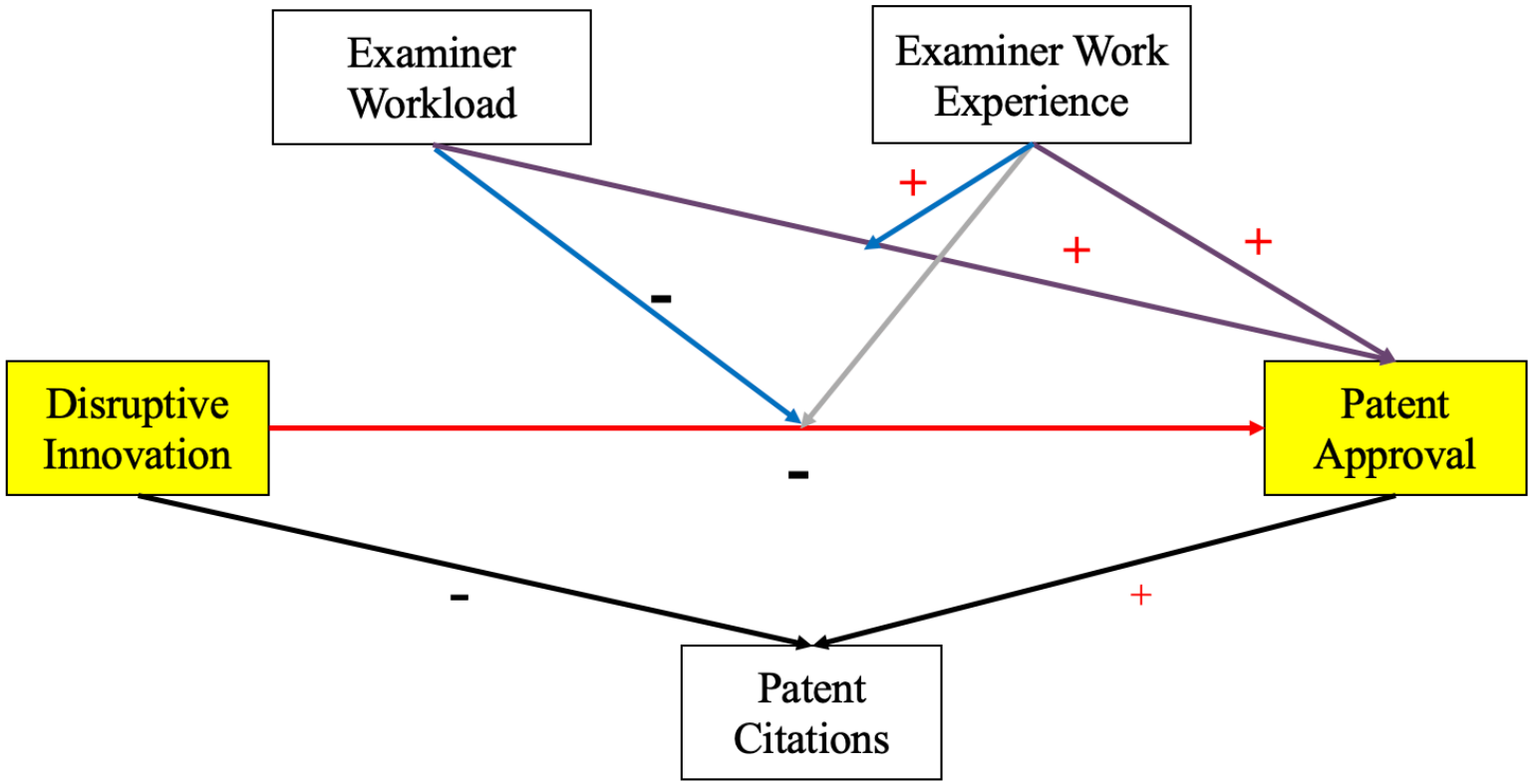
Table 3 *OLS Regression Models with and without PSW on Patent Citations*

	Patent Citations					
	Model 7 unweighted	Model 8 weighted	Model 9 unweighted	Model 10 weighted	Model 11 unweighted	Model 12 weighted
Patent Approval	0.043*** (0.002)	0.059*** (0.009)	0.036*** (0.002)	0.059*** (0.009)	0.062*** (0.003)	0.060*** (0.009)
Disruptive Innovation			-0.183*** (0.002)	-0.094*** (0.014)	-0.149*** (0.005)	-0.093*** (0.014)
Examiner Workload					-0.010* (0.003)	0.007 (0.005)
Examiner Work Experience					0.001 (0.001)	0.005 (0.007)
Control variables						
Team Size	Yes	Yes	Yes	Yes	Yes	Yes
References	Yes	Yes	Yes	Yes	Yes	Yes
Number of Labels	Yes	Yes	Yes	Yes	Yes	Yes
IPCR Labels	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Country	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.383*	1.551***	1.504***	1.591***	1.414***	1.571***
Adjusted R^2	0.132	0.136	0.138	0.138	0.153	0.138

Note: * p <0.05; ** p<0.01; *** p <0.001

As **Table** 3 demonstrates, there is a positive association between patent approval and patent citations, as well as a negative relationship between disruptive innovation and patent citations. We find no significant effect of examiner workload or work experience. Thus, patent approval contributes to an increase in patent citations, while disruptive innovation tends to reduce patent citations.

Results


Examiner Workload
Examiner Work Experience
Disruptive Innovation
Patent Approval
Patent Citations
+
+
+
-
-
-
+

Discussion & Conclusion

In summary, to investigate the scientific gatekeeping of disruptive innovation, this study examines the relationship between disruptive innovation, patent examiners, and patent approval.

- Disruptive innovation is detrimental to patent approval, whereas examiner workload and work experience can enhance it.
- Examiner workload mitigates the negative impact of disruptive innovation on patent approval, while examiner work experience can amplify the impact of examiner workload on patent approval.

This study contributes to the science of science by unveiling the seemingly contradictory gatekeeping logic of patent examiners. The implications help design a more innovation-friendly incentive mechanism for scientific gatekeeping.

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