The Crafting of Intellectual Property
Implications for Trolls, Litigation, and Innovation

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BU IP Day 2017
It is critically important that the USPTO issues patents that are both **correct** and **clear**. [It] can help **stimulate future innovation** without resorting to **needless high-cost court proceedings**.

Michelle Lee, USPTO Director
Research Questions

How much does the patent system affect innovation?

–> Patents: a mix of idea and legal construction
–> Examiners are involved in construction process
  – An understudied channel
–> Lee: examination quality affects both litigation and innovation
  – If effects are big: USPTO as a policy lever (vs. statutory reform)

How responsive are non-practicing entities (NPEs) to the legal construction of patents?

–> Accusation: purchasers and enforcers of weak patents (“needless court proceedings”)
–> Do they purchase patents granted by a specific set of examiners?
–> If so, do these examiners tend to grant weak patents?
Research Questions

- How much does the patent system affect innovation?
  - Patents: a mix of idea and legal construction
  - Examiners are involved in construction process
    - An understudied channel
  - Lee: examination quality affects both litigation and innovation
    - If effects are big: USPTO as a policy lever (vs. statutory reform)

- How responsive are non-practicing entities (NPEs) to the legal construction of patents?
  - Accusation: purchasers and enforcers of weak patents (“needless court proceedings”)
  - Do they purchase patents granted by a specific set of examiners?
  - If so, do these examiners tend to grant weak patents?
Research Design and Findings

Research design: use variation across examiners in post-grant outcomes to quantify the impact of legal construction

- Leverage quasi-random assignment for causal interpretation
  - Refinements: IT-only, docket instrument, random last digit units
- Focus on pool of granted patents
  - Control for selection on idea quality in order to isolate legal construction variation
- Use shrinkage methodology to deal with rare and noisy outcomes

Findings

- Examiners have large causal effects on important outcomes
  - NPE purchase, litigation, late-term private value, future patenting
- NPE purchase, litigation very sensitive to legal construction
  - Purchase from lenient examiners who force fewer additions to claims
- Lenient, high-NPE examiners grant more weak patents
  - Patents more likely to be re-issued, instituted in inter-partes review
**Related Literature**

- **Effect of patent system on innovation**
  - Patent laws: Nordhaus (1969); Klemperer (1990); Gilbert and Shapiro (1990); Sakakibara and Branstetter (2001); Moser (2006); Lerner (2009)
  - Patent grants: Williams and Sampat (2016); Farre-Mensa, Hegde and Ljungqvist (2017); Righi and Simcoe (2017)
  - *This paper: effect of patent examination process*

- **NPEs and innovation**
  - *This paper: effect of patent examiners on NPE activities*
Simple Relationships - Examiners and NPEs

NPE Purchase Rate (%) vs. Leave-One-Out Grant Rate

Feng, Jaravel (Harvard/LSE)
Examiners and Renewals

Feng, Jaravel (Harvard/LSE)

Crafting IP

BU IP Day 2017
Road Map

1. Data

2. Estimation of Examiner Effects on Post-Grant Outcomes
   - Methodology
   - Results
   - Random Assignment and Selection

3. NPE Behavior
   - Which examiners drive the effect?
   - Weak Patents and Additional NPE Behavior
Data Overview

Core sample

- USPTO PatEx plus data on claims examiner blocking actions
  - Frakes and Wasserman; Juristat
- 1.27 million non-continuation granted patents from 2001 to 2012
  - 2/3 continuation applications assigned to same examiner
- 11,401 patent examiners in 643 art units
  - Average tenure: 7 years
  - Average applications reviewed per year: 16

Subsequent outcomes

- 20% of sample is purchased by non-NPEs
- 1% of sample is purchased by NPEs
- 0.65% of sample is litigated by non-NPEs
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Estimating Examiner Effects on Post-Grant Outcomes

• Quasi-random assignment $\rightarrow$ interpret post-grant outcome differences as caused by examiners
  $\quad\rightarrow$ Address potential threats later (Righi and Simcoe 2017)

• Why not compare raw average outcomes across examiners?
  $\quad\rightarrow$ NPE and litigation outcomes are rare
  $\quad\rightarrow$ Simple approach overstates magnitudes
    $\quad$ e.g. 8 times too large for NPE

• Solution: look for persistent differences across examiners
  1. Bayesian shrinkage methodology
  2. Shrink raw averages by a signal to noise ratio

• End up with estimates of the right magnitude (split sample)
Estimation of Examiner Effects on Post-Grant Outcomes

Methodology

Extracting Residuals

\[ T_{ijt} = X_i \beta + a_{ut} + v_{ijt} \]
\[ v_{ijt} = \mu_j + \epsilon_{ijt} \]

- \( i \) indexes the patent, \( j \) the examiner, \( u \) the art unit

Data variables

- \( T \): outcome (e.g. NPE purchase, litigated, 103 blocking action)
- \( a_{ut} \): art unit-year fixed effect (random assignment level)
- \( X_i \): observable application characteristics (assignee, applicant history, number of claims at application)

Other variables

- \( \mu_j \): examiner causal effect
- \( \epsilon_{ijt} \): idiosyncratic noise
Shrinkage Using the Residuals

1. Aggregate residuals at examiner x year level:

\[
\bar{v}_{jt} = \frac{1}{n_{jt}} \sum_i v_{ijt} \left( = \mu_j + \frac{1}{n_{jt}} \sum_i \epsilon_{ijt} \right)
\]

2. Compute correlation of residuals across years (variance of examiner effect distribution):

\[
\hat{\sigma}_\mu^2 = \text{cov}(\bar{v}_{jt}, \bar{v}_{j(t+1)})
\]

3. For each examiner: shrink raw average residual by signal-to-noise ratio to recover estimate with same scale as \(\mu_j\):

\[
\text{ExaminerEffect}_j = \bar{v}_j \frac{\hat{\sigma}_\mu^2}{\text{Var}(\bar{v}_j)}
\]
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## Results

### Causal Examiner Effects on Post-Grant Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>$\hat{\sigma}/$Baseline Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPE Purchase</td>
<td>50.97%</td>
</tr>
<tr>
<td></td>
<td>[33.7%, 60.7%]</td>
</tr>
<tr>
<td>Non-NPE Litigation</td>
<td>62.1%</td>
</tr>
<tr>
<td></td>
<td>[42.62%, 71.99%]</td>
</tr>
<tr>
<td>Non-NPE Purchase</td>
<td>14.01%</td>
</tr>
<tr>
<td></td>
<td>[10.70%, 14.47%]</td>
</tr>
</tbody>
</table>
## Causal Examiner Effects on Post-Grant Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>$\hat{\sigma}_\mu$/Baseline Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment of 4th-Year Maintenance Fees</td>
<td>3.69%</td>
</tr>
<tr>
<td>Payment of 8th-Year Maintenance Fees</td>
<td>6.46%</td>
</tr>
<tr>
<td>Payment of 12th-Year Maintenance Fees</td>
<td>9.02%</td>
</tr>
<tr>
<td>Log patents by Assignee (within 5 years)</td>
<td>13.03%</td>
</tr>
</tbody>
</table>
## Causal Examiner Effects on Post-Grant Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>$\hat{\sigma}_\mu$/Baseline Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Total Citations</td>
<td>24.07%</td>
</tr>
<tr>
<td>External Patent Citations (0-3 years)</td>
<td>18.56%</td>
</tr>
<tr>
<td>Internal Patent Citations (0-3 years)</td>
<td>21.84%</td>
</tr>
</tbody>
</table>
Results Recap

- Largest examiner causal effects on legal-related outcomes
  - NPE purchase, litigation, inter-partes review filing
  - Focus of our second research question

- Smaller but sizable effects for innovation outcomes
  - Citations, future patenting
  - Late-term private value more sensitive than early-term
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Random Assignment Issues

- Previous research: random assignment mechanisms
  - Taking from the top of the pile
  - Random by last digit

- Worry: specialization even within art units
  - New evidence from Righi and Simcoe (2017)
  - Specialization of examiners
Workarounds

1. Focus on IT (tech centers 21, 24, 26)
   -> Righi and Simcoe (2017): specialization in other areas
   -> Recover similar results

2. Busy-ness instrument
   -> Exploit variation in busy-ness of lenient examiners
   -> Examiners with recent disposed applications → more likely to be assigned docketed application
   -> Instrument leniency with busy-ness weighted leniency across all examiners
   -> Recover similar relationships between outcomes and leniency

3. Identify units that randomize by last digit
   -> Chi-square statistic by examiner and last digit
   -> About 1/3 of applications in units that have p-value < 0.01
Estimation of Examiner Effects on Post-Grant Outcomes

Random Assignment and Selection

IT Only

NPE Purchase Rate (%) vs. Leave-One-Out Grant Rate

Feng, Jaravel (Harvard/LSE)
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Busy-ness Instrument

(a) Allocation

(b) Reduced Form
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3. Identify units that randomize by last digit
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   → About 1/3 of applications in units that have p-value < 0.01
Random Last Digit Unit Analysis

- Examiners’ signal SDs are similar in subsample of art units that randomize by last digit

<table>
<thead>
<tr>
<th>Outcome</th>
<th>$\hat{\sigma}_\mu$/Baseline Rate</th>
<th>Original</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPE Purchase</td>
<td>38.16%</td>
<td>50.97%</td>
</tr>
<tr>
<td>Non-NPE Litigation</td>
<td>41.85%</td>
<td>62.10%</td>
</tr>
<tr>
<td>Non-NPE Purchase</td>
<td>14.52%</td>
<td>14.01%</td>
</tr>
</tbody>
</table>
Selection

- Additional concern: examiners selecting based on quality of idea
  
  Variation is not about differences in legal construction

- Workaround
  
  Control flexibly for grant rate in outcome regression
  
  - Compare examiners with same grant rate
  
  - Assumption: idea quality is vertical (grant same ideas)
  
  - Remaining difference is due to legal construction differences
  
  - Similarly large differences in examiner effects remain

  Address remaining variation in selection (given grant rate)
  
  - Add additional controls: similar application, similar examiner
  
  - Inventor, assignee, and application characteristics at filing

- Alternative: Heckman correction (non-linear)
Examiners’ signal SDs are similar when controlling for (leave-one-out) examiner grant rate

<table>
<thead>
<tr>
<th>Outcome</th>
<th>$\hat{\sigma}_\mu$/Baseline Rate</th>
<th>Original</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPE Purchase</td>
<td>62.64%</td>
<td>50.97%</td>
</tr>
<tr>
<td>Non-NPE Litigation</td>
<td>63.06%</td>
<td>62.10%</td>
</tr>
<tr>
<td>Non-NPE Purchase</td>
<td>14.31%</td>
<td>14.01%</td>
</tr>
</tbody>
</table>
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How Do High-NPE Examiners Behave?

- NPEs buy disproportionately from a specific set of examiners
- Use prosecution behaviors of high NPE effect examiners to understand nature of NPE-purchased patents
  -> Note: not causal

Methodology
- Compute leave-one-out examiner effects for various prosecution behaviors
- Predict patent outcomes using these measures ($\hat{E}_j$)

$$NPE_{ijt} = \beta \hat{E}_j + \epsilon_{ijt}$$
Examiner Prosecution Behavior

- Examiner blocking action usage by type:
  - 101: not patentable subject matter, lacking utility
  - 102: not novel
  - 103(a): obvious
  - 112(a): unclear technological disclosure
  - 112(b): unclear claims language

- Claims text changes between application and grant
  - Edits in response to examiner blocking action critiques
NPE Purchase and 103(a) Usage

Which examiners drive the effect?

Feng, Jaravel (Harvard/LSE)
Formal Analysis - Pairwise Correlations

<table>
<thead>
<tr>
<th></th>
<th>NPE Purchase</th>
<th>Non-NPE Lit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>103(a) - Obviousness</td>
<td>-0.099***</td>
<td>-0.039**</td>
</tr>
<tr>
<td>(0.023)</td>
<td>(0.017)</td>
<td></td>
</tr>
<tr>
<td>112(b) - Unclear claims</td>
<td>-0.047**</td>
<td>-0.040**</td>
</tr>
<tr>
<td>(0.023)</td>
<td>(0.018)</td>
<td></td>
</tr>
<tr>
<td>Δ Words/Claim</td>
<td>-0.148***</td>
<td>-0.061***</td>
</tr>
<tr>
<td>(0.021)</td>
<td>(0.016)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>1,269,623</td>
<td></td>
</tr>
</tbody>
</table>

* p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01
Addressing Extensive Margin Selection Effects

Regression Coefficient, Controlling for Examiner Allowance Effect

Regression Coefficient, No Controls for Examiner Allowance Effect

Coeff. 1.13*** (s.e. 0.139), R2=0.94
Summary

- Main finding: examiners with high NPE and non-NPE litigation effects are “lenient”:
  - Use specific blocking actions less often: 103(a), 112(b)

- Why might these patents be useful to NPEs?
  - *Obviousness*: higher likelihood others take this step when developing products
  - *Vague claims language*: many possible interpretations which can be used flexibly to read on subsequent technology

- Remaining questions
  - Are they buying weak patents?
  - Can other NPE purchasing mechanisms explain the data?
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Weak Patents

**Definition:** patents that may well be invalid, but require conclusive litigation to find out

→ NPEs accused of asserting weak patents

**Ideal data**

→ Have courts rule on all granted patents

**Our evidence**

→ Examiner errors: re-issuance filings
  - 35 U.S.C. 251: ask for re-issuance if patent deemed wholly or partly inoperative or invalid through error
  - Much higher rate for lenient examiners

→ Inter-partes review institution (conditional on filing)
  - Lenient examiners more likely to have patents challenged
  - AND found to be likely invalid conditional on filing
Examiner Errors

The graph shows a scatter plot with a trend line. The x-axis represents the Examiner Leave-One-Out Grant Rate, ranging from 0.4 to 1.0, and the y-axis represents the percentage of Re-Issued patents, ranging from 0.16 to 0.24. The trend line indicates a positive correlation between examiner errors and the rate of re-issuance.
Invalidity Rulings

![Graph showing the relationship between IPR Institution Rate and Examiner Grant Rate Effect (SDs).]
Targeted Purchases

- NPEs also target patents within firm portfolios
  - \( \rightarrow \) Results hold after controlling for assignee fixed effects

- Rules out purchasing behavior based solely on characteristics of original firm
  - \( \rightarrow \) Supply-driven: NPEs buy whole portfolios during fire sales
    - Struggling firms hold weaker IP
  - \( \rightarrow \) NPEs buy based on firm attribute: e.g. small firms or individuals
    - Lenient examiners grant more small entity patents

- Another possible form of targeting: buy patents on the best ideas in the pool of weak patents
  - \( \rightarrow \) Use an independent signal of idea quality: EPO decisions
### EPO Evidence

**Table:** NPE Purchase vs. EPO Decision

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPO Grant</td>
<td>-0.461***</td>
<td>-0.211***</td>
<td>-0.199**</td>
<td>-0.023</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.057)</td>
<td>(0.059)</td>
<td>(0.063)</td>
</tr>
<tr>
<td>Artunit-Year F.E.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Examiner F.E.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Assignee F.E.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>218,867</td>
<td>218,867</td>
<td>217,491</td>
<td>197,919</td>
</tr>
</tbody>
</table>
## EPO Evidence

<table>
<thead>
<tr>
<th></th>
<th>NPE Purchase</th>
<th>Non-NPE Purch.</th>
<th>Non-NPE Lit.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EPO Grant</strong></td>
<td>-0.2144**</td>
<td>0.0037</td>
<td>-0.0831</td>
</tr>
<tr>
<td></td>
<td>(0.1001)</td>
<td>(0.0133)</td>
<td>(0.1074)</td>
</tr>
<tr>
<td><strong>Examiner F.E.</strong></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Assignee F.E.</strong></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Artunit-Year F.E.</strong></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>109,383</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample: patents of examiners with above median NPE Effect
Conclusion

Core results

→ Examiners have sizable causal effects on the nature and subsequent usage of patents

→ Biggest impacts on legal outcomes, but general effects on private value and follow-on innovation

NPE behavior

→ Highly dependent on examiner behavior

→ Likely to be selectively purchasing weaker patents
Examiners’ signal SDs are similar when controlling for (leave-one-out) examiner allowance effect, and inventor’s and assignee’s past applications, grants and citations.

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<tbody>
<tr>
<td>NPE Purchase</td>
<td>75.94%</td>
<td>50.97%</td>
</tr>
<tr>
<td>Non-NPE Litigation</td>
<td>90.32%</td>
<td>62.10%</td>
</tr>
<tr>
<td>Non-NPE Purchase</td>
<td>17.04%</td>
<td>14.01%</td>
</tr>
</tbody>
</table>