Quantifying Skill in Games

Theory and Empirical Evidence for Poker

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Agenda

• Introduction
• Current legal situation: Skill vs. Chance
• The impact of repetitions of a game: CRF
• Empirical Evidence for Poker
• Evaluating the Predominance Test
• Perspectives
The Skill vs. Chance Debate for Poker: Appropriate Thoughts but Lack of Concepts

*Joker Club, LLC v. District Attorney, No. 4 CVS 6034 (N.C. Super. Ct. July 1, 2005)*, Hearing on May 23, 2005:

Powell (lawyer): “What might happen if we played a single hand of poker?”

Cooke (expert and professional poker player): “You would have a chance of winning.”

Powell: “How about if we play 1,000 hands?”

Cooke: “You’re dead!”
Predominance of chance/skill is crucial

- Most Legal Systems: Predominance Test
- Three criteria for games of chance:
  - Fee
  - Potential reward
  - Outcome depends *predominantly* on chance

⇒ Three types of games: Pure Games of Skill, Pure Games of Chance, *Mixed Games*
⇒ Problem of *Operationalization* of Skill and Chance
The Predominance Test

Games of Chance vs. Games of Skill

defined as a game of chance

defined as a game of skill

0% pure games of chance, e.g. Roulette

50% (Pure) games of skill, e.g. Chess

Skill 100%

How can skill and chance be measured and quantified?
Quantification of the Skill Condition

- Poker has skill elements
- Skill > chance in poker?
- Qualitative analysis is insufficient → quantification
- The skill condition can be stated as follows:

\[
Share\ of\ skill = \frac{\text{skill}}{\text{skill} + \text{chance}} \times 100\% > 50\%
\]

- Any game for which this condition is satisfied is defined as a game of skill
Skill Adds up – Chance Cancels out

- Skill adds up: $E_{ni}[x] = E_{1i}[x]*n_i$

- Chance cancels out: $\lambda \sigma_{ni} = \lambda \sigma_{1i} * \sqrt{n_i}$

- Skill condition Answer depends on the time dimension!
- $\lambda$: significance coefficient
- $n$: repetitions
- $E^A[x]$: expected value of a game $x$ adjusted by the fee
- $i$: individual player
The question is *when does a game become a game of skill* rather than *if* it is a game of skill!

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Proportion of outcome

--- Skill

--- Chance

50%

n* = CRF_i

n = Repetitions
```
The Critical Repetition Frequency (CRF): 50% Skill and 50% Chance

- A threshold $n^*$ exists at which the outcome of a mixed game is 50% due to skill and 50% due to chance
  - with a probability that depends on the significance level $\lambda$
- $n^*$ is called the critical repetition frequency (CRF) of a game
- The CRF can be calculated as follows:

$$n^*_i = CRF_i = \frac{(\lambda \sigma_{1i})^2}{E_{1i}^A[x]^2}$$

- The CRF is negatively related to
  - The adjusted expected value (relative skill in poker)
- The CRF is positively related to
  - The variance
  - The significance level
Digging the Gold Mine: Empirical Evidence from Online Poker

- Online Poker games for real money
- Pokerstars and Partypoker from 04/08 to 05/08
- Pokerstars from 04/09 to 05/09
- Mostly Midstakes recorded

<table>
<thead>
<tr>
<th></th>
<th>Microstakes</th>
<th>Lowstakes</th>
<th>Midstakes</th>
<th>Highstakes</th>
<th>„Nosebleeds“</th>
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<tbody>
<tr>
<td><strong>Blinds</strong></td>
<td>0,01$/0,02$ to</td>
<td>0,10$/0,25$ to</td>
<td>1$/2$ to</td>
<td>10$/20$ to</td>
<td>&gt; 50$/100$</td>
</tr>
<tr>
<td></td>
<td>0,05$/0,10$</td>
<td>0,5$/1$</td>
<td>5$/10$</td>
<td>50$/100$</td>
<td></td>
</tr>
<tr>
<td><strong>Regular</strong></td>
<td>2$ - 10$</td>
<td>25$-100$</td>
<td>200$-1.000$</td>
<td>2.000$-10.000$</td>
<td>&gt; 10.000$</td>
</tr>
<tr>
<td><strong>buyin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number</strong></td>
<td>~49%</td>
<td>~43%</td>
<td>~6%</td>
<td>~2,6%</td>
<td>~0,07%</td>
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<tr>
<td><strong>of players</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Skill</strong></td>
<td>very large</td>
<td>large</td>
<td>medium</td>
<td>low</td>
<td>very low</td>
</tr>
<tr>
<td><strong>spread</strong></td>
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Main Result: CRF lies between 700 and 5,000 hands depending on the game design

- Data from 04/05 2009:

| Game Type     | Sample Size | \(|\text{winrate}^A|\) | \(\tilde{\sigma}_{1i}\) | CRF\(_{95.5\%}\) | CRF\(_{99.7\%}\) |
|---------------|-------------|-----------------|----------------|-----------------|-----------------|
| NL 25 6max    | 64,291      | 0.3333          | 8.121          | 2,378           | 2,378           |
| NL 25 10max   | 43,698      | 0.3013          | 5.547          | 1,352           | 1,352           |
| NL 400 6max   | 12,106      | 0.283           | 8.438          | 3,556           | 3,556           |
| NL 400 10max  | 5,120       | 0.1957          | 6.719          | 4,715           | 4,715           |
| NL 1000 6max  | 3,336       | 0.2845          | 10.126         | 5,063           | 5,063           |
| FL 1/2 6max   | 17,296      | 0.2585          | 3.471          | 721             | 721             |
| FL 1/2 10max  | 7,395       | 0.2427          | 2.95           | 591             | 591             |

- In comparison 04/05 2008:

| Game Type     | Sample Size | \(|\text{winrate}^A|\) | \(\tilde{\sigma}_{1i}\) | CRF\(_{95.5\%}\) | CRF\(_{99.7\%}\) |
|---------------|-------------|-----------------|----------------|-----------------|-----------------|
| NL 200-1000 6max | 51,761 | 0.6354 | 8.624 | 737 | 1,658 |
## The Average Player Reaches the CRF Quickly

<table>
<thead>
<tr>
<th></th>
<th>Offline</th>
<th></th>
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<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
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<tr>
<td>Hands per Hour</td>
<td>30</td>
<td>75</td>
<td>150</td>
<td>300</td>
<td>450</td>
<td>600</td>
<td>750</td>
<td>900</td>
</tr>
<tr>
<td>Hours for 1,000 hands</td>
<td>33.3</td>
<td>13.3</td>
<td>6.7</td>
<td>3.3</td>
<td>2.2</td>
<td>1.7</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Hours for 4,000 hands</td>
<td>133.2</td>
<td>53.3</td>
<td>26.7</td>
<td>13.3</td>
<td>8.9</td>
<td>6.7</td>
<td>5.3</td>
<td>4.4</td>
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</tbody>
</table>

- **Online**: Average player reaches CRF after a couple of sessions
- For *this* sample poker seems to be a game of skill
- Or better: A game of lacking skill
  - Median player is losing intensely
  - Winning players’ CRF: 50,000 to 500,000 hands
Evaluating the Predominance Test: Legal Uncertainty for (Dynamic) Mixed Games

- The CRF is not robust to the winrate
- The winrate changes over time:
  - Players join and leave the player pool, the skill spread rises and the CRF decreases (new players are generally less skilled)
  - Existing players improve due to learning effects
- Another sample may yield a different CRF (100,000 is not unlikely)
- Poker then becomes a game of chance rather than a game of skill
- It is a normative question which CRF is sufficient for a game to be a game of skill

→ Legal uncertainty!

→ Predominance test is insufficient!
A Different Approach: Social Costs

• Goal: Maximizing welfare
• The relevant question: „Does a game lead to social losses?“
  ➢ Reduce availability of welfare decreasing games
  ➢ Social Costs as legitimation for regulation of gambling
• What are the social losses of gambling?
• Is the predominance test the best way to identify undesirable games?
• Does chance correlate with social losses?
  ➢ Illusion of Control (Langer/Roth)
First Step: Slight Modification of the Predominance Test

- Possible criteria
  - (Significant) Fee
  - Potential Reward
  - Outcome depends at least partially on chance (as regulation in UK)
  - No Sports

- Avoiding legal uncertainty (the definition only excludes pure games of skill)

- Sports are excluded as they are socially desirable

- Empowerment of the administration to fix a de minimus threshold for interpreting „fee“
  - Important: relative threshold (Call-in Shows)
Next step: Evaluating Games and Choosing the Right Level of Regulation

• Evaluating games
  - Slot machines are worse than casino table games
  - Casino table games are worse than lotteries
  - Etc.
• For instance, in Germany the „heroin of gambling“ (slot machines) is the least regulated…
• What about internet gambling?

Aim: Coherent regulation according to risk exposure
Predominance Test

Degree of Regulation according to risk exposure

Non-problematic Games

Games

Regulated Games

Predominance Test

Degree of Regulation according to risk exposure

Coherent Regulation

University of Hamburg Institute of Commercial Law

Skill in Games: Ingo C. Fiedler
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Thank you for your kind attention!

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