

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

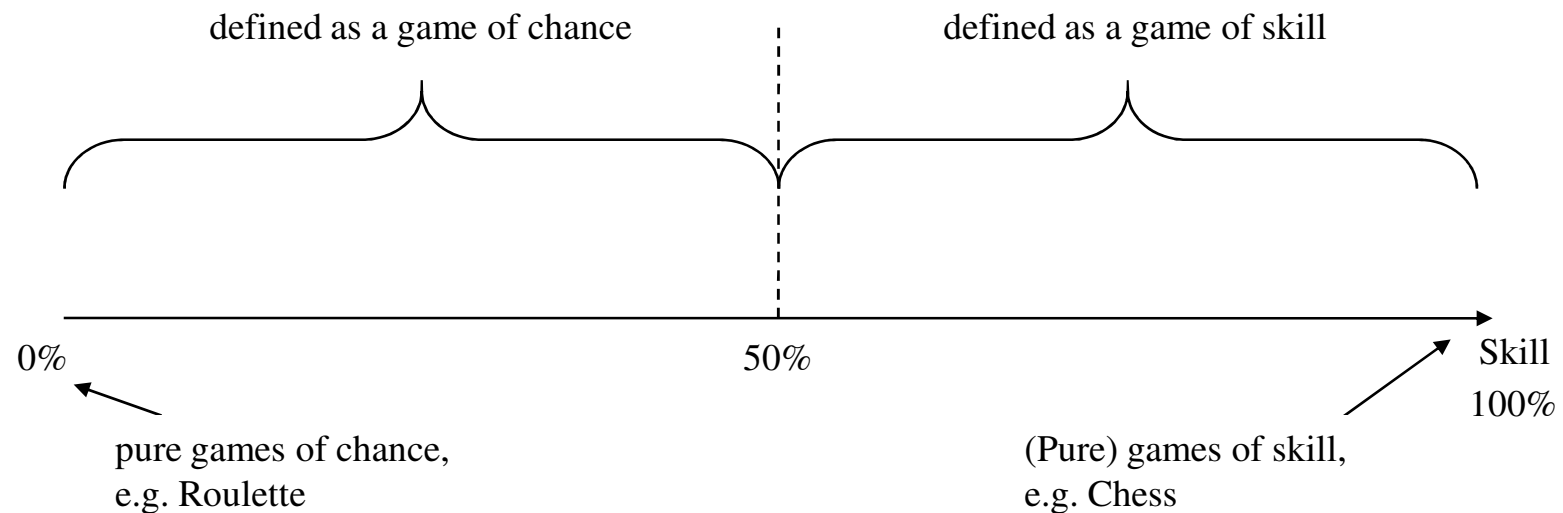
- Most Legal Systems: Predominance Test
- Three criteria for games of chance:
 - Fee
 - Potential reward
 - **Outcome depends *predominantly* on chance**

⇒ 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



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:

$$\textit{Share of skill} = \frac{\textit{skill}}{\textit{skill} + \textit{chance}} * 100\% \stackrel{!}{>} 50\%$$

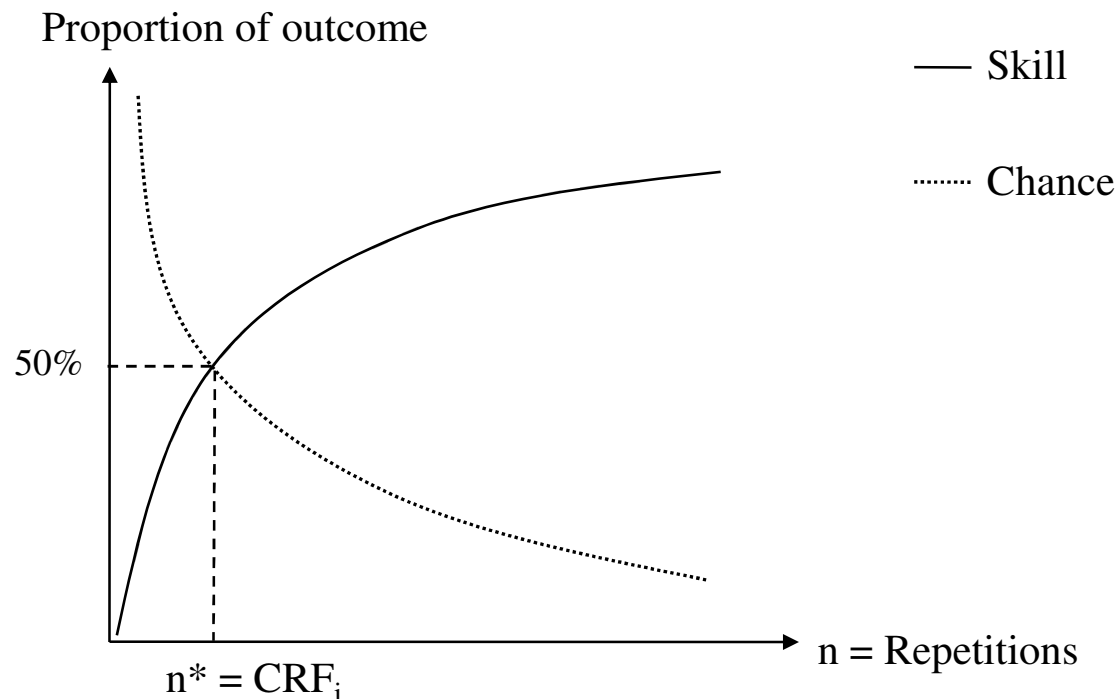
- Any game for which this condition is satisfied is defined as a game of skill

Skill Adds up – Chance Cancels out

- Skill adds up: $E_{ni}^A[x] = E_{1i}^A[x] * n_i$
- Chance cancels out: $\lambda \sigma_{ni} = \lambda \sigma_{1i} * \sqrt{n_i}$
- Skill condition Answer depends on the time dimension!
- λ := significance coefficient
- n := repetitions
- $E^A[x]$:= expected value of a game x adjusted by the fee
- i := individual player

The Influence of Repetitions

The question is *when does a game become a game of skill rather than if it is a game of skill!*



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 λ
- 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

	Microstakes	Lowstakes	Midstakes	Highstakes	„Nosebleeds“
Blinds	0,01\$/0,02\$ to 0,05\$/0,10\$	0,10\$/0,25\$ to 0,5\$/1\$	1\$/2\$ to 5\$/10\$	10\$/20\$ to 50\$/100\$	> 50\$/100\$
Regular buyin	2\$ - 10\$	25\$-100\$	200\$- 1.000\$	2.000\$- 10.000\$	> 10.000\$
Number of players	~49%	~43%	~6%	~2,6%	~0,07%
Skill spread	very large	large	medium	low	very low

Main Result: CRF lies between 700 and 5,000 hands depending on the game design

- Data from 04/05 2009:

	NL 25 6max	NL 25 10max	NL 400 6max	NL 400 10max	NL 1000 6max	FL 1/2 6max	FL 1/2 10max
n	64,291	43,698	12,106	5,120	3,336	17,296	7,395
$ winrate^A $	0.3333	0.3013	0.283	0.1957	0.2845	0.2585	0.2427
$\tilde{\sigma}_{1i}$	8.121	5.547	8.438	6.719	10.126	3.471	2.95
CRF_{95.5%}	2,378	1,352	3,556	4,715	5,063	721	591
CRF_{99.7%}	5,351	3,043	8,001	10,609	11,392	1,622	1,330

- In comparison 04/05 2008:

	n	$ winrate^A $	$\tilde{\sigma}_{1i}$	CRF95.5%	CRF99.7%
NL 200-1000 6max	51,761	0.6354	8.624	737	1,658

The Average Player Reaches the CRF Quickly

	Offline		Online						
Number of Tables	1	1	2	4	6	8	10	12	16
Hands per Hour	30	75	150	300	450	600	750	900	1,200
Hours for 1,000 hands	33.3	13.3	6.7	3.3	2.2	1.7	1.3	1.1	0.8
Hours for 4,000 hands	133.2	53.3	26.7	13.3	8.9	6.7	5.3	4.4	3.3

- 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

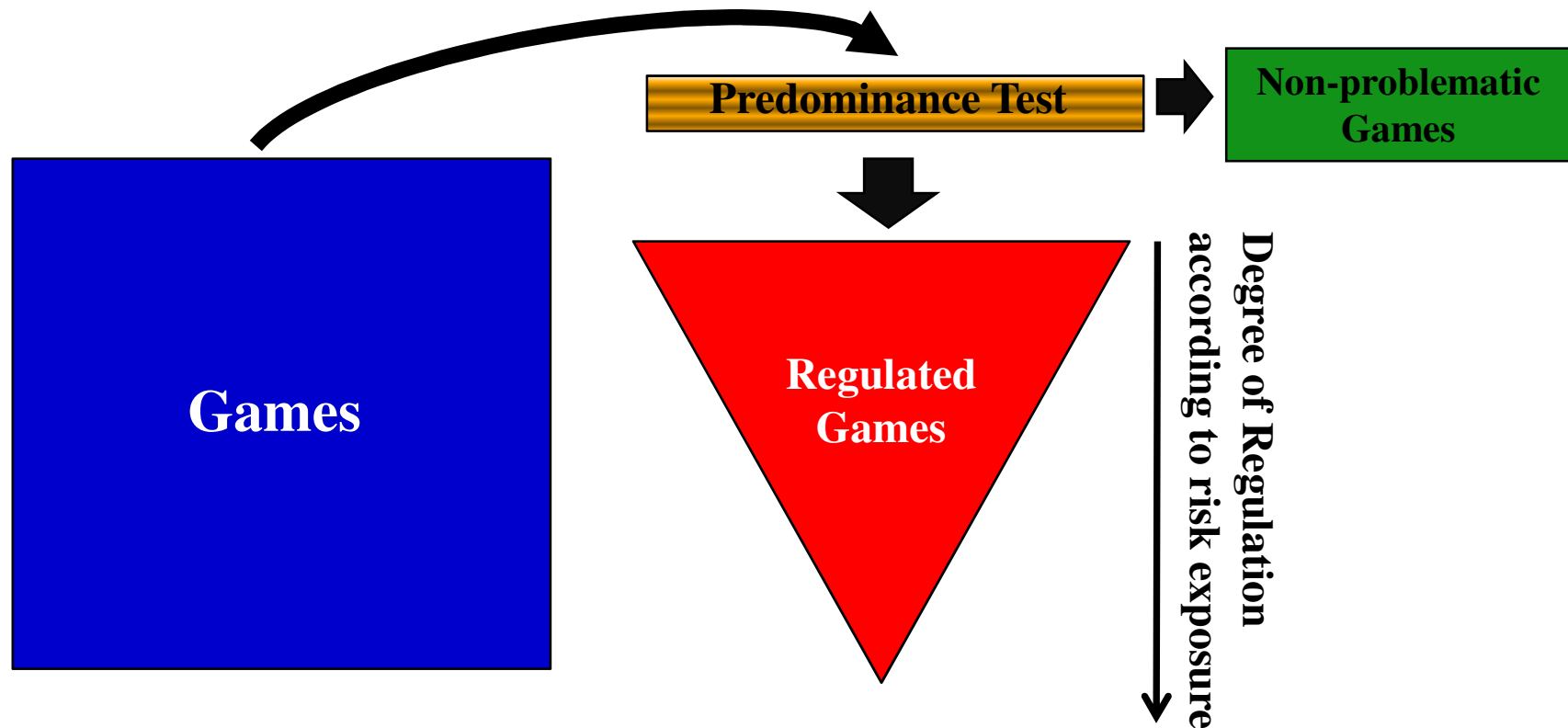
- Possible criteria
 - (Significant) Fee
 - Potential Reward
 - Outcome depends at least *partially* on chance (as regulation in UK)
 - No Sports
- Avoiding legal uncertainty (the definition only excludes *pure* games of skill)
- Sports are excluded as they are socially desirable
- Empowerment of the 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

Coherent Regulation



Thank you for your kind attention!

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