

Skill in Games

Theory and Empirical Evidence for Poker

Ingo C. Fiedler

ingo.fiedler@public.uni-hamburg.de

EMLE-Workshop 13th February 2009
Hamburg

I.C. Fiedler/J.P. Rock, Quantifying Skill in Games – Theory and Empirical Evidence for Poker, Gaming Law Review and Economics, 2009, 13(1), pp. 50-57.

U+H



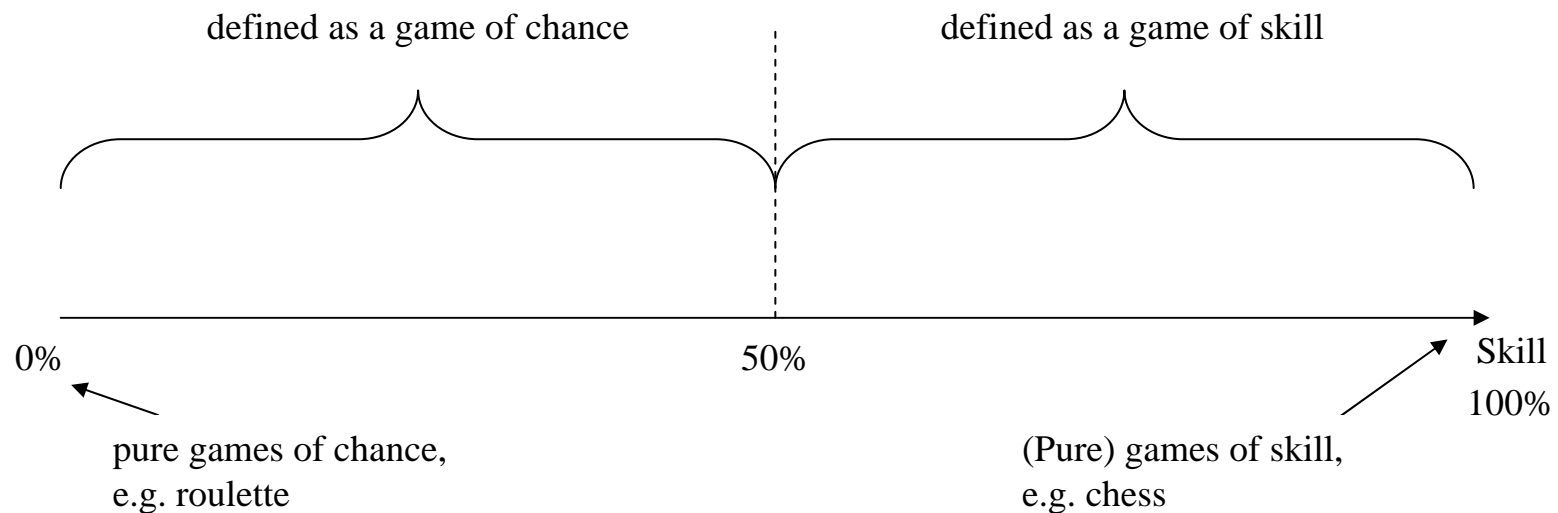
University of Hamburg
Institute of Commercial Law

Different Regulation of Games

- Games of Skill not regulated
- Games of chance strongly regulated
- Three criteria for games of chance:
 - Fee
 - Potential reward
 - Outcome depends predominantly on chance
- Chance/skill ratio of the *average* player is determining

The Definition of Chance Games

The German Definition of Chance Games



How can skill be measured and quantified?

Skill in Poker

- Poker requires the following decisions
 - Folding, calling, betting, raising
 - Before the flop, on the flop, on the turn, on the river
 - Determining how much to bet/raise (only the No Limit variant)
- Decisions depend on various parameters
- Parameters have to be recognized, weighted and involved in the decision process to maximize value
- This procedure requires several skill components

Poker: Literature on the Skill/Chance Debate

- Qualitative Approaches: *Kretschmer; Koenig/Simon; Fischhaber/Manz; Holznagel; Meyer/Hayer*
 - Fail to quantify influence of chance and skill
- Modelling Poker: *Dreef/Borm/Van der Genugten; Alon*
 - Poker is too complex to model
- Empirical Research: *Dedonno/Dettermann; Sévigny/Ladouceur/Dufor; Cabot/Hannum*
 - Due to the artificial environment no imitation of reality

➔ Need for an empirical study of poker in *reality*

Skill in Games: Operationalization

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

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

- If this condition holds for a game, it is a game of skill

Skill in Games: Operationalization (2)

- *Outcome*:= payoff - initial payment
- *Chance*:= everything which is cancelled in the long run, is equally distributed between the players and non-discriminatory
 - *Chance*:= standard deviation of the outcome of player i : $\lambda\sigma_{ni}$,
- *Skill*:= The outcome, which remains after infinite repetitions of a game (everything which is not chance)
 - *Skill*:= relative skill = adjusted expected value of a player: $E_{ni}^A[x]$

λ := significance coefficient

n := repetitions

x := specific game

i := individual player

Skill in Games: Operationalization (3)

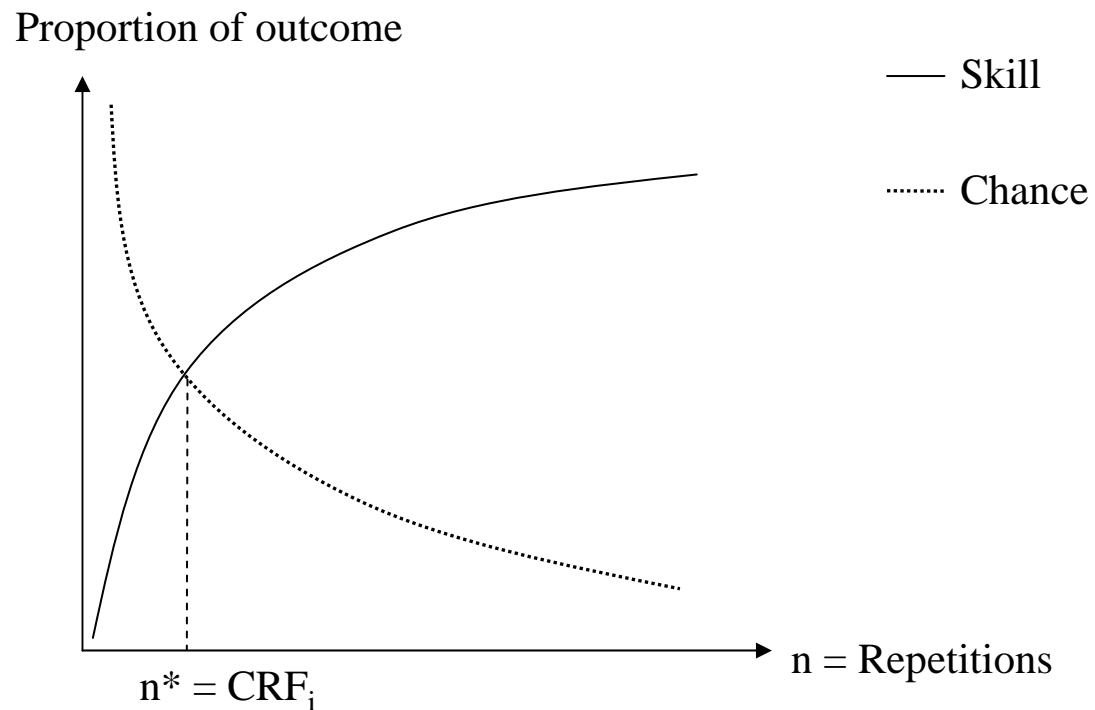
$$\text{Share of skill for player } i = \frac{|E_{ni}^A[x]|}{|E_{ni}^A[x]| + \lambda\sigma_{ni}} * 100\% \stackrel{!}{>} 50\%$$

$$|E_{ni}^A[x]| = E_{1i}^A[x] * n_i$$

$$\lambda\sigma_{ni} = \lambda\sigma_{1i} * \sqrt{n_i}$$

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

Skill in Games: The influence of repetitions



Skill in Games: The critical repetition frequency (CRF)

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

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

Skill in Games: The CRF (2)

- The CRF is positively related with
 - The variance of the outcome per repetition
 - The significance level:

$$\text{for } \lambda = 1 : \quad CRF_{i,68.3\%} = \frac{\sigma_{1i}^2}{E_{1i}^A[x]^2}, \quad \text{for } \lambda = 2 : \quad CRF_{i,95.5\%} = \frac{4\sigma_{1i}^2}{E_{1i}^A[x]^2}$$

$$\text{for } \lambda = 3 : \quad CRF_{i,99.7\%} = \frac{9\sigma_{1i}^2}{E_{1i}^A[x]^2}$$

- The CRF is negatively related with
 - The adjusted expected value per repetition
- The CRF varies for different players i

➔ CRF for the average Poker player?

Empirical Evidence for Poker: The Sample

- Online Poker games for real money
- Pokerstars and Partypoker from 04/19 to 07/05 2008
- 51,761 players
- 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	huge	large	medium	low	very low

Empirical Evidence for Poker: Main Results

Player group	n	$ \text{winrate}^A $	$\tilde{\sigma}_{1i}$	$\text{CRF}_{95.5\%}$	$\text{CRF}_{99.7\%}$
All players	51,761	0.6354	8.6243	737	1,658

Winrate := adjusted expected value in big blinds

Empirical Evidence for Poker: Interpreting the Results

- But: Midstakes are not representative → CRF is lower
- best CRF? $CRF_{95,5\%}$ or $CRF_{99,7\%}$?
- We round the CRF to 1,000 hands
- How many hours are 1,000 hands?

	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	1200
Hours to reach CRF	33,3	13,3	6,7	3,3	2,2	1,7	1,3	1,1	0,8

Empirical Evidence for Poker: Interpreting the Results (2)

- Average player reaches CRF after a couple of sessions
- For *this* sample poker seems to be a game of skill
- But:
 - 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)
 - Learning effects
 - Another sample can come to a different CRF (100,000 is not unlikely)
 - Poker is then a game of chance rather than a game of skill
- In Addition: It is a normative question which CRF is sufficient for a game to be a game of skill

➡ **Legal uncertainty!**

➡ **Improving the definition of games of chance!**

Thank you for your kind attention!

ingo.fiedler@public.uni-hamburg.de

I.C. Fiedler/J.P. Rock, Quantifying Skill in Games – Theory and Empirical Evidence for Poker, Gaming Law Review and Economics, 2009, 13(1), pp. 50-57.

Backup Slides

Skill in Poker: Parameters that Influence Decisions in Poker

- Absolute position
- Relative position
- Stack sizes
- Pot size (pot odds)
- Strategy of opponents
- Actions of opponents
- Hand range of opponents
- Hand range that the opponents suspect the player has
- Risk preferences
- The player's cards
- The cards on Flop, Turn and River

Skill in Poker: Skill Components in Poker

- Mathematic understanding
- Analytical intellectual power
- Attentiveness
- Memory
- Ability to make fast decisions
- Elimination of emotions form one's decisions
- Knowledge of game theoretic insights
- Strategic thinking
- Adaptiveness
- Enjoyment of continous learning
- Ability to self-control and self-monitor

Empirical Evidence for Poker: Results

Player group	n	$ \text{winrate}^A $	$\tilde{\sigma}_{1i}$	$\text{CRF}_{95,5\%}$	$\text{CRF}_{99,7\%}$
All	51,761	0.6354	8.6243	737	1,658
>100 hands	22,548	0.2753		3,925	8,832
>1,000 hands	5,138	0.107		25,986	58,468
> 10,000 hands	934	0.0686		63,220	142,246
Top 100	100	0.0577		89,362	201,065

Winrate = adjusted expected value

Empirical Evidence for Poker: Results (2)

- Median of the absolute winrate decreases rapidly the more hands a group played
- Skill of top 100 group is highest, but absolute amount of skill is lower
- Top 100 has a high homogeneity
- High absolute winrates only with negative winrates
- Absence of losing players in top 100 $\rightarrow |\text{winrate}^A| \downarrow \rightarrow \text{CRF} \uparrow$

➔ Low skill establishes itself much faster than high skill

Evaluating the Predominance Test

- Goal: Maximizing welfare
- The relevant question: „Does a game lead to social losses?“
 - Minimize availability of welfare decreasing games
 - Social Costs as legitimation for regulation of gambling
- Are skill and the predominance test the best way to identify undesirable games?
- Does chance correlate with social losses?

The Social Costs of Gambling

- Currently, there is no sufficient research on the social costs of gambling
- Main component: *pathological gambling* and its consequences
 - Financial losses
 - Mental disorders
 - Physical harm
 - Deficit decision-making
 - Damages to the personal environment
 - Delinquency (Gambling-related crime)

➔ What drives pathological gambling?

What drives pathological gambling?

- Chance in the form of variance is an important factor
 - Illusion of control
- But there are many other factors not covered by the current regulation
 - Frequency of events
 - Possibilities to influence the outcome
 - Jackpots
 - Information asymmetry
 - Availability
 - Cue Density

 **Need for a definition which catches all socially detrimental games**

Changing the definition of regulated games

- Suggestion of criteria
 - Fee
 - Potential Reward
 - Outcome depends at least *partially* on chance
 - No Sports
- Avoiding legal uncertainty (only pure games of skill are excluded from this definition)
- Sports are excluded as they are socially desirable
- Empowerment of the administration to fix a de minimus threshold („Bagatellgrenze“) for interpreting „fee“
 - Important: *relative* threshold (Call-in Shows)

Next step: Choosing the right level of regulation

- Evaluating games
 - Slot machines are worse than casino games
 - Casino games are worse than lotteries
 - Etc.
- In Germany the slot machines are the least regulated games...

➔ Coherent regulation of the 30bn € German gambling market?