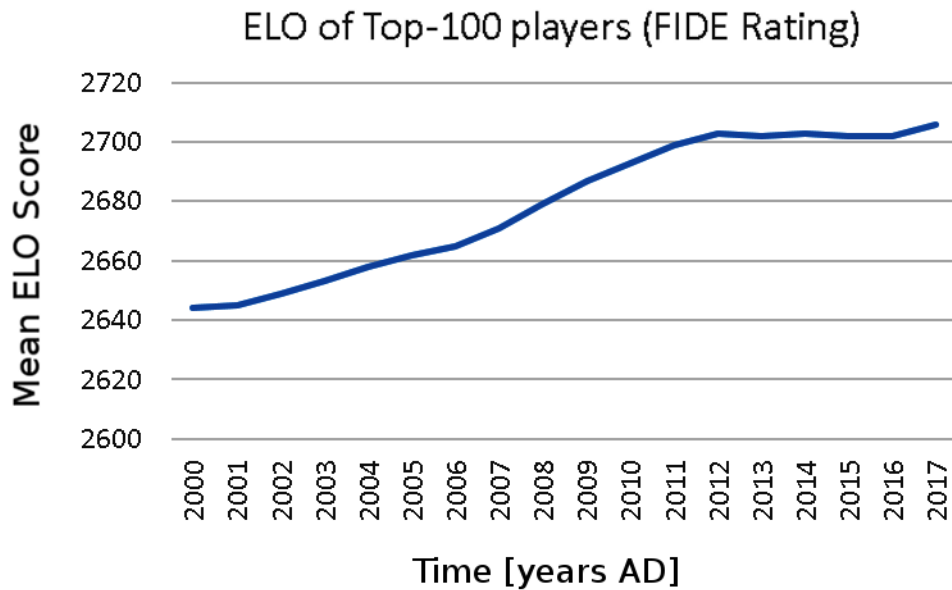
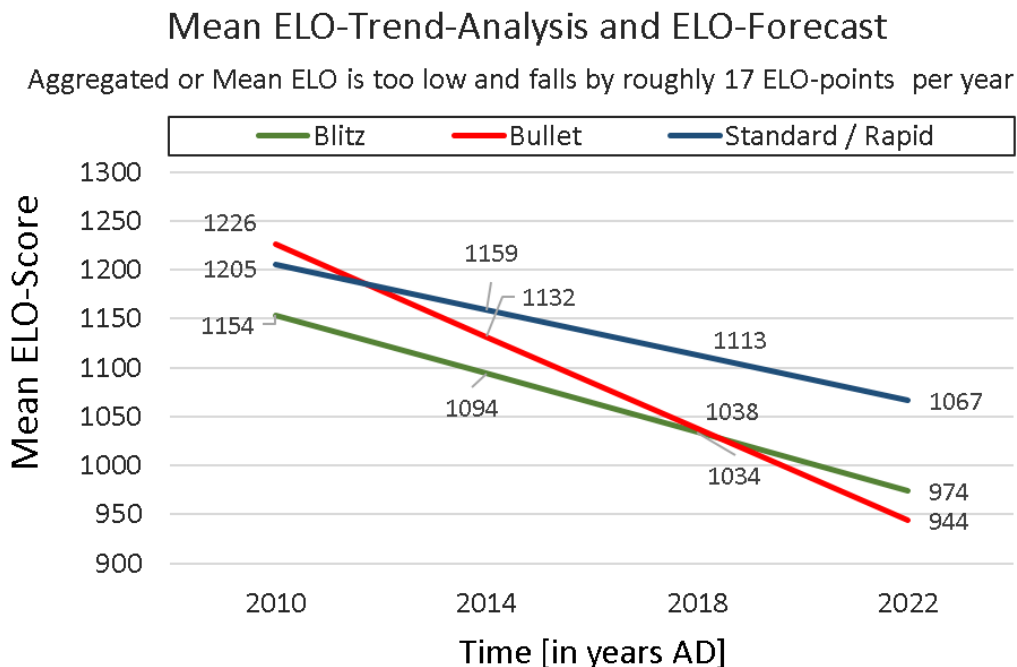


Supplementary material



Supplementary Figure 1 FIDE-ELO-ratings of the top-100 chess players is increasing since 2000. This likely also indicates a global trend of slightly improving chess skills of all chess players. It has never been so easy to learn chess due to websites and apps like chess.com that offer great possibilities to learn chess. Thus, one may assume that the mean RSS-ELO of chess players is slightly increasing. In comparison, the average ELO of online chess seems to fall slightly in the same time window, while even the top player's ELO could and can still rise.



Supplementary Figure 2 The Online-Chess aggregated or average ELO-rating is most likely too low and keeps falling by roughly 17 ELO-points per year. Original mean ELO values are shown for the year 2014 and 2018. 2010 and 2022 ELO-values are a past guess and a forecast based on the real data and trend of 2014 and 2018. Obviously, many hundred ELO-points seem to be already missing per player and the trends are still falling year by year. The lack of ELO-points might be ELO-segment specific as this might vary for players

of different skill strength due to the changing marginal skills of ELO (MSE) along the ELO curve of all players. Millions of underrated chess palyers might be frustrated.

$$\Delta ELO_n = \sum_n^{i=1} dELO_n + ELO_{total} * d$$

Formula 1 The overall change in aggregated ELO as the sum of adjustment changes of all players (n) and system drift (d) due to a changing average skill strength. This makes inflation or deflation of ELO ratings possible: inflation if starting values are too high, and deflation if starting values are too low. Sites that use Glicko-2 have starting values around 1200 although Gicko-2 suggests a starting value of 1500 and a rating deviation of 350. dELO is the unbalanced and partial adjustment of ELO: i.e. a new underrated player adjusts the ELO leading to more points in the system but at the unreimbursed cost of ELO points of other players. Thus, the system must refill ELO points at the level of $\Delta ELO(n)$ over time. For a number of x games $\Delta ELO(n)$ could be refilled by not costing any ELO points for any opponents or during a rating period in which a player's rating deviation is still too high to be an accurate measure.