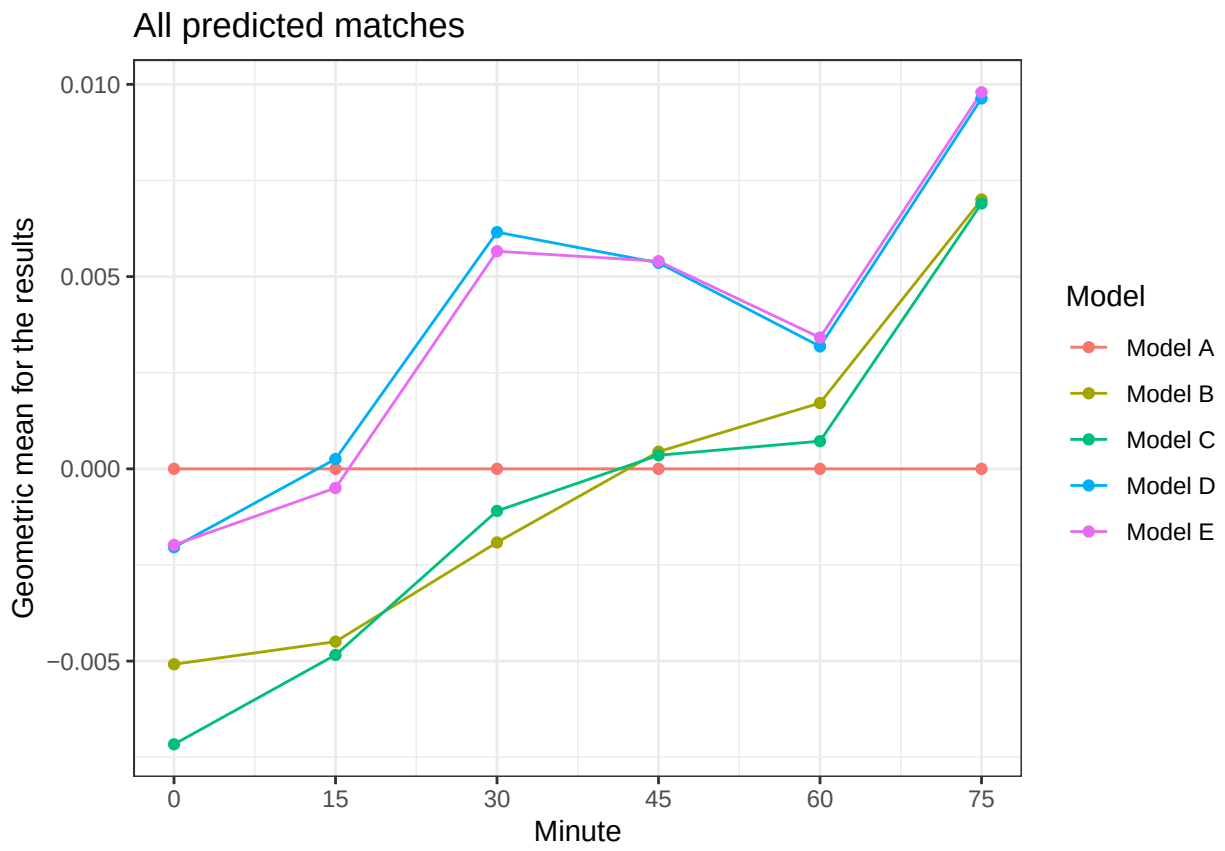
Geometric mean

```
library(dplyr)
library(ggplot2)
library(tidyr)
library(knitr)

load("data/HDA_dc_2.RData")
load("data/first_matches.RData")

HDA = HDA_dc %>%
  anti_join(first_matches)

nrow(HDA)
```

```
## [1] 1858
```

```
HDA[,c(9:158)][which(HDA[,c(9:158)] == 0, arr.ind = TRUE)] = 10^-5
```

```
results = tibble(GeoMean = apply(HDA[,c(99:128)], 2, EnvStats::geoMean),
                 Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                 Model = factor(c(rep("A", 6),
                                  rep("B", 6),
                                  rep("C", 6),
                                  rep("D", 6),
                                  rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")


results %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches") +
  ylab("Geometric mean for the results")
```

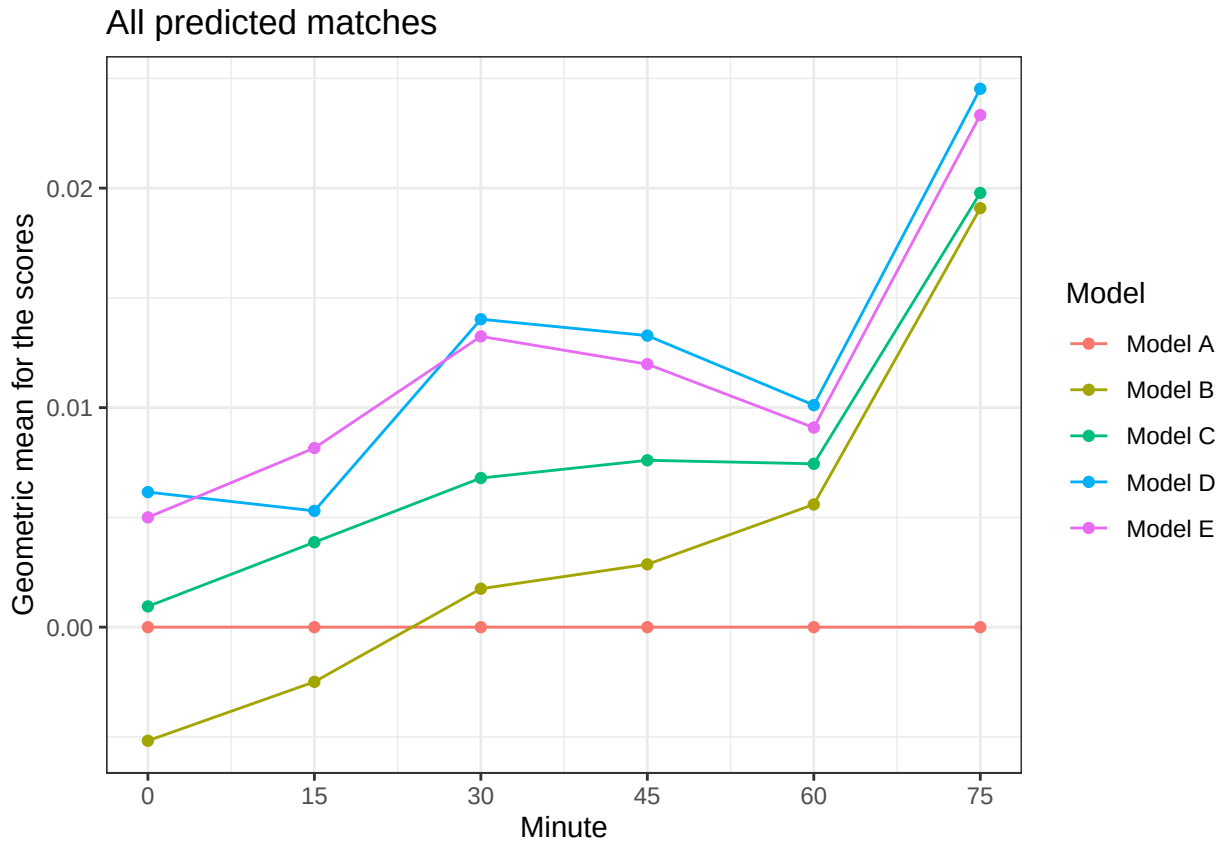



```
results %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0050830	-0.0044942	-0.0019138	0.0004458	0.0017122	0.0070038
Model C	-0.0071644	-0.0048408	-0.0010950	0.0003527	0.0007197	0.0069024
Model D	-0.0020390	0.0002557	0.0061560	0.0053594	0.0031854	0.0096346
Model E	-0.0019799	-0.0004976	0.0056584	0.0054008	0.0034135	0.0097926

```
scores = tibble(GeoMean = apply(HDA[,c(129:158)], 2, EnvStats::geoMean),
                Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                Model = factor(c(rep("A", 6),
                                 rep("B", 6),
                                 rep("C", 6),
                                 rep("D", 6),
                                 rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
```

```
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches") +
  ylab("Geometric mean for the scores")
```




```
scores %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0051754	-0.0024916	0.0017509	0.0028609	0.0055911	0.0190873
Model C	0.0009452	0.0038688	0.0067928	0.0076022	0.0074422	0.0197810
Model D	0.0061534	0.0052974	0.0140277	0.0132818	0.0101162	0.0245261
Model E	0.0050004	0.0081606	0.0132462	0.0119814	0.0090928	0.0233283

```r
load("~/GitHub/soccer-live-predictions/soccer-live-predictions/scrape/data/reds.RData")

matches = reds %>%
  filter(Season > 2015, Half == 1) %>%
  select(Season, Match)

HDA_reds = HDA %>%
  inner_join(matches)
```

```
## Joining, by = c("Season", "Match")
```

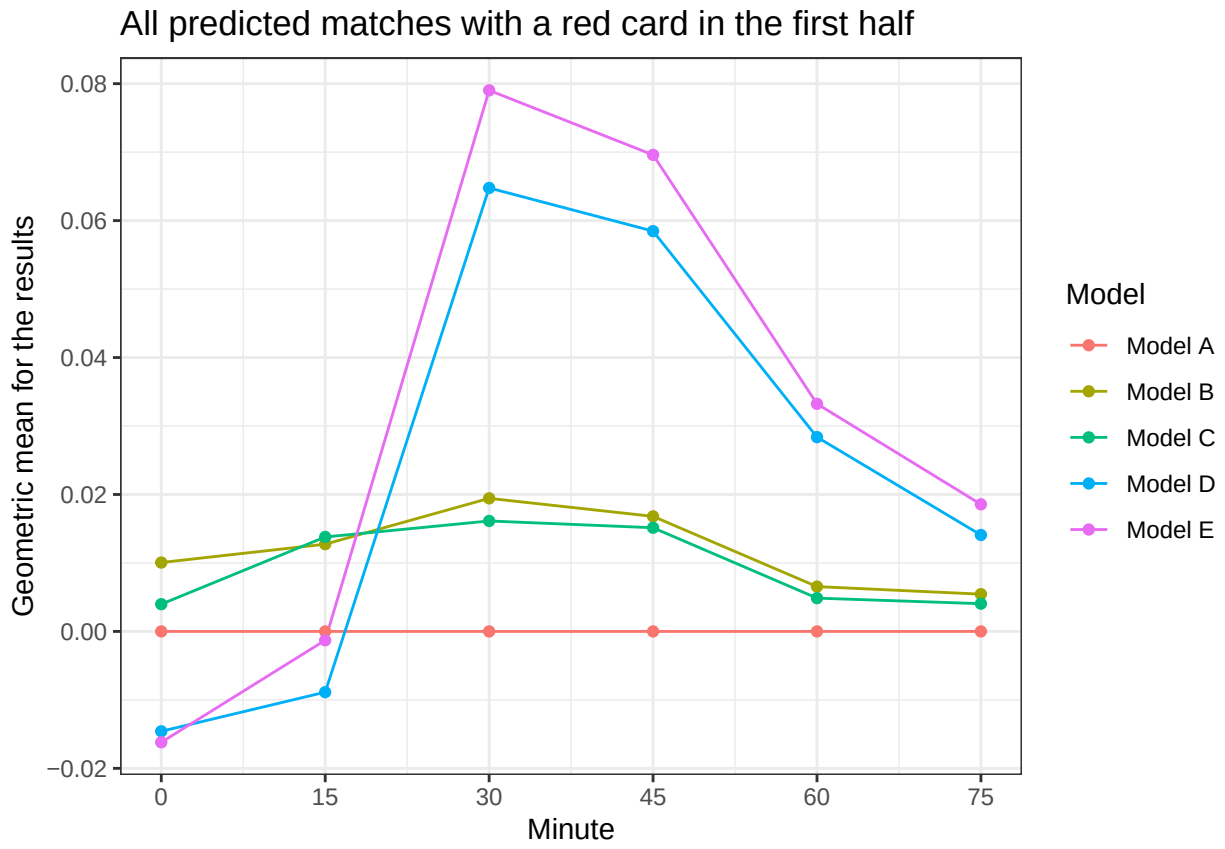
```r
HDA_no_reds = HDA %>%
  anti_join(matches)
```

```
## Joining, by = c("Season", "Match")
```

```r
nrow(HDA_reds)
```

```
## [1] 82
```

```r
results_reds = tibble(GeoMean = apply(HDA_reds[,c(99:128)], 2, EnvStats::geoMean),
                      Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                      Model = factor(c(rep("A", 6),
                                       rep("B", 6),
                                       rep("C", 6),
                                       rep("D", 6),
                                       rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_reds %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with a red card in the first half") +
  ylab("Geometric mean for the results")
```

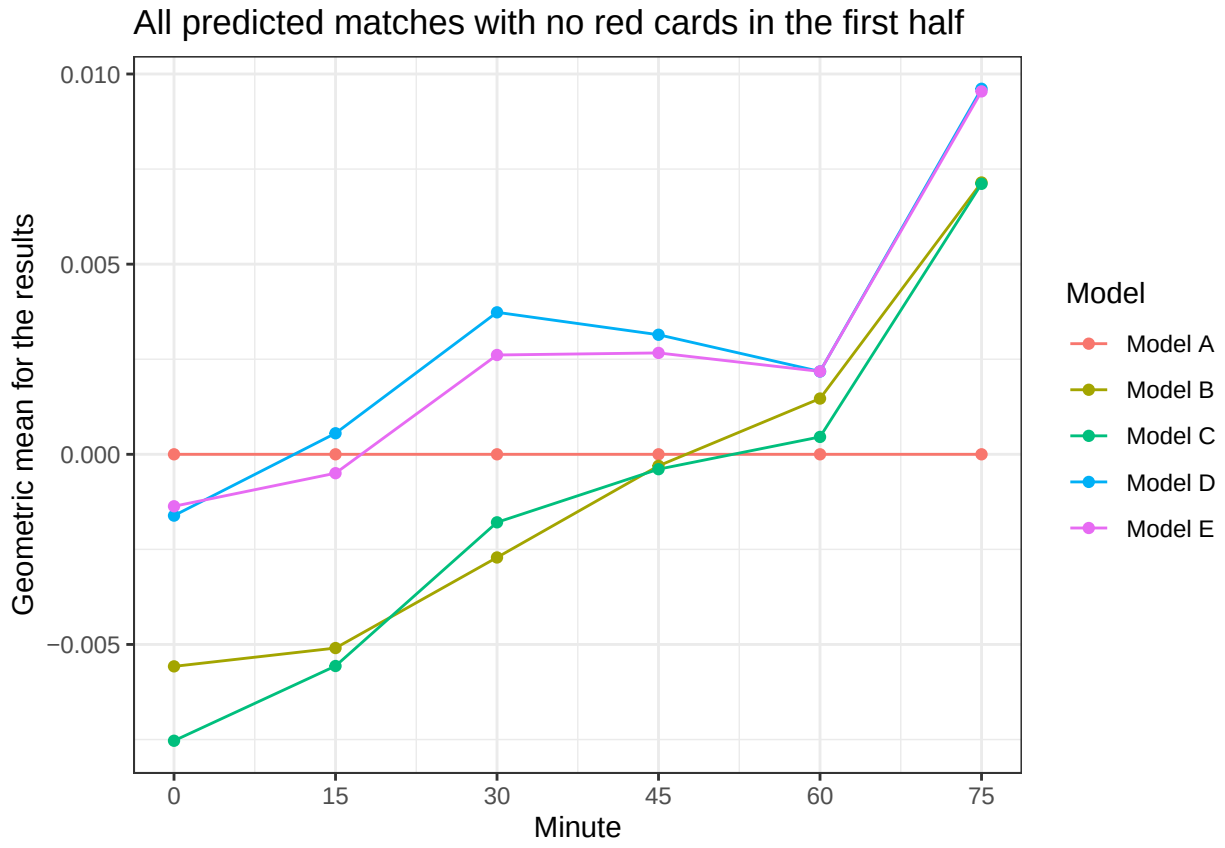



```
results_reds %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	0.0100593	0.0127398	0.0194376	0.0168047	0.0065459	0.0054407
Model C	0.0039783	0.0137975	0.0161298	0.0151433	0.0048625	0.0040526
Model D	-0.0145901	-0.0088729	0.0647713	0.0584654	0.0283797	0.0140808
Model E	-0.0161959	-0.0012889	0.0790279	0.0696009	0.0332385	0.0185605

```
results_no_reds = tibble(GeoMean = apply(HDA_no_reds[,c(99:128)], 2, EnvStats::geoMean),
                 Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                 Model = factor(c(rep("A", 6),
                                  rep("B", 6),
                                  rep("C", 6),
                                  rep("D", 6),
                                  rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
```

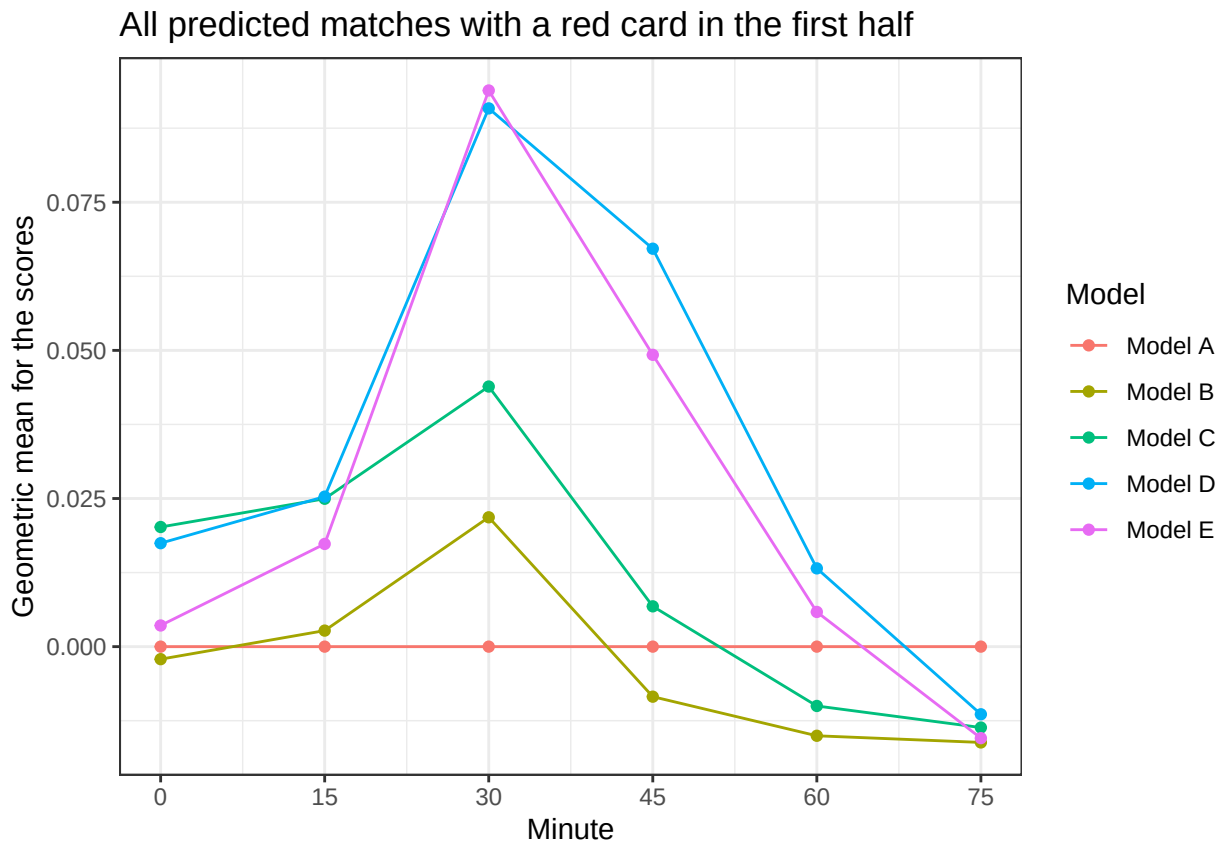
```
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_no_reds %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with no red cards in the first half") +
  ylab("Geometric mean for the results")
```




```
results_no_reds %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0055757	-0.0050940	-0.0027127	-0.0003030	0.0014663	0.0071475
Model C	-0.0075320	-0.0055662	-0.0017883	-0.0003913	0.0004570	0.0071122
Model D	-0.0016118	0.0005530	0.0037334	0.0031436	0.0021773	0.0096109
Model E	-0.0013664	-0.0004966	0.0026115	0.0026658	0.0021795	0.0095432

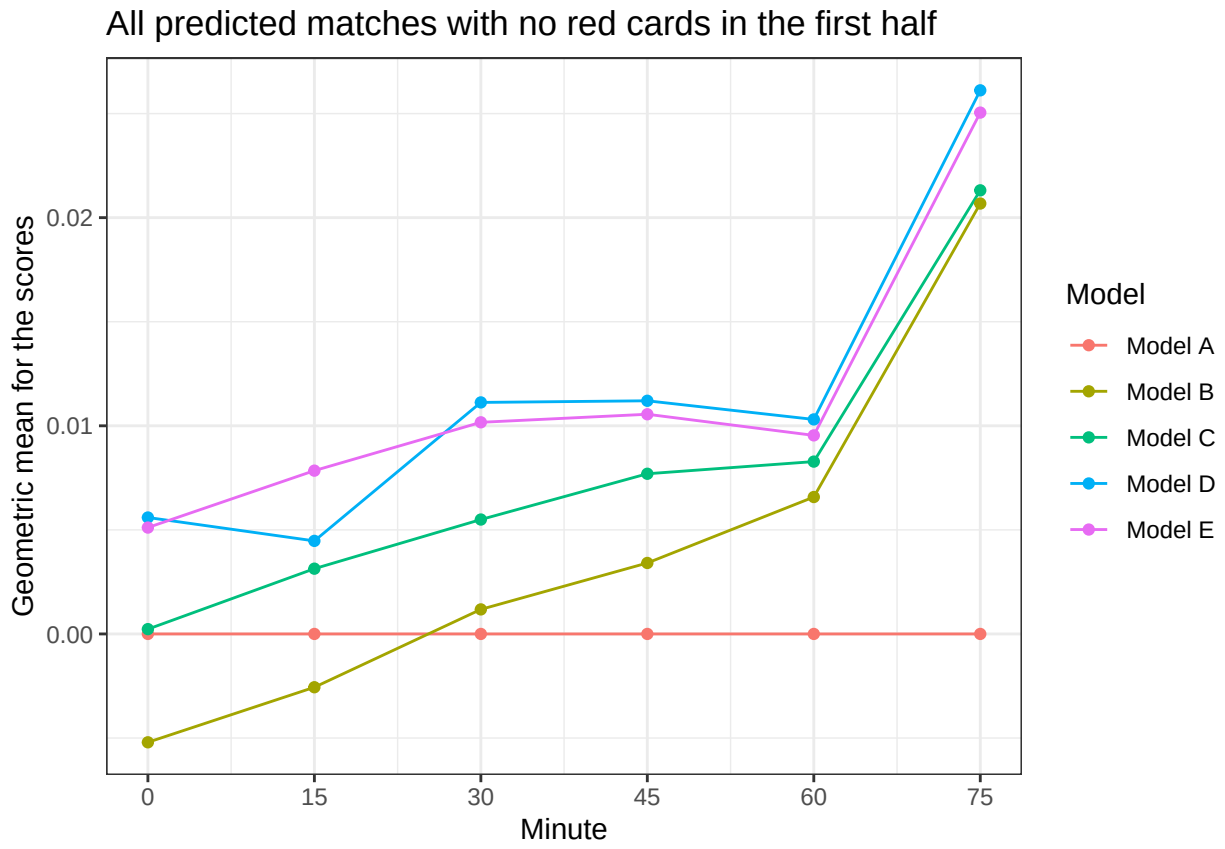
```r
scores_reds = tibble(GeoMean = apply(HDA_reds[,c(129:158)], 2, EnvStats::geoMean),
                     Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                     Model = factor(c(rep("A", 6),
                                      rep("B", 6),
                                      rep("C", 6),
                                      rep("D", 6),
                                      rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_reds %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with a red card in the first half") +
  ylab("Geometric mean for the scores")
```



```
scores_reds %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0021167	0.0027039	0.0218298	-0.0084463	-0.0150459	-0.0161702
Model C	0.0201882	0.0249565	0.0438951	0.0067985	-0.0100154	-0.0136582
Model D	0.0174591	0.0253175	0.0908397	0.0671582	0.0132089	-0.0114157
Model E	0.0035712	0.0173301	0.0938627	0.0492465	0.0058546	-0.0154456

```
scores_no_reds = tibble(GeoMean = apply(HDA_no_reds[,c(129:158)], 2, EnvStats::geoMean),
                 Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                 Model = factor(c(rep("A", 6),
                                  rep("B", 6),
                                  rep("C", 6),
                                  rep("D", 6),
                                  rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_no_reds %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with no red cards in the first half") +
  ylab("Geometric mean for the scores")
```




```
scores_no_reds %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

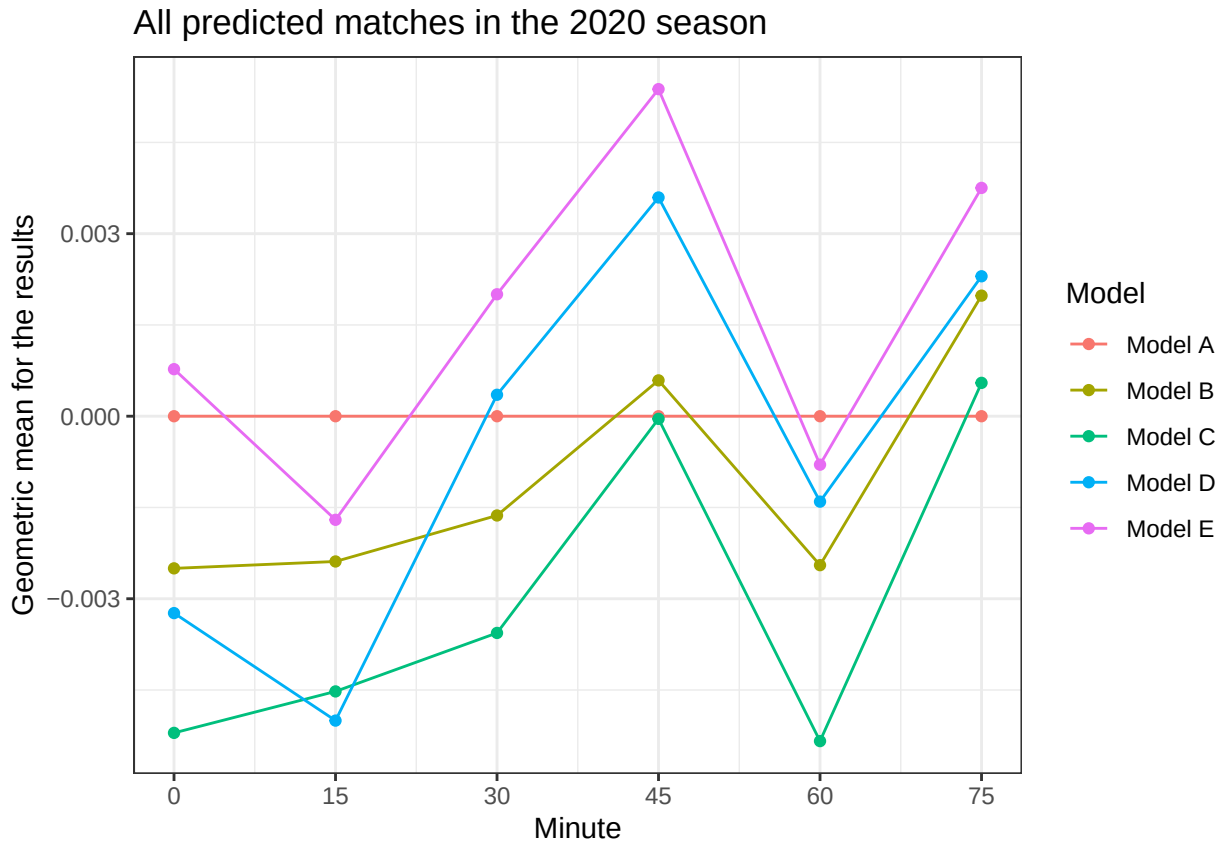
Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0052060	-0.0025607	0.0011794	0.0034094	0.0065777	0.0206790
Model C	0.0002307	0.0031352	0.0054965	0.0076958	0.0082800	0.0213127
Model D	0.0055947	0.0044703	0.0111232	0.0112016	0.0103060	0.0261170
Model E	0.0051118	0.0078454	0.0101676	0.0105542	0.0095401	0.0250477

```
HDA_2020 = HDA %>%
  filter(Season == 2020)

nrow(HDA_2020)
```

```
## [1] 376
```

```
results_2020 = tibble(GeoMean = apply(HDA_2020[,c(99:128)], 2, EnvStats::geoMean),
                Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                Model = factor(c(rep("A", 6),
                                 rep("B", 6),
```

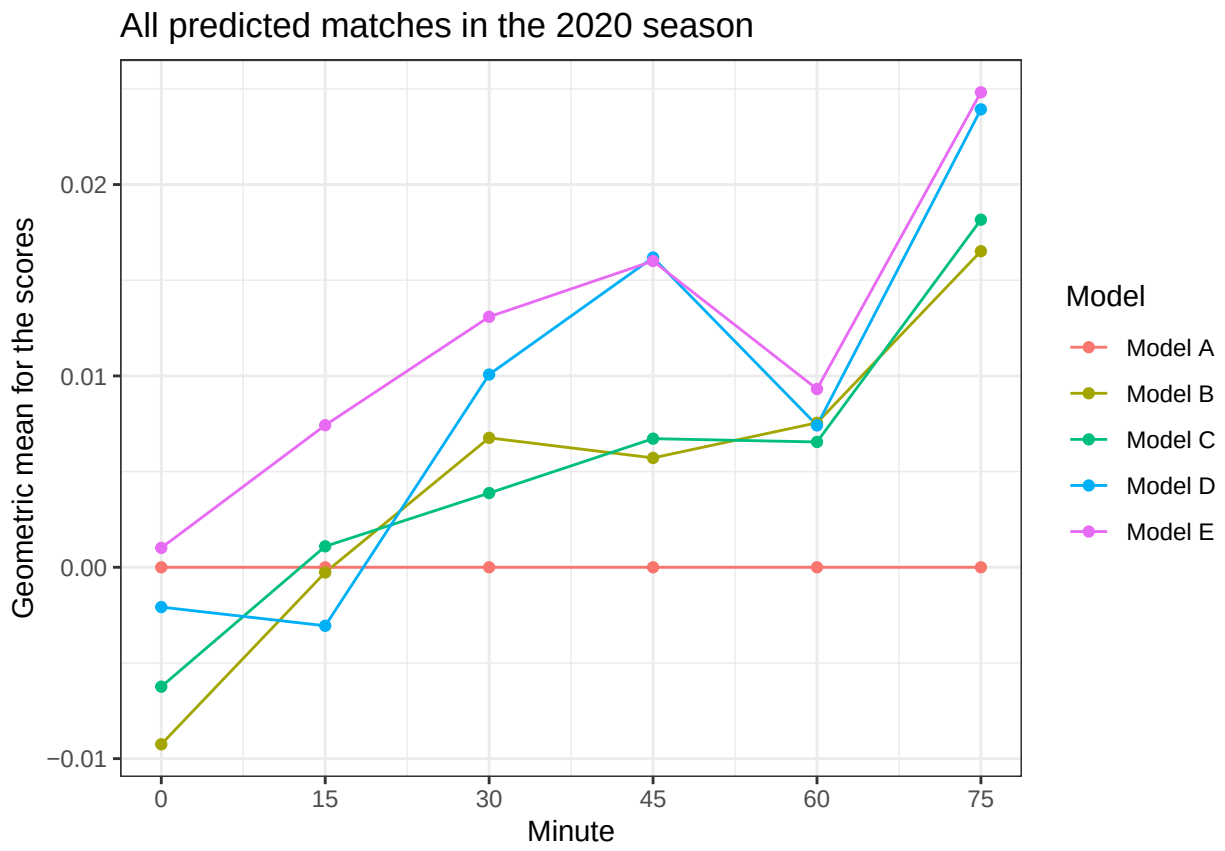
```
                                  rep("C", 6),
                                  rep("D", 6),
                                  rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_2020 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches in the 2020 season") +
  ylab("Geometric mean for the results")
```




```
results_2020 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0025007	-0.0023876	-0.0016313	0.0005890	-0.0024479	0.0019818
Model C	-0.0052050	-0.0045233	-0.0035622	-0.0000434	-0.0053399	0.0005480
Model D	-0.0032359	-0.0050027	0.0003524	0.0035951	-0.0014039	0.0023000
Model E	0.0007733	-0.0017027	0.0020043	0.0053758	-0.0007964	0.0037524

```
scores_2020 = tibble(GeoMean = apply(HDA_2020[,c(129:158)], 2, EnvStats::geoMean),
                     Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                     Model = factor(c(rep("A", 6),
                                      rep("B", 6),
                                      rep("C", 6),
                                      rep("D", 6),
                                      rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_2020 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches in the 2020 season") +
  ylab("Geometric mean for the scores")
```




```
scores_2020 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0092506	-0.0002693	0.0067635	0.0057149	0.0075514	0.0165179
Model C	-0.0062386	0.0010945	0.0038794	0.0067212	0.0065486	0.0181650
Model D	-0.0020800	-0.0030570	0.0100732	0.0161854	0.0074168	0.0239314
Model E	0.0010146	0.0074241	0.0130901	0.0160045	0.0093150	0.0248199

```
load("~/GitHub/soccer-live-predictions/soccer-live-predictions/scrape/data/results.RData")
load("~/GitHub/soccer-live-predictions/soccer-live-predictions/scrape/data/goals.RData")
```

```
at_45 = results %>%
  select(Season, Match) %>%
  filter(Season > 2015)
```

```
home_score_at_45 <- function(season, match) {
  goals %>%
    filter(Season == season,
           Match == match,
```

```
            Team == 1,
            Half == 1) %>%
    nrow()
}

away_score_at_45 <- function(season, match) {
  goals %>%
    filter(Season == season,
           Match == match,
           Team == 2,
           Half == 1) %>%
    nrow()
}
```

```
at_45 = at_45 %>%
  rowwise() %>%
  mutate(Home_Score = home_score_at_45(Season, Match),
         Away_Score = away_score_at_45(Season, Match),
         abs_dif = abs(Home_Score - Away_Score))
```

```
tmp_00 = at_45 %>%
  filter(abs_dif == 0) %>%
  select(Season, Match)

HDA_00 = HDA %>%
  inner_join(tmp_00)
```

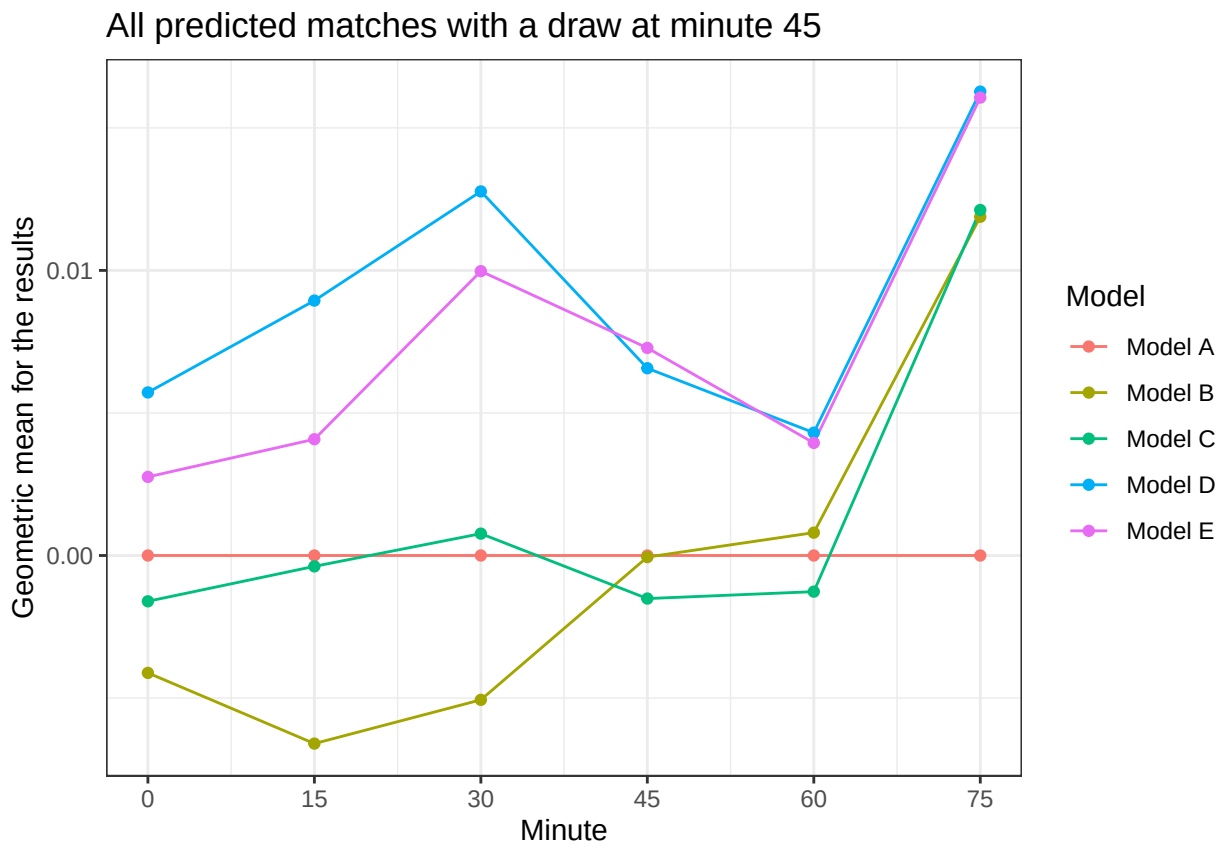
```
## Joining, by = c("Season", "Match")
```

```
nrow(HDA_00)
```

```
## [1] 838
```

```
results_00 = tibble(GeoMean = apply(HDA_00[,c(99:128)], 2, EnvStats::geoMean),
                Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                Model = factor(c(rep("A", 6),
                                 rep("B", 6),
                                 rep("C", 6),
                                 rep("D", 6),
                                 rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_00 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
```

```
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with a draw at minute 45") +
  ylab("Geometric mean for the results")
```

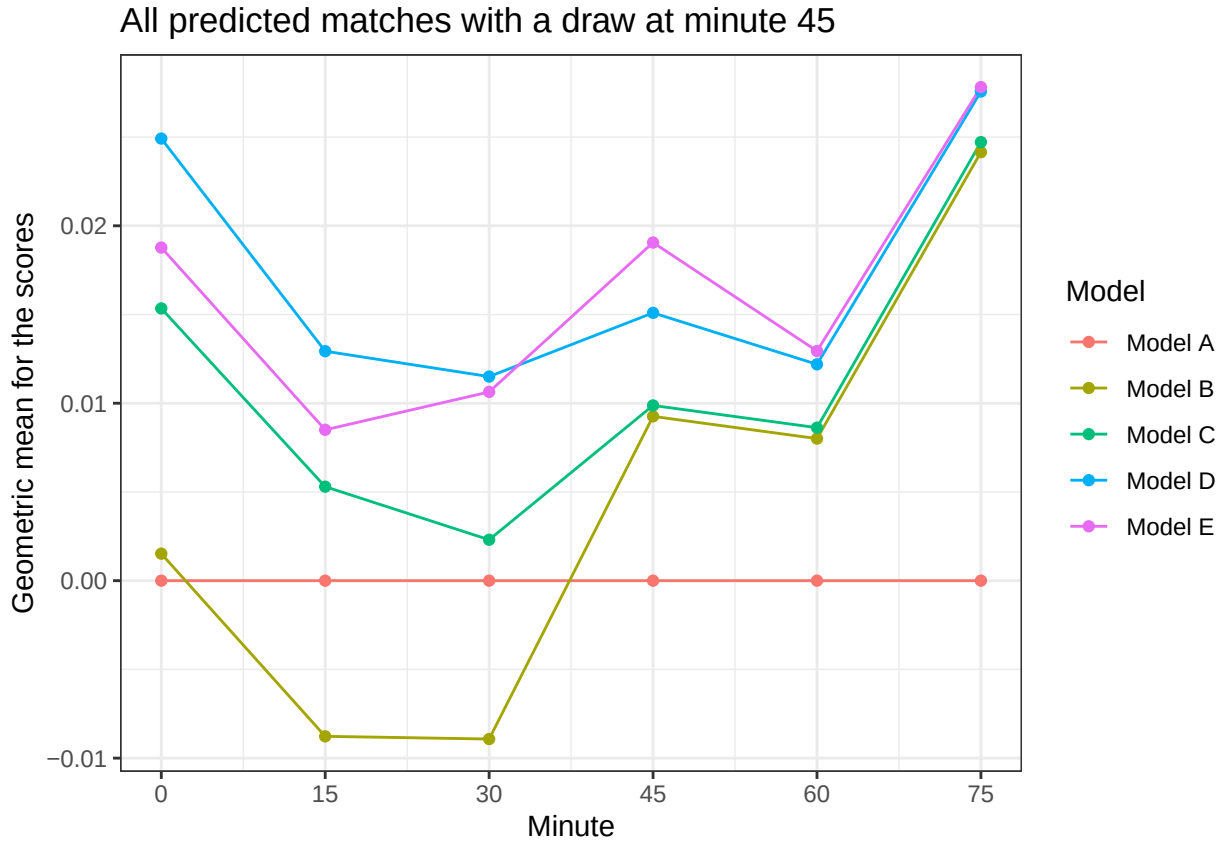



```
results_00 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0041180	-0.0065978	-0.0050627	-0.0000553	0.0008013	0.0118811
Model C	-0.0016062	-0.0003809	0.0007661	-0.0015107	-0.0012684	0.0121196
Model D	0.0057201	0.0089421	0.0127716	0.0065683	0.0043080	0.0162713
Model E	0.0027566	0.0040785	0.0099731	0.0072810	0.0039499	0.0160618

```
scores_00 = tibble(GeoMean = apply(HDA_00[,c(129:158)], 2, EnvStats::geoMean),
                   Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                   Model = factor(c(rep("A", 6),
                                    rep("B", 6),
                                    rep("C", 6),
```

```
                                  rep("D", 6),
                                  rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_00 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with a draw at minute 45") +
  ylab("Geometric mean for the scores")
```




```
scores_00 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	0.0015206	-0.0087730	-0.0089253	0.0092611	0.0080067	0.0241499
Model C	0.0153431	0.0052966	0.0023057	0.0098753	0.0086225	0.0247159
Model D	0.0249162	0.0129321	0.0115032	0.0150926	0.0121918	0.0275698
Model E	0.0187736	0.0085019	0.0106375	0.0190577	0.0129421	0.0278185

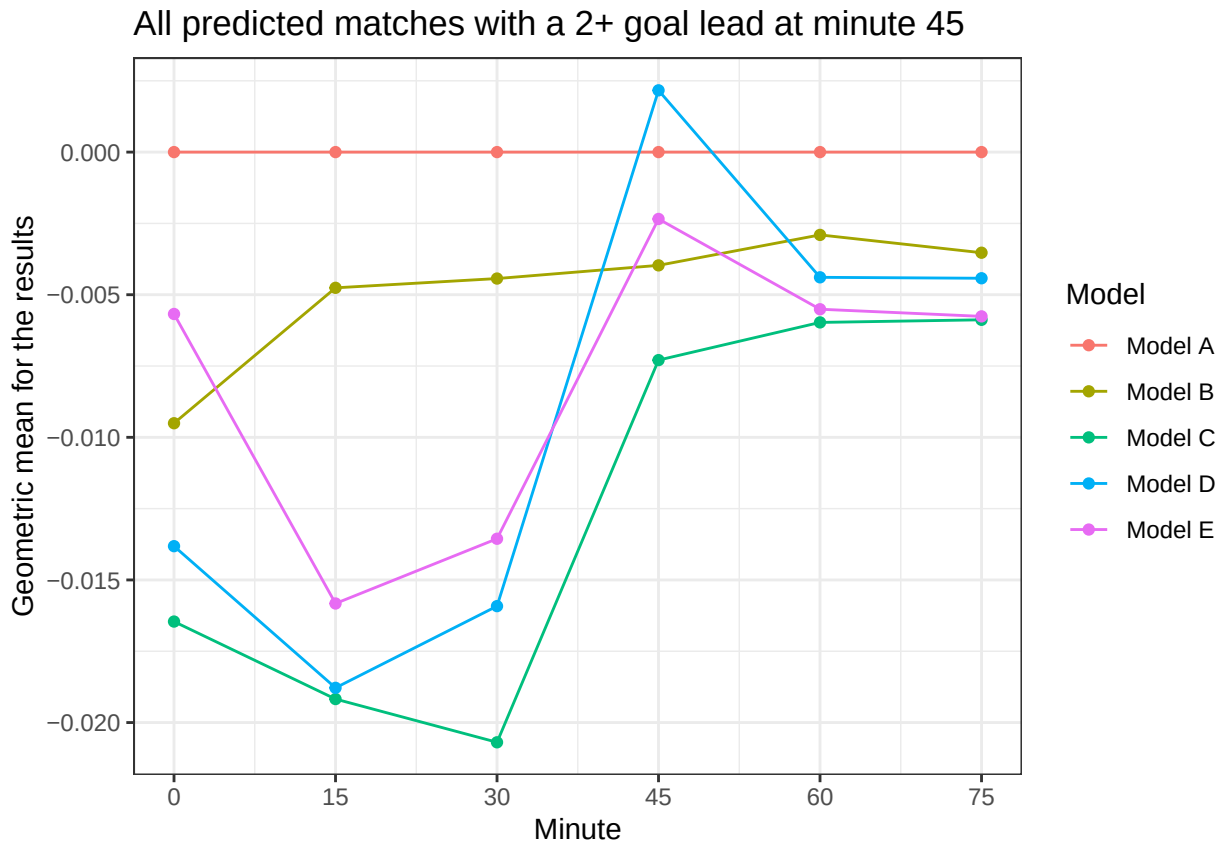
```
tmp_20 = at_45 %>%
  filter(abs_dif >= 2) %>%
  select(Season, Match)

HDA_20 = HDA %>%
  inner_join(tmp_20)
```

```
## Joining, by = c("Season", "Match")
```

```
nrow(HDA_20)
```

```
## [1] 211
```

```
results_20 = tibble(GeoMean = apply(HDA_20[,c(99:128)], 2, EnvStats::geoMean),
                    Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                    Model = factor(c(rep("A", 6),
                                     rep("B", 6),
                                     rep("C", 6),
                                     rep("D", 6),
                                     rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_20 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with a 2+ goal lead at minute 45") +
  ylab("Geometric mean for the results")
```

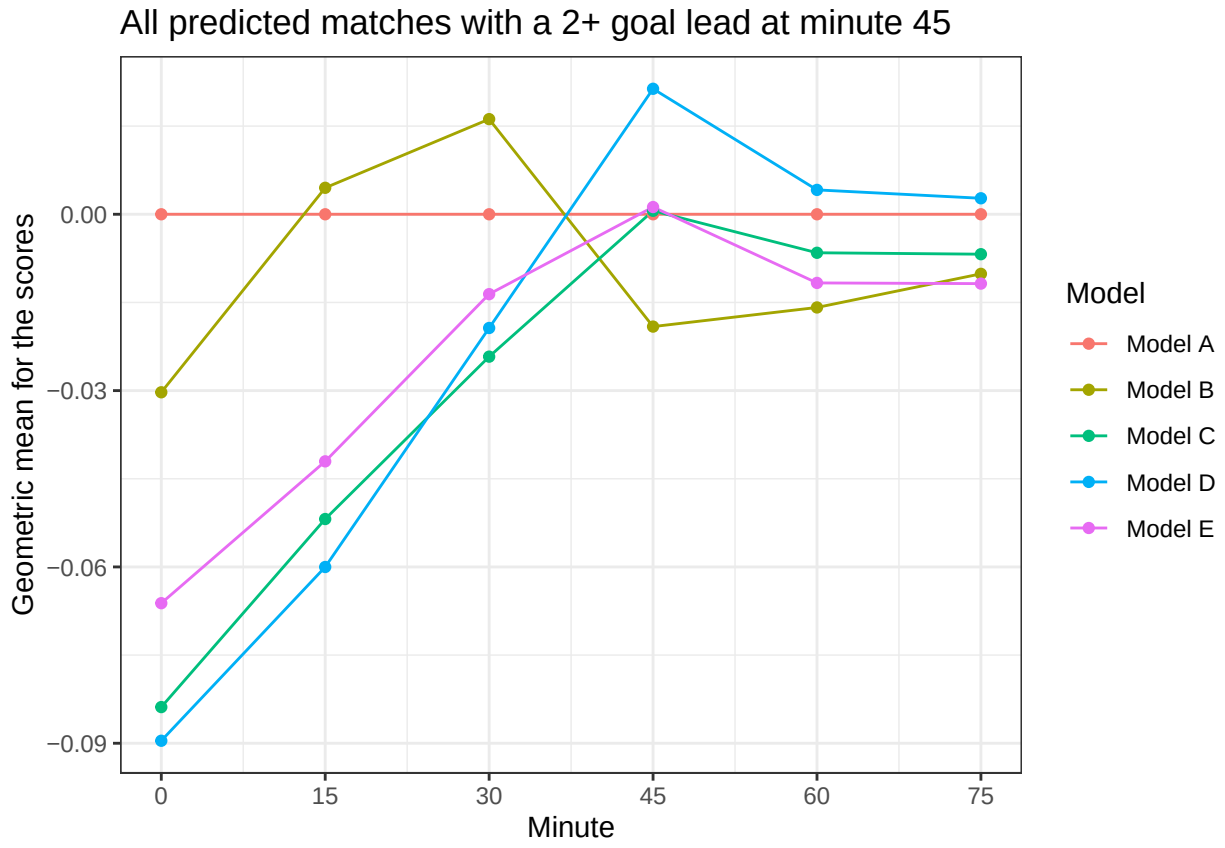



```
results_20 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0095059	-0.0047586	-0.0044337	-0.0039713	-0.0029034	-0.0035282
Model C	-0.0164595	-0.0191762	-0.0206926	-0.0072930	-0.0059716	-0.0058801
Model D	-0.0138164	-0.0187832	-0.0159184	0.0021653	-0.0043905	-0.0044233
Model E	-0.0056755	-0.0158261	-0.0135563	-0.0023447	-0.0055092	-0.0057598

```
scores_20 = tibble(GeoMean = apply(HDA_20[,c(129:158)], 2, EnvStats::geoMean),
                   Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                   Model = factor(c(rep("A", 6),
                                    rep("B", 6),
                                    rep("C", 6),
                                    rep("D", 6),
                                    rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
```

```
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_20 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with a 2+ goal lead at minute 45") +
  ylab("Geometric mean for the scores")
```




```
scores_20 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0302863	0.0045028	0.0161864	-0.0191086	-0.0158537	-0.0101350
Model C	-0.0838447	-0.0518512	-0.0242255	0.0005933	-0.0065506	-0.0067907
Model D	-0.0895750	-0.0600116	-0.0193468	0.0213497	0.0041478	0.0027224
Model E	-0.0661697	-0.0420375	-0.0135868	0.0012302	-0.0116800	-0.0117986

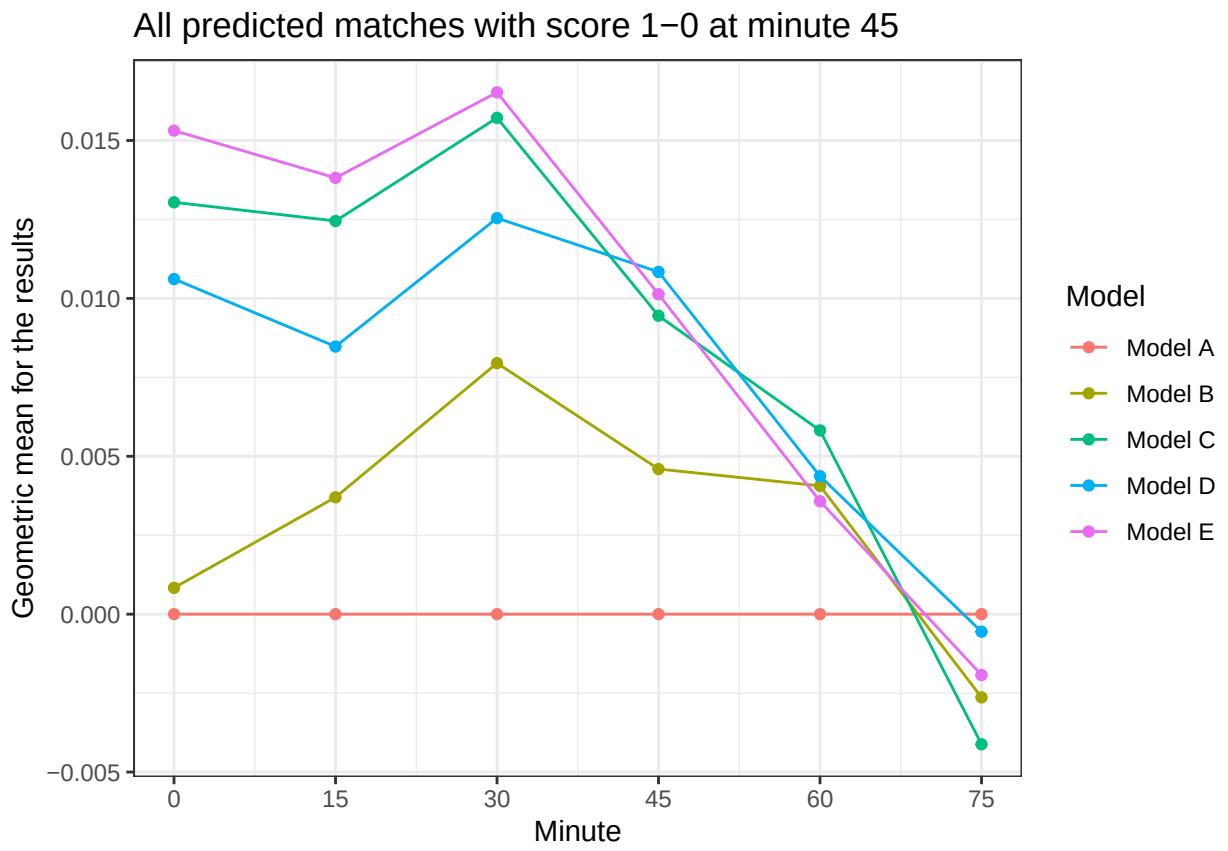
```r
tmp_10 = at_45 %>%
  filter(Home_Score == 1, Away_Score == 0) %>%
  select(Season, Match)

HDA_10 = HDA %>%
  inner_join(tmp_10)
```

```
## Joining, by = c("Season", "Match")
```

```r
nrow(HDA_10)
```

```
## [1] 435
```

```r
results_10 = tibble(GeoMean = apply(HDA_10[,c(99:128)], 2, EnvStats::geoMean),
                    Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                    Model = factor(c(rep("A", 6),
                                     rep("B", 6),
                                     rep("C", 6),
                                     rep("D", 6),
                                     rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_10 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with score 1-0 at minute 45") +
  ylab("Geometric mean for the results")
```

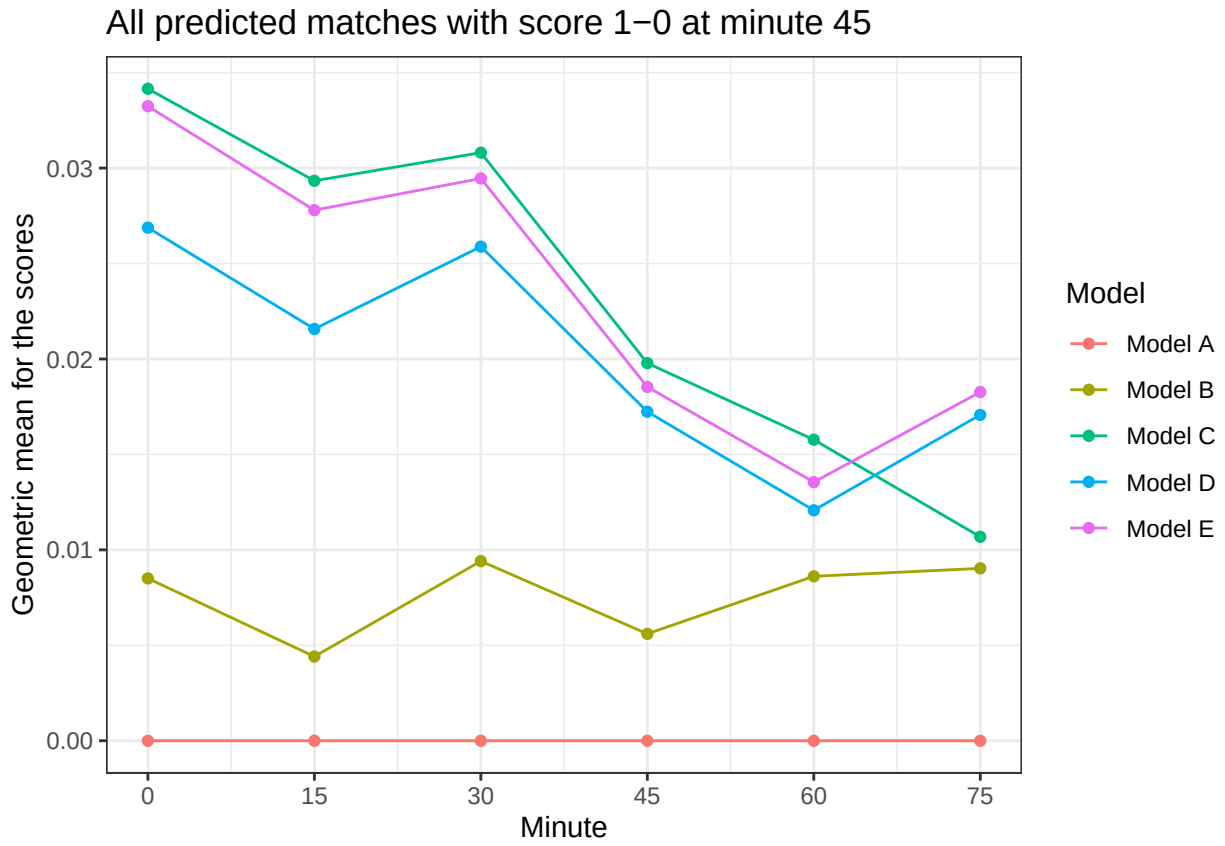



```
results_10 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	0.0008345	0.0037022	0.0079499	0.0045958	0.0040635	-0.0026358
Model C	0.0130443	0.0124519	0.0157191	0.0094499	0.0058181	-0.0041212
Model D	0.0106138	0.0084752	0.0125425	0.0108392	0.0043706	-0.0005552
Model E	0.0153144	0.0138165	0.0165257	0.0101325	0.0035766	-0.0019285

```
scores_10 = tibble(GeoMean = apply(HDA_10[,c(129:158)], 2, EnvStats::geoMean),
                   Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                   Model = factor(c(rep("A", 6),
                                    rep("B", 6),
                                    rep("C", 6),
                                    rep("D", 6),
                                    rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
```

```
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_10 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with score 1-0 at minute 45") +
  ylab("Geometric mean for the scores")
```




```
scores_10 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	0.0085043	0.0044119	0.0094102	0.0056006	0.0086154	0.0090305
Model C	0.0341541	0.0293356	0.0308079	0.0197809	0.0157713	0.0106837
Model D	0.0268790	0.0215709	0.0258845	0.0172387	0.0120726	0.0170711
Model E	0.0332421	0.0277955	0.0294563	0.0185350	0.0135493	0.0182678

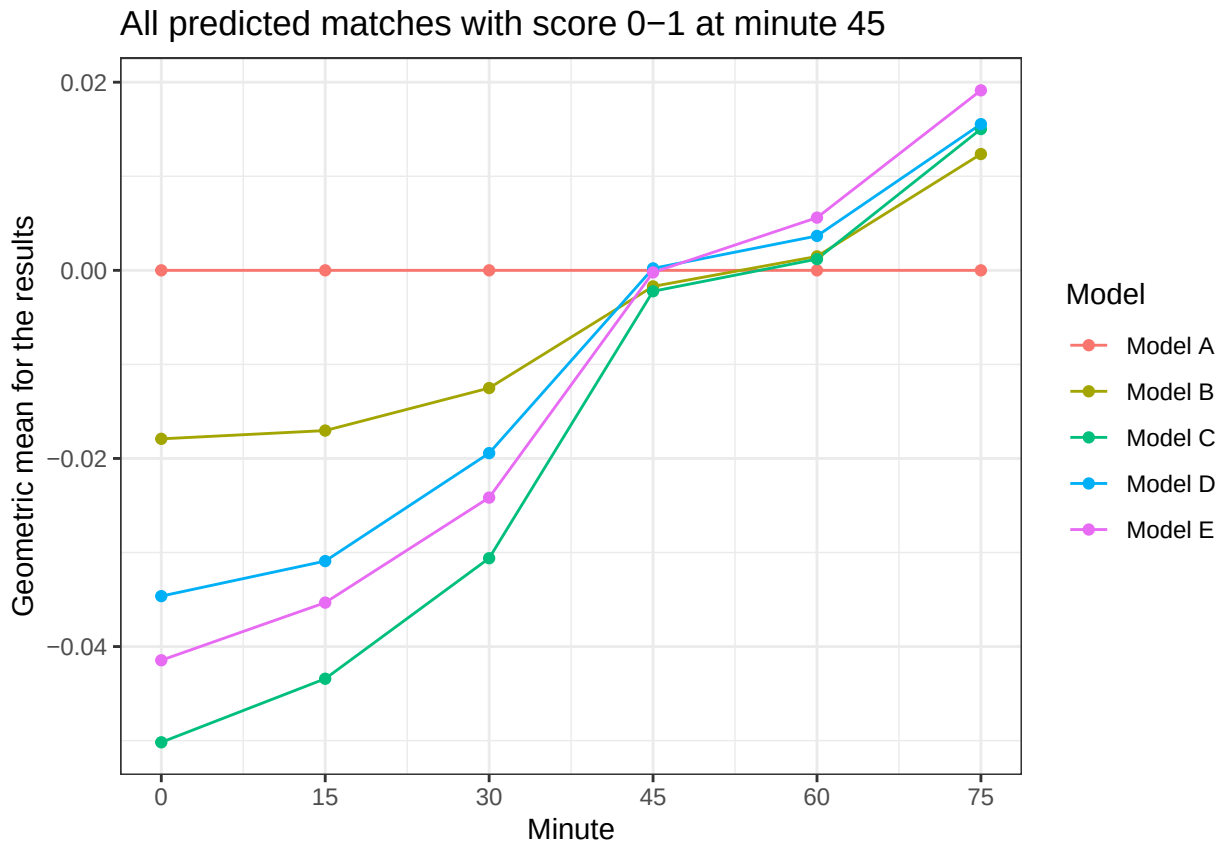
```
tmp_01 = at_45 %>%
  filter(Home_Score == 0, Away_Score == 1) %>%
  select(Season, Match)

HDA_01 = HDA %>%
  inner_join(tmp_01)
```

```
## Joining, by = c("Season", "Match")
```

```
nrow(HDA_01)
```

```
## [1] 275
```

```
results_01 = tibble(GeoMean = apply(HDA_01[,c(99:128)], 2, EnvStats::geoMean),
                    Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                    Model = factor(c(rep("A", 6),
                                     rep("B", 6),
                                     rep("C", 6),
                                     rep("D", 6),
                                     rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

results_01 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with score 0-1 at minute 45") +
  ylab("Geometric mean for the results")
```

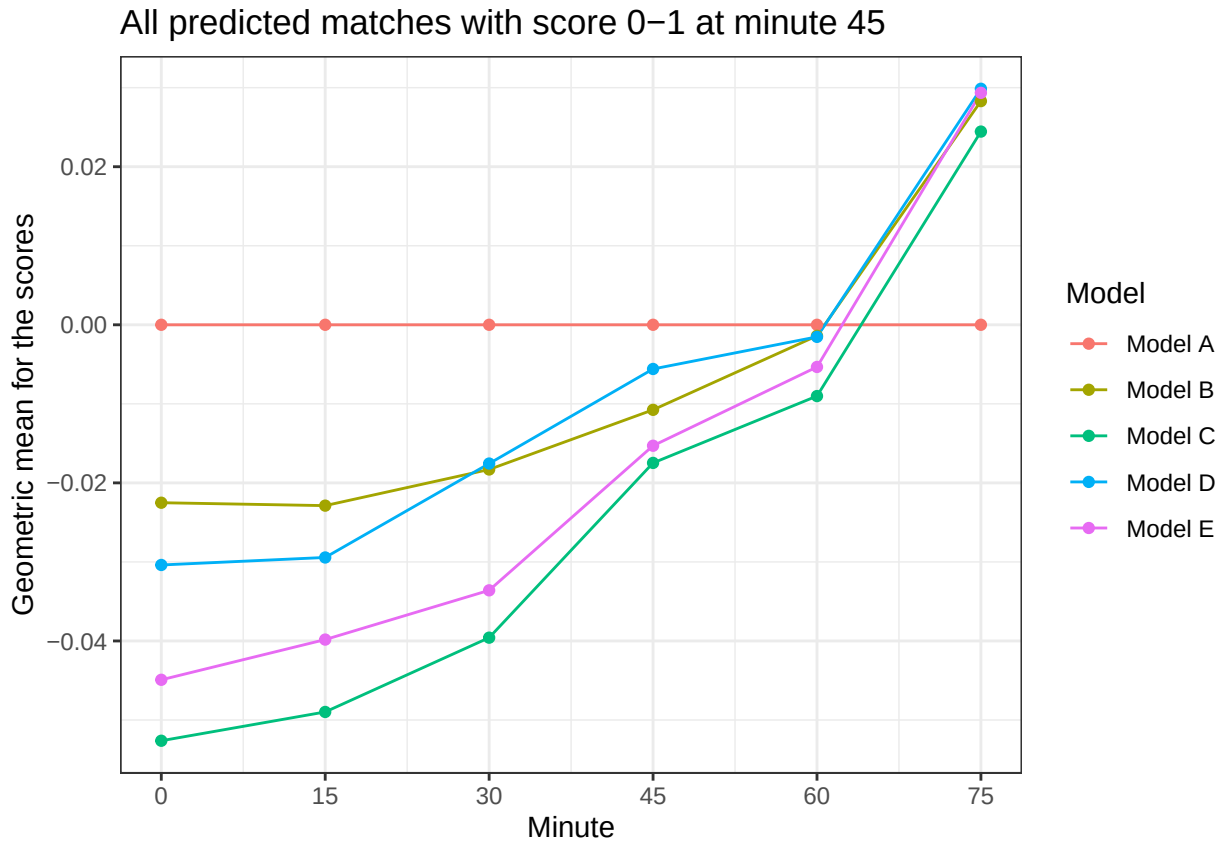



```
results_01 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0179159	-0.0170361	-0.0125142	-0.0017080	0.0014821	0.0123630
Model C	-0.0501786	-0.0434216	-0.0306085	-0.0022241	0.0011931	0.0150233
Model D	-0.0346381	-0.0309120	-0.0194354	0.0002052	0.0036562	0.0155435
Model E	-0.0414568	-0.0353285	-0.0241641	-0.0002188	0.0056020	0.0191365

```
scores_01 = tibble(GeoMean = apply(HDA_01[,c(129:158)], 2, EnvStats::geoMean),
                   Minute = as.integer(rep(c(0, 15, 30, 45, 60, 75), 5)),
                   Model = factor(c(rep("A", 6),
                                    rep("B", 6),
                                    rep("C", 6),
                                    rep("D", 6),
                                    rep("E", 6)))) %>%
  pivot_wider(names_from = "Model", values_from = "GeoMean", names_prefix = "Model ") %>%
  mutate(`Model B` = log(`Model B`) - log(`Model A`),
         `Model C` = log(`Model C`) - log(`Model A`),
         `Model D` = log(`Model D`) - log(`Model A`),
```

```
         `Model E` = log(`Model E`) - log(`Model A`),
         `Model A` = 0) %>%
  pivot_longer(cols = starts_with("Model"), names_to = "Model", values_to = "GeoMean")

scores_01 %>%
  ggplot(aes(x = Minute, y = GeoMean, col = Model)) +
  geom_line() +
  geom_point() +
  scale_x_continuous(breaks = c(0, 15, 30, 45, 60, 75)) +
  theme_bw() +
  ggtitle("All predicted matches with score 0-1 at minute 45") +
  ylab("Geometric mean for the scores")
```




```
scores_01 %>%
  pivot_wider(id_cols = "Model", values_from = "GeoMean", names_from = "Minute",
              names_prefix = "Minute ") %>%
  kable()
```

Model	Minute 0	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75
Model A	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
Model B	-0.0225112	-0.0228786	-0.0183044	-0.0107573	-0.0013956	0.0282999
Model C	-0.0526267	-0.0489820	-0.0395837	-0.0174752	-0.0090168	0.0244431
Model D	-0.0303868	-0.0294374	-0.0175572	-0.0055894	-0.0015256	0.0298584
Model E	-0.0449157	-0.0398251	-0.0335938	-0.0153024	-0.0053331	0.0293473