Homework on Bass Model

Anahit Navoyan

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1. Go to the list, choose an innovation, and put the link of the selected product here.

XK300 Autonomous Health Monitoring

2. Think about look-alike innovation from the past. When you pick one, give your justifications in 1-2 paragraphs.

The innovation from Times XK300 Autonomous Health Monitoring system and innovation from the past that looks similar, namely Philips Health Watch, both represent significant advancements in health monitoring technology despite their different approaches. The XK300 utilizes radar-based technology to monitor vital signs remotely, analyzing nano vibrations to provide contact-free, real-time data transmission to healthcare staff. This innovation is particularly beneficial for overburdened health systems facing staffing shortages, as it allows for continuous monitoring of patients and early detection of deterioration, with the ability to collect thousands of measurements per day per person.On the other hand, while not explicitly radar-based, the Philips Health Watch shares a common goal of continuous health monitoring. This wearable device is designed for personal use, allowing individuals to track their vital signs, physical activity, and sleep patterns. It provides users with real-time data and insights into their health, empowering them to make informed decisions about their well-being. The Philips Health Watch is a consumer-oriented solution that aligns with the broader trend of empowering individuals to actively manage their health.

Both innovations concentrate on monitoring health and creating personal health tracking, and the goal is advancing healthcare through continuous monitoring and data-driven insights. The advantage of the XK300 is that it's contact-free with radar-based technology, and the Philips Health Watch is a personal health tracker through a wearable device.

3. Go to Statista (the University provides access to it) and find a time series that approximates the look-alike innovation. (the University provides access to it under AUA WIFI.) and find a time series matching the look-alike innovation. Give your justification by 1-3 paragraphs. You can also use any other available resource for the data; remember to provide a reference.

The data source is Statista.com. The data includes Philips' sales by geographic region from 2012 to 2022, presented in million euros. The ultimate dataset utilized for the model contains time series data and aggregates the sales from all the given regions. It has four columns: year, sales in Western Europe, sales in North America, and sales in other areas. This dataset was chosen because it provides information about Philips' sales dynamics over a certain period.

```r
libs<-c('ggplot2','ggpubr','knitr','diffusion', 'readxl')
load_libraries<-function(libs){
new_libs <- libs[!(libs %in% installed.packages()[,"Package"])]
if(length(new_libs)>0) {install.packages(new_libs)}
lapply(libs, library, character.only = TRUE)
}
load_libraries(libs)
```

```
## Warning: package 'diffusion' was built under R version 4.2.3
```

```
## [[1]]
## [1] "ggplot2"   "stats"     "graphics"  "grDevices" "utils"     "datasets"
## [7] "methods"   "base"
##
## [[2]]
## [1] "ggpubr"    "ggplot2"   "stats"     "graphics"  "grDevices" "utils"
## [7] "datasets"  "methods"   "base"
##
## [[3]]
##  [1] "knitr"     "ggpubr"    "ggplot2"   "stats"     "graphics"  "grDevices"
##  [7] "utils"     "datasets"  "methods"   "base"
##
## [[4]]
##  [1] "diffusion" "knitr"     "ggpubr"    "ggplot2"   "stats"     "graphics"
##  [7] "grDevices" "utils"     "datasets"  "methods"   "base"
##
## [[5]]
##  [1] "readxl"    "diffusion" "knitr"     "ggpubr"    "ggplot2"   "stats"
##  [7] "graphics"  "grDevices" "utils"     "datasets"  "methods"   "base"
```

```r
philips <- read_excel("philips_sales_by_region_2012_2022.xlsx", sheet = "Data")
print(philips)
```

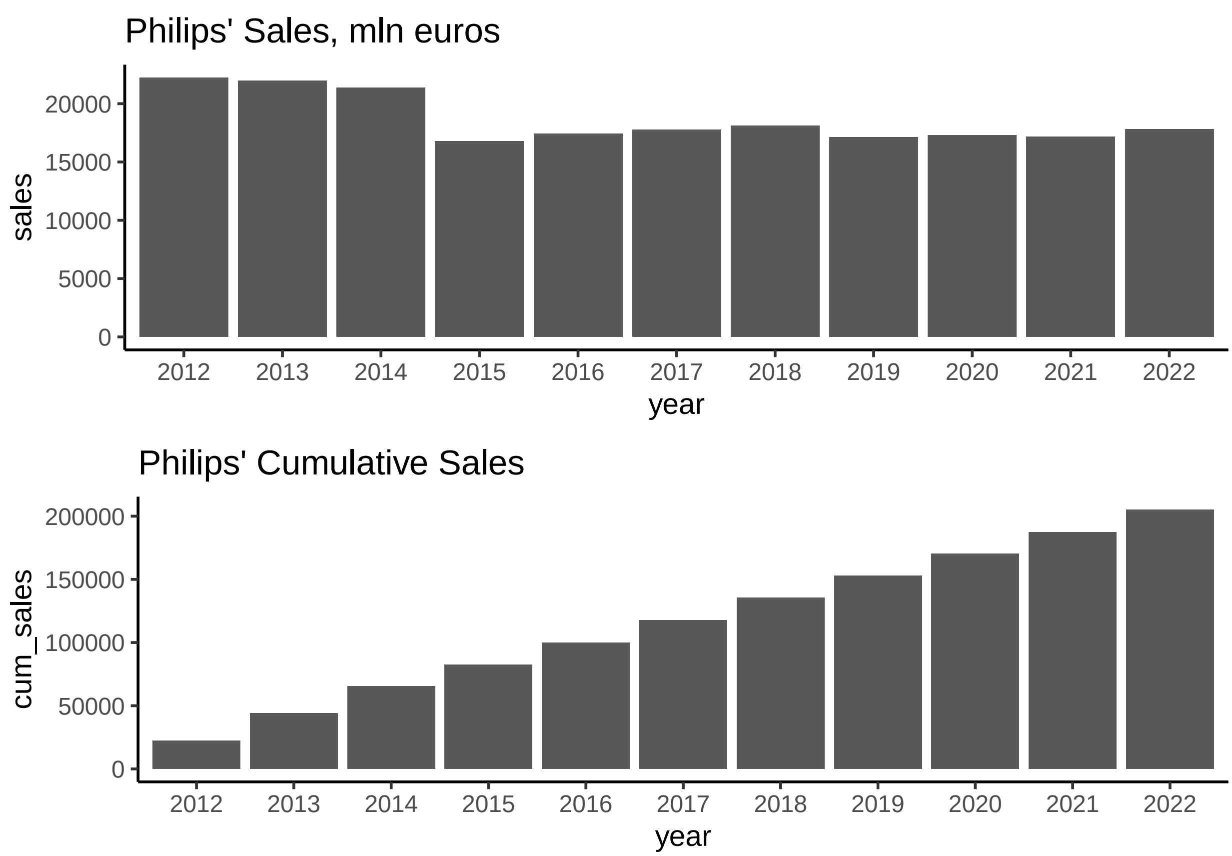
```
## # A tibble: 11 x 4
##    Year  `Western Europe` `North America` `Other*`
##    <chr>            <dbl>           <dbl>    <dbl>
##  1 2012              5686            7340     9208
##  2 2013              5680            6883     9427
##  3 2014              5665            6678     9048
##  4 2015              3675            6063     7067
##  5 2016              3756            6279     7388
##  6 2017              3802            6409     7569
##  7 2018              3990            6338     7793
##  8 2019              3328            6904     6916
##  9 2020              3702            6884     6727
## 10 2021              3645            6781     6730
## 11 2022              3603            7588     6636
```

```r
# Sum the values in columns
sum_values <- rowSums(philips[, c("Western Europe", "North America", "Other*")])

# Add a new column with the summed values
philips$Sales <- sum_values

print(philips)
```

```
## # A tibble: 11 x 5
##    Year  `Western Europe` `North America` `Other*` Sales
##    <chr>            <dbl>           <dbl>    <dbl> <dbl>
##  1 2012              5686            7340     9208 22234
```

```
##   2 2013              5680            6883      9427  21990
##   3 2014              5665            6678      9048  21391
##   4 2015              3675            6063      7067  16805
##   5 2016              3756            6279      7388  17423
##   6 2017              3802            6409      7569  17780
##   7 2018              3990            6338      7793  18121
##   8 2019              3328            6904      6916  17148
##   9 2020              3702            6884      6727  17313
##  10 2021              3645            6781      6730  17156
##  11 2022              3603            7588      6636  17827
```

```r
sales <- ggplot(philips, aes(x = Year, y = Sales)) + geom_bar(stat = 'identity') +
  ggtitle("Philips' Sales, mln euros") + theme_classic() +
  ylab("sales") + xlab("year")

philips$cum_sales = cumsum(philips$Sales)

cum_sales <- ggplot(philips, aes(x = Year, y = cum_sales)) +
  geom_bar(stat="identity") + ggtitle("Philips' Cumulative Sales") + theme_classic() +
  xlab("year")

ggarrange(sales, cum_sales, ncol = 1)
```



4. Estimate Bass model parameters for the look-alike innovation.

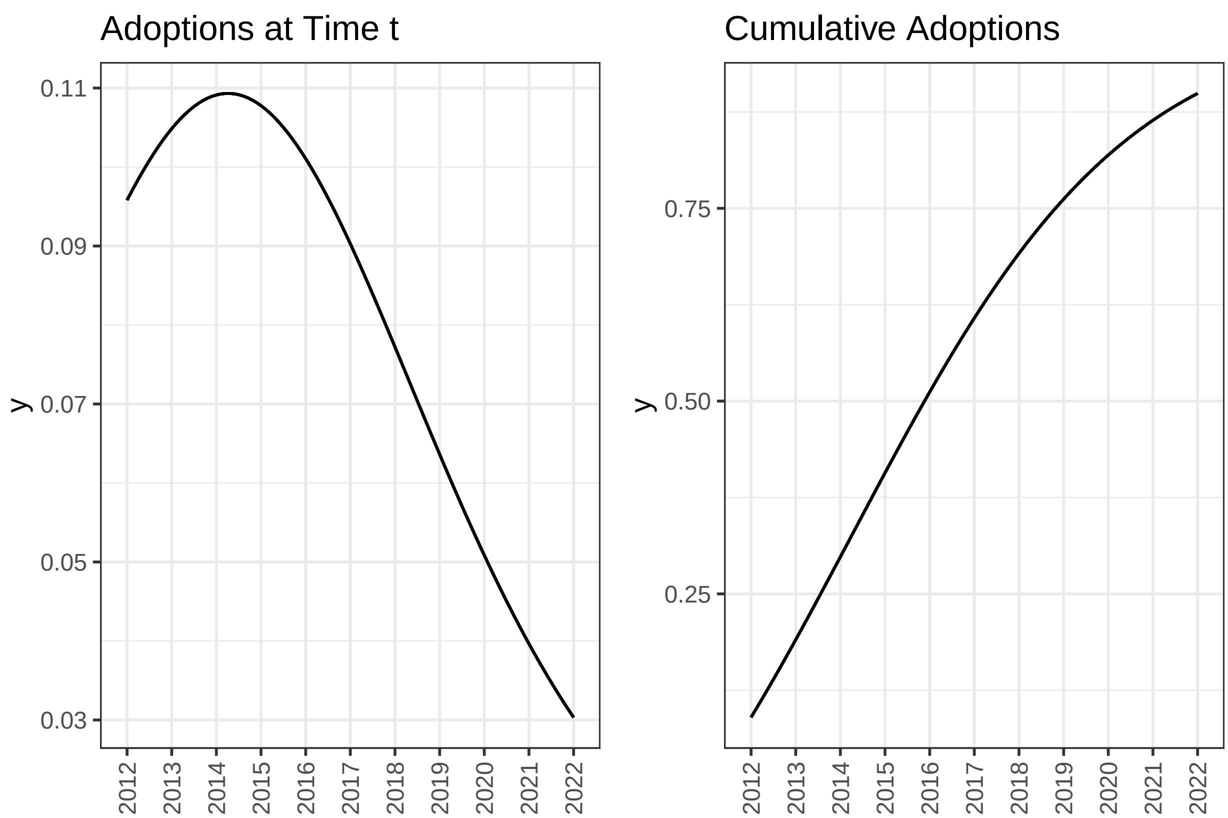
```
library(diffusion)

diffusion(philips$Sales)
```

```
## bass model
##
## Parameters:
##                                   Estimate p-value
## p - Coefficient of innovation      0.0836      NA
## q - Coefficient of imitation       0.2423      NA
## m - Market potential          206629.4229      NA
##
## sigma: 5083.1364
```

5. Make predictions of the diffusion of the innovation you chose at stage 1

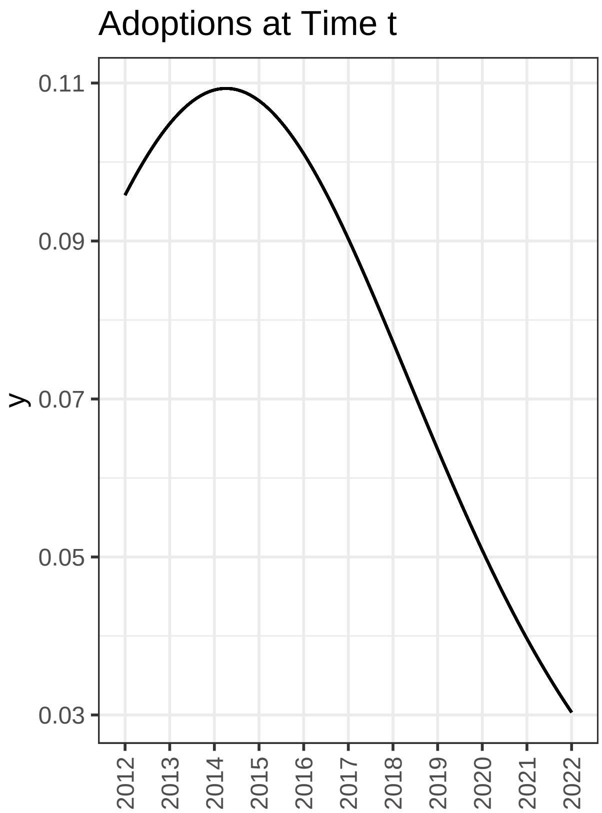
```
data_frame <- data.frame(t = philips$Year, sales = philips$Sales)

p <-0.0836
q <-0.2411

bass.F <- function(t,p,q)
{
  (1 - exp(-(p + q) * t)) / (1 + (q / p) * exp(-(p + q) * t))
}

bass.f <- function(t,p,q)
{
  ((p + q) ^ 2 / p) * exp(-(p + q) * t) / (1 + (q / p) * exp(-(p + q) * t)) ^ 2
}


# modeling f(t)

time_ad <- ggplot(data_frame, aes(t)) +
  stat_function(fun = bass.f, args = c(p, q)) +
  labs(title = 'Adoptions at Time t', x = "") + theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))

cum_ad <- ggplot(data_frame, aes(t)) +
  stat_function(fun = bass.F, args = c(p, q)) +
  labs(title = "Cumulative Adoptions", x = "") + theme_bw() +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1))

ggarrange(time_ad, cum_ad)
```

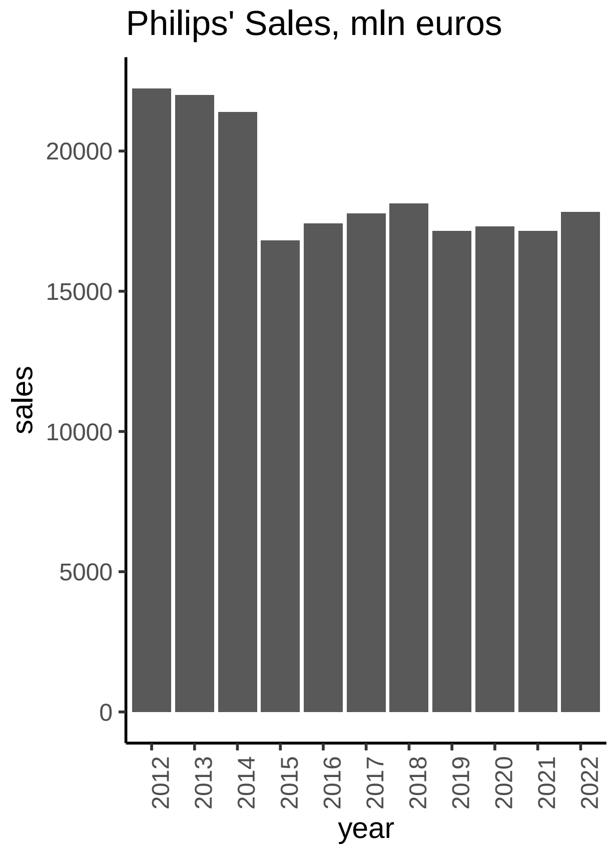
```
## Warning: Multiple drawing groups in `geom_function()`. Did you use the correct `group`, `colour`, or
## Multiple drawing groups in `geom_function()`. Did you use the correct `group`, `colour`, or `fill` a
```




```
ggarrange(time_ad, sales + theme(axis.text.x = element_text(angle = 90, hjust = 1)))
```

```
## Warning: Multiple drawing groups in `geom_function()`. Did you use the correct
## `group`, `colour`, or `fill` aesthetics?
```





6. Estimate the number of adopters by period. Thus, you will need to estimate the potential market share. You can use Fermi's logic here as well.

There were 216.43 million smartwatch users in 2022. So approximately 3% of whole population is using smart watches. If we consider that there are 8 billion people in the world and 5% might use health watch and assuming Philip Health Watch has a 10% market share among health watches also competing with smart watches of Apple, Samsung, Huawei and others. It becomes estimated users would be 8 bln × 0.05 × 0.10 = 40 million.

Turner, A. (2023, July 12). Smartwatch Market Share Globally & US (Oct 2023). BankMyCell. https://www.bankmycell.com/blog/global-smartwatch-market-share/

Ruby, D. (2023). Smartwatch statistics 2023: How many people use smartwatches? DemandSage. https://www.demandsage.com/smartwatch-statistics/

```
# Parameter Estimation, potential market share

sales = philips$Sales
t = 1:length(sales)

m = 40000000
bass_m = m * (((p + q) ^ 2 / p) * exp(-(p + q) * t)) / (1 + (q / p) * exp(-(p + q) * t)) ^ 2
bass_m
```

```
##  [1] 3832384 4194333 4364976 4310698 4042399 3611094 3088677 2545331 2034116
## [10] 1586097 1213240
```

```r
# Sales prediction

philips$pred_sales = bass.f(1:11, p, q)*206630
ggplot(philips, aes(x = Year, y = Sales)) +
  geom_bar(stat = 'identity') +
  geom_point(mapping = aes(x = Year, y = pred_sales), color = 'red')+
  labs(title = "Sales Prediction", x= 'Year ', y = 'Sales') + theme_classic()
```