Canada

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Importanto a base

Como a primeira coluna, referente ao ano (. . . 1) é descritiva, estamos retirando da base.

```
library(readxl)
xlsfile <- file.path('/cloud/project','Canada.xlsx')
df <- read_xlsx(xlsfile)
```

```
## New names:
## * `` -> `...1`
```

```
df$...1 <- NULL
```

Seleção de variáveis

Ao fazer o summary, eu reparei que as variáveis **EXGR_INTDVAPSH, EXGRPSH, EXGR_DVAPSH, IMGRPSH, FFD_DVAPSH, DFD_FVAPSH, FD_VASH, CONS_VASH, GFCF_VASH** sempre tem o mesmo valor, então elas já podem ser descartadas da seleção de variáveis.

```
summary(df)
```

```
##       EXGR           EXGR_FNL         EXGR_INT         EXGR_DVA
##  Min.   :211974   Min.   : 84451   Min.   :127523   Min.   :156207
##  1st Qu.:298183   1st Qu.:122894   1st Qu.:175289   1st Qu.:221262
##  Median :429628   Median :151081   Median :273022   Median :329283
##  Mean   :397406   Mean   :143401   Mean   :254004   Mean   :301488
##  3rd Qu.:495869   3rd Qu.:169087   3rd Qu.:319593   3rd Qu.:376236
##  Max.   :546981   Max.   :183861   Max.   :372224   Max.   :419720
##     EXGR_DDC         EXGR_IDC         EXGR_RIM         EXGR_FVA
##  Min.   :100218   Min.   : 55182   Min.   : 807.2   Min.   : 55767
##  1st Qu.:139389   1st Qu.: 80765   1st Qu.:1078.0   1st Qu.: 76448
##  Median :205694   Median :119353   Median :1377.8   Median : 97806
##  Mean   :190071   Mean   :110028   Mean   :1389.3   Mean   : 95918
##  3rd Qu.:239081   3rd Qu.:139512   3rd Qu.:1684.2   3rd Qu.:117980
##  Max.   :265951   Max.   :152060   Max.   :2126.0   Max.   :129361
##      IMGR           IMGR_FNL         IMGR_INT         IMGR_DVA
##  Min.   :194027   Min.   : 73782   Min.   :120245   Min.   :2255
##  1st Qu.:257286   1st Qu.: 99710   1st Qu.:158064   1st Qu.:3176
##  Median :405444   Median :173061   Median :233981   Median :4823
##  Mean   :394256   Mean   :165140   Mean   :229116   Mean   :4756
##  3rd Qu.:514745   3rd Qu.:221374   3rd Qu.:293371   3rd Qu.:5813
##  Max.   :571391   Max.   :246796   Max.   :326714   Max.   :7775
##      BALGR            REII             PROD             VALU
##  Min.   :-48213   Min.   : 56940   Min.   :1036794   Min.   : 577857
##  1st Qu.:-38326   1st Qu.: 77997   1st Qu.:1343605   1st Qu.: 709673
```

```
##    Median : 16031    Median : 99838    Median :2359129   Median :1290798
##    Mean   :  3150    Mean   : 97878    Mean   :2169737   Mean   :1181006
##    3rd Qu.: 34256    3rd Qu.:120435    3rd Qu.:2836823   3rd Qu.:1558232
##    Max.   : 47846    Max.   :131509    Max.   :3249040   Max.   :1773918
##      FFD_DVA           DFD_FVA           BALVAFD           FD_VA
##    Min.   :153952    Min.   :136006    Min.   :-48213    Min.   : 559911
##    1st Qu.:218086    1st Qu.:177422    1st Qu.:-38326    1st Qu.: 663028
##    Median :324460    Median :308675    Median : 16031    Median :1285771
##    Mean   :296731    Mean   :293582    Mean   :  3150    Mean   :1177856
##    3rd Qu.:370262    3rd Qu.:389780    3rd Qu.: 34256    3rd Qu.:1600359
##    Max.   :411945    Max.   :441505    Max.   : 47846    Max.   :1813438
##      CONS_VA           GFCF_VA          EXGR_DVASH        EXGR_FVASH
##    Min.   : 435755   Min.   :107036    Min.   :72.10     Min.   :21.61
##    1st Qu.: 509853   1st Qu.:142846    1st Qu.:74.20     1st Qu.:23.09
##    Median : 957964   Median :294601    Median :75.78     Median :24.21
##    Mean   : 881135   Mean   :267298    Mean   :75.53     Mean   :24.47
##    3rd Qu.:1193811   3rd Qu.:359996    3rd Qu.:76.91     3rd Qu.:25.80
##    Max.   :1326523   Max.   :433755    Max.   :78.39     Max.   :27.90
##    EXGR_DVAFXSH   EXGR_FNLDVASH   EXGR_INTDVASH   EXGR_INTDVAPSH    EXGRPSH
##    Min.   : 9.51  Min.   :23.21   Min.   :41.89   Min.   :100     Min.   :100
##    1st Qu.:10.31  1st Qu.:25.65   1st Qu.:45.04   1st Qu.:100     1st Qu.:100
##    Median :13.26  Median :26.75   Median :48.67   Median :100     Median :100
##    Mean   :12.81  Mean   :27.02   Mean   :48.51   Mean   :100     Mean   :100
##    3rd Qu.:14.86  3rd Qu.:29.07   3rd Qu.:52.14   3rd Qu.:100     3rd Qu.:100
##    Max.   :17.00  Max.   :30.59   Max.   :55.04   Max.   :100     Max.   :100
##    EXGR_DVAPSH    EXGR_TDVAIND    EXGR_TFVAIND    EXGR_SERV_DVASH EXGR_SERV_FVASH
##    Min.   :100    Min.   :72.10   Min.   :21.61   Min.   :30.23   Min.   : 8.850
##    1st Qu.:100    1st Qu.:74.20   1st Qu.:23.09   1st Qu.:32.23   1st Qu.: 9.555
##    Median :100    Median :75.78   Median :24.21   Median :34.33   Median :10.305
##    Mean   :100    Mean   :75.53   Mean   :24.47   Mean   :34.81   Mean   :10.439
##    3rd Qu.:100    3rd Qu.:76.91   3rd Qu.:25.80   3rd Qu.:37.27   3rd Qu.:11.230
##    Max.   :100    Max.   :78.39   Max.   :27.90   Max.   :39.50   Max.   :12.110
##    IMGRINT_REII    IMGR_DVASH      IMGRPSH        FFD_DVAPSH     DFD_FVAPSH
##    Min.   :37.40  Min.   :0.942   Min.   :100    Min.   :100    Min.   :100
##    1st Qu.:40.52  1st Qu.:1.159   1st Qu.:100    1st Qu.:100    1st Qu.:100
##    Median :42.45  Median :1.212   Median :100    Median :100    Median :100
##    Mean   :43.94  Mean   :1.211   Mean   :100    Mean   :100    Mean   :100
##    3rd Qu.:48.26  3rd Qu.:1.315   3rd Qu.:100    3rd Qu.:100    3rd Qu.:100
##    Max.   :51.69  Max.   :1.478   Max.   :100    Max.   :100    Max.   :100
##    VALU_FFDDVA     PROD_VASH       FD_VASH        CONS_VASH      GFCF_VASH
##    Min.   :21.75  Min.   :52.76   Min.   :100    Min.   :100    Min.   :100
##    1st Qu.:23.01  1st Qu.:53.80   1st Qu.:100    1st Qu.:100    1st Qu.:100
##    Median :26.57  Median :54.46   Median :100    Median :100    Median :100
##    Mean   :26.13  Mean   :54.33   Mean   :100    Mean   :100    Mean   :100
##    3rd Qu.:28.35  3rd Qu.:54.74   3rd Qu.:100    3rd Qu.:100    3rd Qu.:100
##    Max.   :32.38  Max.   :55.73   Max.   :100    Max.   :100    Max.   :100
##     DEXFVAPSH       FEXDVAPSH
##    Min.   :21.61  Min.   : 9.512
##    1st Qu.:23.09  1st Qu.:10.313
##    Median :24.21  Median :13.261
##    Mean   :24.47  Mean   :12.811
##    3rd Qu.:25.80  3rd Qu.:14.865
##    Max.   :27.89  Max.   :16.999
```

Removendo as variáveis com valor constante do dataframe

```
df$EXGR_INTDVAPSH <- NULL
df$EXGRPSH <- NULL
df$EXGR_DVAPSH <- NULL
df$IMGRPSH <- NULL
df$FFD_DVAPSH <- NULL
df$DFD_FVAPSH <- NULL
df$FD_VASH <- NULL
df$CONS_VASH <- NULL
df$GFCF_VASH <- NULL
```

Analisando a autocorrelação das variáveis

```
cor(df)
```

```
##                        EXGR     EXGR_FNL     EXGR_INT     EXGR_DVA    EXGR_DDC
## EXGR             1.00000000   0.96338500   0.99552221   0.99821975   0.9952920
## EXGR_FNL         0.96338500   1.00000000   0.93372615   0.95088801   0.9425997
## EXGR_INT         0.99552221   0.93372615   1.00000000   0.99755116   0.9965642
## EXGR_DVA         0.99821975   0.95088801   0.99755116   1.00000000   0.9986876
## EXGR_DDC         0.99529203   0.94259973   0.99656424   0.99868758   1.0000000
## EXGR_IDC         0.99707451   0.95911683   0.99312095   0.99615182   0.9903587
## EXGR_RIM         0.91297677   0.84748881   0.92019139   0.91711488   0.9300919
## EXGR_FVA         0.97446155   0.97937508   0.95578666   0.95933357   0.9504187
## IMGR             0.97835311   0.93287194   0.97737749   0.97278385   0.9636471
## IMGR_FNL         0.96634887   0.90889130   0.96980431   0.96250587   0.9532492
## IMGR_INT         0.98419610   0.94928177   0.97939348   0.97715998   0.9681693
## IMGR_DVA         0.95294359   0.85676681   0.97028281   0.96227830   0.9700426
## BALGR           -0.61346814  -0.55414682  -0.62371600  -0.59776961  -0.5720373
## REII             0.97554158   0.97916124   0.95730407   0.96070345   0.9521910
## PROD             0.97617461   0.91666407   0.98018299   0.97620643   0.9681942
## VALU             0.97179685   0.90867036   0.97715616   0.97218544   0.9640541
## FFD_DVA          0.99835571   0.95202330   0.99733243   0.99998560   0.9984952
## DFD_FVA          0.97028517   0.91542584   0.97275615   0.96654836   0.9571929
## BALVAFD         -0.61346814  -0.55414682  -0.62371600  -0.59776961  -0.5720373
## FD_VA            0.96121838   0.89731072   0.96703702   0.96040041   0.9508042
## CONS_VA          0.95629545   0.89594515   0.96094553   0.95484931   0.9441248
## GFCF_VA          0.96912158   0.89835466   0.97722109   0.97011291   0.9629762
## EXGR_DVASH       0.67825822   0.54877343   0.71211620   0.71925804   0.7306977
## EXGR_FVASH      -0.67825822  -0.54877343  -0.71211620  -0.71925804  -0.7306977
## EXGR_DVAFXSH     0.92604788   0.80657499   0.95206788   0.93347343   0.9338344
## EXGR_FNLDVASH   -0.89709372  -0.75036820  -0.93322521  -0.91159277  -0.9167279
## EXGR_INTDVASH    0.84987405   0.70205115   0.88721341   0.87781180   0.8862727
## EXGR_TDVAIND     0.67825822   0.54877343   0.71211620   0.71925804   0.7306977
## EXGR_TFVAIND    -0.67825822  -0.54877343  -0.71211620  -0.71925804  -0.7306977
## EXGR_SERV_DVASH  0.74690793   0.74732320   0.73377526   0.74011737   0.7131583
## EXGR_SERV_FVASH -0.25278085  -0.07372279  -0.31151379  -0.30783164  -0.3377423
## IMGRINT_REII    -0.83351420  -0.72652819  -0.85674069  -0.84992485  -0.8412193
## IMGR_DVASH       0.05804516  -0.04408965   0.09304425   0.09144961   0.1325522
## VALU_FFDDVA     -0.71143637  -0.61631989  -0.73260068  -0.71547933  -0.6954071
## PROD_VASH        0.21981080   0.05808079   0.27300780   0.23510260   0.2274452
## DEXFVAPSH       -0.67790626  -0.54828421  -0.71181876  -0.71893654  -0.7304155
## FEXDVAPSH        0.92601898   0.80647878   0.95206321   0.93346139   0.9338595
##                     EXGR_IDC     EXGR_RIM     EXGR_FVA         IMGR    IMGR_FNL
## EXGR              0.99707451   0.91297677   0.97446155   0.9783531   0.9663489
```

```
## EXGR_FNL           0.95911683  0.84748881  0.97937508  0.9328719  0.9088913
## EXGR_INT           0.99312095  0.92019139  0.95578666  0.9773775  0.9698043
## EXGR_DVA           0.99615182  0.91711488  0.95933357  0.9727839  0.9625059
## EXGR_DDC           0.99035868  0.93009189  0.95041874  0.9636471  0.9532492
## EXGR_IDC           1.00000000  0.88840988  0.96840167  0.9826113  0.9727306
## EXGR_RIM           0.88840988  1.00000000  0.86796182  0.8381446  0.8164846
## EXGR_FVA           0.96840167  0.86796182  1.00000000  0.9677779  0.9496614
## IMGR               0.98261135  0.83814462  0.96777790  1.0000000  0.9971234
## IMGR_FNL           0.97273062  0.81648456  0.94966140  0.9971234  1.0000000
## IMGR_INT           0.98659841  0.85298715  0.97895514  0.9978500  0.9900119
## IMGR_DVA           0.94273998  0.96666764  0.88707503  0.9157333  0.9079456
## BALGR             -0.63884582 -0.34993160 -0.65279307 -0.7636150 -0.7900914
## REII               0.96906107  0.87264807  0.99995392  0.9675930  0.9493602
## PROD               0.98422451  0.83543804  0.94458186  0.9944572  0.9935414
## VALU               0.98047372  0.82734845  0.93900200  0.9936050  0.9941354
## FFD_DVA            0.99644981  0.91544198  0.96003124  0.9731713  0.9628520
## DFD_FVA            0.97689173  0.82196903  0.95307101  0.9985786  0.9990056
## BALVAFD           -0.63884582 -0.34993160 -0.65279307 -0.7636150 -0.7900914
## FD_VA              0.97130148  0.80534539  0.93330719  0.9930736  0.9955695
## CONS_VA            0.96777625  0.78856062  0.93090805  0.9916662  0.9948153
## GFCF_VA            0.97659051  0.84167952  0.93414371  0.9910292  0.9920073
## EXGR_DVASH         0.69634701  0.63472642  0.50202828  0.6191013  0.6291311
## EXGR_FVASH        -0.69634701 -0.63472642 -0.50202828 -0.6191013 -0.6291311
## EXGR_DVAFXSH       0.92740926  0.84329768  0.86823438  0.9470024  0.9575830
## EXGR_FNLDVASH     -0.89736340 -0.86082194 -0.81358222 -0.8958685 -0.9044042
## EXGR_INTDVASH      0.85854500  0.80812673  0.71728901  0.8211401  0.8308906
## EXGR_TDVAIND       0.69634701  0.63472642  0.50202828  0.6191013  0.6291311
## EXGR_TFVAIND      -0.69634701 -0.63472642 -0.50202828 -0.6191013 -0.6291311
## EXGR_SERV_DVASH    0.78292199  0.43065058  0.74839282  0.8293325  0.8456302
## EXGR_SERV_FVASH   -0.25556860 -0.37843264 -0.03736763 -0.1651642 -0.1795320
## IMGRINT_REII      -0.86072976 -0.64106321 -0.74485546 -0.8787437 -0.8959162
## IMGR_DVASH         0.01929034  0.42336709 -0.06959205 -0.1029074 -0.1228953
## VALU_FFDDVA       -0.74657234 -0.45260118 -0.67327717 -0.8193174 -0.8455825
## PROD_VASH          0.24825193  0.04374286  0.15515095  0.3455872  0.3927132
## DEXFVAPSH         -0.69596067 -0.63459965 -0.50157304 -0.6187120 -0.6287635
## FEXDVAPSH          0.92733299  0.84356075  0.86814292  0.9468546  0.9574173
##                    IMGR_INT   IMGR_DVA      BALGR       REII       PROD
## EXGR               0.98419610  0.9529436 -0.6134681  0.97554158  0.97617461
## EXGR_FNL           0.94928177  0.8567668 -0.5541468  0.97916124  0.91666407
## EXGR_INT           0.97939348  0.9702828 -0.6237160  0.95730407  0.98018299
## EXGR_DVA           0.97715998  0.9622783 -0.5977696  0.96070345  0.97620643
## EXGR_DDC           0.96816933  0.9700426 -0.5720373  0.95219101  0.96819422
## EXGR_IDC           0.98659841  0.9427400 -0.6388458  0.96906107  0.98422451
## EXGR_RIM           0.85298715  0.9666676 -0.3499316  0.87264807  0.83543804
## EXGR_FVA           0.97895514  0.8870750 -0.6527931  0.99995392  0.94458186
## IMGR               0.99784995  0.9157333 -0.7636150  0.96759302  0.99445723
## IMGR_FNL           0.99001194  0.9079456 -0.7900914  0.94936020  0.99354139
## IMGR_INT           1.00000000  0.9182206 -0.7371797  0.97887171  0.99063745
## IMGR_DVA           0.91822055  1.0000000 -0.5213213  0.89068750  0.92647857
## BALGR             -0.73717968 -0.5213213  1.0000000 -0.64871781 -0.74926011
## REII               0.97887171  0.8906875 -0.6487178  1.00000000  0.94464525
## PROD               0.99063745  0.9264786 -0.7492601  0.94464525  1.00000000
## VALU               0.98853870  0.9226426 -0.7596669  0.93900176  0.99970807
## FFD_DVA            0.97758141  0.9608045 -0.5988241  0.96135585  0.97644687
```

```
## DFD_FVA          0.99357859  0.9117823 -0.7833632  0.95280061  0.99654709
## BALVAFD         -0.73717968 -0.5213213  1.0000000 -0.64871781 -0.74926011
## FD_VA            0.98631011  0.9079904 -0.7906443  0.93299965  0.99773718
## CONS_VA          0.98434442  0.8948597 -0.8006331  0.93030775  0.99600770
## GFCF_VA          0.98558760  0.9356363 -0.7581841  0.93453247  0.99727083
## EXGR_DVASH       0.60755758  0.7390029 -0.2463684  0.50505223  0.69037067
## EXGR_FVASH      -0.60755758 -0.7390029  0.2463684 -0.50505223 -0.69037067
## EXGR_DVAFXSH     0.93346167  0.9374072 -0.7245643  0.86983300  0.95625453
## EXGR_FNLDVASH   -0.88433324 -0.9433486  0.6197694 -0.81631903 -0.91560318
## EXGR_INTDVASH    0.80890102  0.9060206 -0.4819241  0.72033783  0.86646986
## EXGR_TDVAIND     0.60755758  0.7390029 -0.2463684  0.50505223  0.69037067
## EXGR_TFVAIND    -0.60755758 -0.7390029  0.2463684 -0.50505223 -0.69037067
## EXGR_SERV_DVASH  0.81139402  0.5894849 -0.8344470  0.74381504  0.83380620
## EXGR_SERV_FVASH -0.15197466 -0.4394461 -0.1584017 -0.04342542 -0.25111571
## IMGRINT_REII    -0.85981957 -0.8059055  0.7527903 -0.74425463 -0.91712729
## IMGR_DVASH      -0.08514669  0.3000436  0.5738119 -0.06036412 -0.06746106
## VALU_FFDDVA     -0.79280664 -0.6444906  0.9069016 -0.67045394 -0.84059536
## PROD_VASH        0.30323490  0.2269977 -0.6329839  0.15324030  0.37325628
## DEXFVAPSH       -0.60715136 -0.7388448  0.2459808 -0.50460192 -0.68999449
## FEXDVAPSH        0.93333004  0.9375397 -0.7240904  0.86974847  0.95611725
##                      VALU     FFD_DVA    DFD_FVA    BALVAFD       FD_VA
## EXGR             0.97179685  0.99835571  0.9702852 -0.6134681  0.9612184
## EXGR_FNL         0.90867036  0.95202330  0.9154258 -0.5541468  0.8973107
## EXGR_INT         0.97715616  0.99733243  0.9727561 -0.6237160  0.9670370
## EXGR_DVA         0.97218544  0.99998560  0.9665484 -0.5977696  0.9604004
## EXGR_DDC         0.96405409  0.99849515  0.9571929 -0.5720373  0.9508042
## EXGR_IDC         0.98047372  0.99644981  0.9768917 -0.6388458  0.9713015
## EXGR_RIM         0.82734845  0.91544198  0.8219690 -0.3499316  0.8053454
## EXGR_FVA         0.93900200  0.96003124  0.9530710 -0.6527931  0.9333072
## IMGR             0.99360505  0.97317134  0.9985786 -0.7636150  0.9930736
## IMGR_FNL         0.99413540  0.96285202  0.9990056 -0.7900914  0.9955695
## IMGR_INT         0.98853870  0.97758141  0.9935786 -0.7371797  0.9863101
## IMGR_DVA         0.92264264  0.96080447  0.9117823 -0.5213213  0.9079904
## BALGR           -0.75966691 -0.59882410 -0.7833632  1.0000000 -0.7906443
## REII             0.93900176  0.96135585  0.9528006 -0.6487178  0.9329997
## PROD             0.99970807  0.97644687  0.9965471 -0.7492601  0.9977372
## VALU             1.00000000  0.97242528  0.9967417 -0.7596669  0.9987968
## FFD_DVA          0.97242528  1.00000000  0.9668955 -0.5988241  0.9607057
## DFD_FVA          0.99674169  0.96689550  1.0000000 -0.7833632  0.9975160
## BALVAFD         -0.75966691 -0.59882410 -0.7833632  1.0000000 -0.7906443
## FD_VA            0.99879681  0.96070575  0.9975160 -0.7906443  1.0000000
## CONS_VA          0.99736054  0.95530835  0.9965097 -0.8006331  0.9994010
## GFCF_VA          0.99743215  0.97005717  0.9944314 -0.7581841  0.9962673
## EXGR_DVASH       0.69104438  0.71832302  0.6359880 -0.2463684  0.6692040
## EXGR_FVASH      -0.69104438 -0.71832302 -0.6359880  0.2463684 -0.6692040
## EXGR_DVAFXSH     0.95938291  0.93268785  0.9547172 -0.7245643  0.9579083
## EXGR_FNLDVASH   -0.91798261 -0.91027503 -0.9039334  0.6197694 -0.9110269
## EXGR_INTDVASH    0.86818965  0.87658961  0.8338705 -0.4819241  0.8537514
## EXGR_TDVAIND     0.69104438  0.71832302  0.6359880 -0.2463684  0.6692040
## EXGR_TFVAIND    -0.69104438 -0.71832302 -0.6359880  0.2463684 -0.6692040
## EXGR_SERV_DVASH  0.83878042  0.74252709  0.8421435 -0.8344470  0.8526461
## EXGR_SERV_FVASH -0.25235319 -0.30500215 -0.1862434 -0.1584017 -0.2256480
## IMGRINT_REII    -0.92318873 -0.85014843 -0.8996515  0.7527903 -0.9259597
## IMGR_DVASH      -0.07774079  0.08726599 -0.1150979  0.5738119 -0.1164650
```

```
## VALU_FFDDVA     -0.85151393 -0.71633682 -0.8449024  0.9069016 -0.8700987
## PROD_VASH        0.39450547  0.23508403  0.3841273 -0.6329839  0.4191644
## DEXFVAPSH       -0.69067925 -0.71799854 -0.6356127  0.2459808 -0.6688310
## FEXDVAPSH        0.95924139  0.93267297  0.9545547 -0.7240904  0.9577393
##                      CONS_VA      GFCF_VA EXGR_DVASH EXGR_FVASH EXGR_DVAFXSH
## EXGR             0.9562955  0.96912158  0.6782582 -0.6782582   0.92604788
## EXGR_FNL         0.8959451  0.89835466  0.5487734 -0.5487734   0.80657499
## EXGR_INT         0.9609455  0.97722109  0.7121162 -0.7121162   0.95206788
## EXGR_DVA         0.9548493  0.97011291  0.7192580 -0.7192580   0.93347343
## EXGR_DDC         0.9441248  0.96297622  0.7306977 -0.7306977   0.93383445
## EXGR_IDC         0.9677763  0.97659051  0.6963470 -0.6963470   0.92740926
## EXGR_RIM         0.7885606  0.84167952  0.6347264 -0.6347264   0.84329768
## EXGR_FVA         0.9309080  0.93414371  0.5020283 -0.5020283   0.86823438
## IMGR             0.9916662  0.99102920  0.6191013 -0.6191013   0.94700237
## IMGR_FNL         0.9948153  0.99200734  0.6291311 -0.6291311   0.95758304
## IMGR_INT         0.9843444  0.98558760  0.6075576 -0.6075576   0.93346167
## IMGR_DVA         0.8948597  0.93563632  0.7390029 -0.7390029   0.93740724
## BALGR           -0.8006331 -0.75818415 -0.2463684  0.2463684  -0.72456427
## REII             0.9303078  0.93453247  0.5050522 -0.5050522   0.86983300
## PROD             0.9960077  0.99727083  0.6903707 -0.6903707   0.95625453
## VALU             0.9973605  0.99743215  0.6910444 -0.6910444   0.95938291
## FFD_DVA          0.9553084  0.97005717  0.7183230 -0.7183230   0.93268785
## DFD_FVA          0.9965097  0.99443137  0.6359880 -0.6359880   0.95471723
## BALVAFD         -0.8006331 -0.75818415 -0.2463684  0.2463684  -0.72456427
## FD_VA            0.9994010  0.99626734  0.6692040 -0.6692040   0.95790830
## CONS_VA          1.0000000  0.99294340  0.6629582 -0.6629582   0.95158319
## GFCF_VA          0.9929434  1.00000000  0.6876000 -0.6876000   0.96599132
## EXGR_DVASH       0.6629582  0.68759997  1.0000000 -1.0000000   0.70347307
## EXGR_FVASH      -0.6629582 -0.68759997 -1.0000000  1.0000000  -0.70347307
## EXGR_DVAFXSH     0.9515832  0.96599132  0.7034731 -0.7034731   1.00000000
## EXGR_FNLDVASH   -0.9021113 -0.92613973 -0.7681903  0.7681903  -0.97146301
## EXGR_INTDVASH    0.8455268  0.87137958  0.9258730 -0.9258730   0.90563409
## EXGR_TDVAIND     0.6629582  0.68759997  1.0000000 -1.0000000   0.70347307
## EXGR_TFVAIND    -0.6629582 -0.68759997 -1.0000000  1.0000000  -0.70347307
## EXGR_SERV_DVASH  0.8675657  0.81866264  0.5166382 -0.5166382   0.72714057
## EXGR_SERV_FVASH -0.2091118 -0.26677423 -0.8153255  0.8153255  -0.36838001
## IMGRINT_REII    -0.9278388 -0.91835721 -0.8121856  0.8121856  -0.89662339
## IMGR_DVASH      -0.1449723 -0.04479079  0.3532027 -0.3532027   0.04921984
## VALU_FFDDVA     -0.8778944 -0.84583373 -0.5755776  0.5755776  -0.82361834
## PROD_VASH        0.4258871  0.39169969  0.3183551 -0.3183551   0.48881039
## DEXFVAPSH       -0.6625714 -0.68725083 -0.9999986  0.9999986  -0.70328054
## FEXDVAPSH        0.9513954  0.96587144  0.7035660 -0.7035660   0.99999933
##               EXGR_FNLDVASH EXGR_INTDVASH EXGR_TDVAIND EXGR_TFVAIND
## EXGR             -0.8970937     0.8498740    0.6782582   -0.6782582
## EXGR_FNL         -0.7503682     0.7020511    0.5487734   -0.5487734
## EXGR_INT         -0.9332252     0.8872134    0.7121162   -0.7121162
## EXGR_DVA         -0.9115928     0.8778118    0.7192580   -0.7192580
## EXGR_DDC         -0.9167279     0.8862727    0.7306977   -0.7306977
## EXGR_IDC         -0.8973634     0.8585450    0.6963470   -0.6963470
## EXGR_RIM         -0.8608219     0.8081267    0.6347264   -0.6347264
## EXGR_FVA         -0.8135822     0.7172890    0.5020283   -0.5020283
## IMGR             -0.8958685     0.8211401    0.6191013   -0.6191013
## IMGR_FNL         -0.9044042     0.8308906    0.6291311   -0.6291311
## IMGR_INT         -0.8843332     0.8089010    0.6075576   -0.6075576
```

```
## IMGR_DVA            -0.9433486     0.9060206     0.7390029    -0.7390029
## BALGR                0.6197694    -0.4819241    -0.2463684     0.2463684
## REII                -0.8163190     0.7203378     0.5050522    -0.5050522
## PROD                -0.9156032     0.8664699     0.6903707    -0.6903707
## VALU                -0.9179826     0.8681896     0.6910444    -0.6910444
## FFD_DVA             -0.9102750     0.8765896     0.7183230    -0.7183230
## DFD_FVA             -0.9039334     0.8338705     0.6359880    -0.6359880
## BALVAFD              0.6197694    -0.4819241    -0.2463684     0.2463684
## FD_VA               -0.9110269     0.8537514     0.6692040    -0.6692040
## CONS_VA             -0.9021113     0.8455268     0.6629582    -0.6629582
## GFCF_VA             -0.9261397     0.8713796     0.6876000    -0.6876000
## EXGR_DVASH          -0.7681903     0.9258730     1.0000000    -1.0000000
## EXGR_FVASH           0.7681903    -0.9258730    -1.0000000     1.0000000
## EXGR_DVAFXSH        -0.9714630     0.9056341     0.7034731    -0.7034731
## EXGR_FNLDVASH        1.0000000    -0.9531431    -0.7681903     0.7681903
## EXGR_INTDVASH       -0.9531431     1.0000000     0.9258730    -0.9258730
## EXGR_TDVAIND        -0.7681903     0.9258730     1.0000000    -1.0000000
## EXGR_TFVAIND         0.7681903    -0.9258730    -1.0000000     1.0000000
## EXGR_SERV_DVASH     -0.6344314     0.6181648     0.5166382    -0.5166382
## EXGR_SERV_FVASH      0.4876150    -0.6732054    -0.8153255     0.8153255
## IMGRINT_REII         0.8765009    -0.9009243    -0.8121856     0.8121856
## IMGR_DVASH          -0.1888438     0.2788133     0.3532027    -0.3532027
## VALU_FFDDVA          0.7604538    -0.7205523    -0.5755776     0.5755776
## PROD_VASH           -0.4596216     0.4215876     0.3183551    -0.3183551
## DEXFVAPSH            0.7680176    -0.9257718    -0.9999986     0.9999986
## FEXDVAPSH           -0.9715690     0.9057407     0.7035660    -0.7035660
##              EXGR_SERV_DVASH EXGR_SERV_FVASH IMGRINT_REII  IMGR_DVASH
## EXGR              0.74690793     -0.25278085   -0.8335142  0.05804516
## EXGR_FNL          0.74732320     -0.07372279   -0.7265282 -0.04408965
## EXGR_INT          0.73377526     -0.31151379   -0.8567407  0.09304425
## EXGR_DVA          0.74011737     -0.30783164   -0.8499249  0.09144961
## EXGR_DDC          0.71315831     -0.33774233   -0.8412193  0.13255224
## EXGR_IDC          0.78292199     -0.25556860   -0.8607298  0.01929034
## EXGR_RIM          0.43065058     -0.37843264   -0.6410632  0.42336709
## EXGR_FVA          0.74839282     -0.03736763   -0.7448555 -0.06959205
## IMGR              0.82933249     -0.16516422   -0.8787437 -0.10290740
## IMGR_FNL          0.84563017     -0.17953196   -0.8959162 -0.12289531
## IMGR_INT          0.81139402     -0.15197466   -0.8598196 -0.08514669
## IMGR_DVA          0.58948491     -0.43944607   -0.8059055  0.30004359
## BALGR            -0.83444703     -0.15840174    0.7527903  0.57381192
## REII              0.74381504     -0.04342542   -0.7442546 -0.06036412
## PROD              0.83380620     -0.25111571   -0.9171273 -0.06746106
## VALU              0.83878042     -0.25235319   -0.9231887 -0.07774079
## FFD_DVA           0.74252709     -0.30500215   -0.8501484  0.08726599
## DFD_FVA           0.84214351     -0.18624340   -0.8996515 -0.11509786
## BALVAFD          -0.83444703     -0.15840174    0.7527903  0.57381192
## FD_VA             0.85264612     -0.22564800   -0.9259597 -0.11646501
## CONS_VA           0.86756572     -0.20911175   -0.9278388 -0.14497232
## GFCF_VA           0.81866264     -0.26677423   -0.9183572 -0.04479079
## EXGR_DVASH        0.51663822     -0.81532549   -0.8121856  0.35320271
## EXGR_FVASH       -0.51663822      0.81532549    0.8121856 -0.35320271
## EXGR_DVAFXSH      0.72714057     -0.36838001   -0.8966234  0.04921984
## EXGR_FNLDVASH    -0.63443136      0.48761495    0.8765009 -0.18884378
## EXGR_INTDVASH     0.61816484     -0.67320545   -0.9009243  0.27881334
```

7

```
## EXGR_TDVAIND          0.51663822     -0.81532549   -0.8121856  0.35320271
## EXGR_TFVAIND         -0.51663822      0.81532549    0.8121856 -0.35320271
## EXGR_SERV_DVASH       1.00000000      0.02016466   -0.8551632 -0.51912883
## EXGR_SERV_FVASH       0.02016466      1.00000000    0.4302685 -0.67406359
## IMGRINT_REII         -0.85516322      0.43026846    1.0000000  0.12163183
## IMGR_DVASH           -0.51912883     -0.67406359    0.1216318  1.00000000
## VALU_FFDDVA          -0.89073007      0.17186113    0.9338240  0.40537705
## PROD_VASH             0.46069583     -0.20163027   -0.5912763 -0.36576412
## DEXFVAPSH            -0.51612535      0.81565912    0.8119431 -0.35361438
## FEXDVAPSH             0.72665609     -0.36875874   -0.8964156  0.04990577
##               VALU_FFDDVA   PROD_VASH   DEXFVAPSH    FEXDVAPSH
## EXGR            -0.7114364  0.21981080 -0.6779063  0.92601898
## EXGR_FNL        -0.6163199  0.05808079 -0.5482842  0.80647878
## EXGR_INT        -0.7326007  0.27300780 -0.7118188  0.95206321
## EXGR_DVA        -0.7154793  0.23510260 -0.7189365  0.93346139
## EXGR_DDC        -0.6954071  0.22744519 -0.7304155  0.93385952
## EXGR_IDC        -0.7465723  0.24825193 -0.6959607  0.92733299
## EXGR_RIM        -0.4526012  0.04374286 -0.6345997  0.84356075
## EXGR_FVA        -0.6732772  0.15515095 -0.5015730  0.86814292
## IMGR            -0.8193174  0.34558720 -0.6187120  0.94685456
## IMGR_FNL        -0.8455825  0.39271322 -0.6287635  0.95741730
## IMGR_INT        -0.7928066  0.30323490 -0.6071514  0.93333004
## IMGR_DVA        -0.6444906  0.22699765 -0.7388448  0.93753967
## BALGR            0.9069016 -0.63298385  0.2459808 -0.72409036
## REII            -0.6704539  0.15324030 -0.5046019  0.86974847
## PROD            -0.8405954  0.37325628 -0.6899945  0.95611725
## VALU            -0.8515139  0.39450547 -0.6906792  0.95924139
## FFD_DVA         -0.7163368  0.23508403 -0.7179985  0.93267297
## DFD_FVA         -0.8449024  0.38412730 -0.6356127  0.95455469
## BALVAFD          0.9069016 -0.63298385  0.2459808 -0.72409036
## FD_VA           -0.8700987  0.41916435 -0.6688310  0.95773932
## CONS_VA         -0.8778944  0.42588712 -0.6625714  0.95139541
## GFCF_VA         -0.8458337  0.39169969 -0.6872508  0.96587144
## EXGR_DVASH      -0.5755776  0.31835510 -0.9999986  0.70356598
## EXGR_FVASH       0.5755776 -0.31835510  0.9999986 -0.70356598
## EXGR_DVAFXSH    -0.8236183  0.48881039 -0.7032805  0.99999933
## EXGR_FNLDVASH    0.7604538 -0.45962157  0.7680176 -0.97156898
## EXGR_INTDVASH   -0.7205523  0.42158763 -0.9257718  0.90574066
## EXGR_TDVAIND    -0.5755776  0.31835510 -0.9999986  0.70356598
## EXGR_TFVAIND     0.5755776 -0.31835510  0.9999986 -0.70356598
## EXGR_SERV_DVASH -0.8907301  0.46069583 -0.5161253  0.72665609
## EXGR_SERV_FVASH  0.1718611 -0.20163027  0.8156591 -0.36875874
## IMGRINT_REII     0.9338240 -0.59127631  0.8119431 -0.89641556
## IMGR_DVASH       0.4053771 -0.36576412 -0.3536144  0.04990577
## VALU_FFDDVA      1.0000000 -0.74398070  0.5753233 -0.82325785
## PROD_VASH       -0.7439807  1.00000000 -0.3187137  0.48865007
## DEXFVAPSH        0.5753233 -0.31871374  1.0000000 -0.70337349
## FEXDVAPSH       -0.8232579  0.48865007 -0.7033735  1.00000000
```

O resultado do sumário abaixo, ficou um pouco inconclusivo. Vou retirar mais algumas variáveis resposta que são autocorrelacionadas e testar novamente.

```
mod = lm(PROD ~ ., data=df)
summary(mod)
```

```
## 
## Call:
## lm(formula = PROD ~ ., data = df)
## 
## Residuals:
## ALL 24 residuals are 0: no residual degrees of freedom!
## 
## Coefficients: (13 not defined because of singularities)
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      7.098e+06        NaN     NaN      NaN
## EXGR            -1.364e+05        NaN     NaN      NaN
## EXGR_FNL        -1.538e+04        NaN     NaN      NaN
## EXGR_INT        -1.539e+04        NaN     NaN      NaN
## EXGR_DVA        -8.384e+04        NaN     NaN      NaN
## EXGR_DDC        -3.537e+04        NaN     NaN      NaN
## EXGR_IDC        -3.536e+04        NaN     NaN      NaN
## EXGR_RIM        -3.444e+04        NaN     NaN      NaN
## EXGR_FVA        -1.088e+05        NaN     NaN      NaN
## IMGR             2.609e+05        NaN     NaN      NaN
## IMGR_FNL        -4.983e+00        NaN     NaN      NaN
## IMGR_INT               NA         NA      NA       NA
## IMGR_DVA         1.007e+04        NaN     NaN      NaN
## BALGR            2.710e+05        NaN     NaN      NaN
## REII            -4.014e+02        NaN     NaN      NaN
## VALU            -2.352e+00        NaN     NaN      NaN
## FFD_DVA                NA         NA      NA       NA
## DFD_FVA          1.006e+04        NaN     NaN      NaN
## BALVAFD                NA         NA      NA       NA
## FD_VA                  NA         NA      NA       NA
## CONS_VA          4.234e+00        NaN     NaN      NaN
## GFCF_VA         -5.428e-01        NaN     NaN      NaN
## EXGR_DVASH       1.204e+06        NaN     NaN      NaN
## EXGR_FVASH             NA         NA      NA       NA
## EXGR_DVAFXSH    -1.621e+04        NaN     NaN      NaN
## EXGR_FNLDVASH   -1.287e+06        NaN     NaN      NaN
## EXGR_INTDVASH   -1.287e+06        NaN     NaN      NaN
## EXGR_TDVAIND           NA         NA      NA       NA
## EXGR_TFVAIND           NA         NA      NA       NA
## EXGR_SERV_DVASH  3.160e+03        NaN     NaN      NaN
## EXGR_SERV_FVASH -1.084e+05        NaN     NaN      NaN
## IMGRINT_REII           NA         NA      NA       NA
## IMGR_DVASH             NA         NA      NA       NA
## VALU_FFDDVA            NA         NA      NA       NA
## PROD_VASH             NA         NA      NA       NA
## DEXFVAPSH             NA         NA      NA       NA
## FEXDVAPSH            NA         NA      NA       NA
## 
## Residual standard error: NaN on 0 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:    NaN
## F-statistic:   NaN on 23 and 0 DF,  p-value: NA
```

Para tentar melhorar o ajuste eu retirei as seguintes variaveis por suspeita de autocorrelação entre preditoras:
EXGR_FNL,EXGR_INT,EXGR_DVA,EXGR_DDC,EXGR_IDC,EXGR_RIM,EXGR_FVA,IMGR,IMG

Restaram as variáveis: **BALGR+REII+VALU+FFD_DVA+DFD_FVA+BALVAFD+FD_VA+CONS_VA+G**

Observando o resultado do sumário do modelo, o resultado melhorou significativamente **0,9991 de R-squared**

```
mod = lm(PROD ~ BALGR+REII+VALU+FFD_DVA+DFD_FVA+BALVAFD+FD_VA+CONS_VA+GFCF_VA+EXGR_TDVAIND+EXGR_TFVAIND-

summary(mod)
```

```
##
## Call:
## lm(formula = PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
##     BALVAFD + FD_VA + CONS_VA + GFCF_VA + EXGR_TDVAIND + EXGR_TFVAIND +
##     EXGR_SERV_DVASH + EXGR_SERV_FVASH + IMGRINT_REII + IMGR_DVASH +
##     VALU_FFDDVA + PROD_VASH + DEXFVAPSH + FEXDVAPSH, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1407.3  -716.2  -124.3   597.5  1674.6
##
## Coefficients: (3 not defined because of singularities)
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     -2.323e+05  1.691e+07  -0.014  0.98942
## BALGR            2.481e+04  1.233e+04   2.012  0.08417 .
## REII             1.497e+00  6.163e-01   2.430  0.04544 *
## VALU             2.132e+00  1.662e-01  12.823 4.07e-06 ***
## FFD_DVA         -2.481e+04  1.233e+04  -2.012  0.08417 .
## DFD_FVA          2.481e+04  1.233e+04   2.012  0.08417 .
## BALVAFD                 NA         NA      NA       NA
## FD_VA                  NA         NA      NA       NA
## CONS_VA         -5.040e-01  1.613e-01  -3.124  0.01675 *
## GFCF_VA         -1.524e-01  1.420e-01  -1.073  0.31874
## EXGR_TDVAIND     2.186e+04  1.692e+05   0.129  0.90085
## EXGR_TFVAIND           NA         NA      NA       NA
## EXGR_SERV_DVASH -1.448e+03  1.243e+03  -1.165  0.28219
## EXGR_SERV_FVASH -8.406e+03  2.776e+03  -3.029  0.01915 *
## IMGRINT_REII     3.457e+03  1.349e+03   2.562  0.03746 *
## IMGR_DVASH      -2.640e+04  1.914e+04  -1.379  0.21026
## VALU_FFDDVA     -9.159e+03  2.015e+03  -4.545  0.00265 **
## PROD_VASH       -2.839e+04  2.503e+03 -11.342 9.27e-06 ***
## DEXFVAPSH        1.688e+04  1.692e+05   0.100  0.92334
## FEXDVAPSH       -4.691e+03  1.410e+03  -3.326  0.01265 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1586 on 7 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:      1
## F-statistic: 3.737e+05 on 16 and 7 DF,  p-value: < 2.2e-16
```

Fazendo a seleção da melhor combinação de variáveis possível com o step, o melhor resultado foi a combinação das variáveis:

**lm(formula = PROD ~ BALGR+REII+VALU+FFD_DVA+DFD_FVA+CONS_VA+GFCF_VA+EXGR_
data = df)**

```
mod2=step(mod, direction = "backward")

## Start:  AIC=358.14
## PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA + BALVAFD + FD_VA +
```

```
##        CONS_VA + GFCF_VA + EXGR_TDVAIND + EXGR_TFVAIND + EXGR_SERV_DVASH +
##        EXGR_SERV_FVASH + IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA +
##        PROD_VASH + DEXFVAPSH + FEXDVAPSH
##
##
## Step:  AIC=358.14
## PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA + BALVAFD + FD_VA +
##        CONS_VA + GFCF_VA + EXGR_TDVAIND + EXGR_SERV_DVASH + EXGR_SERV_FVASH +
##        IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA + PROD_VASH + DEXFVAPSH +
##        FEXDVAPSH
##
##
## Step:  AIC=358.14
## PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA + BALVAFD + CONS_VA +
##        GFCF_VA + EXGR_TDVAIND + EXGR_SERV_DVASH + EXGR_SERV_FVASH +
##        IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA + PROD_VASH + DEXFVAPSH +
##        FEXDVAPSH
##
##
## Step:  AIC=358.14
## PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA + CONS_VA + GFCF_VA +
##        EXGR_TDVAIND + EXGR_SERV_DVASH + EXGR_SERV_FVASH + IMGRINT_REII +
##        IMGR_DVASH + VALU_FFDDVA + PROD_VASH + DEXFVAPSH + FEXDVAPSH
##
##                    Df Sum of Sq       RSS    AIC
## - DEXFVAPSH         1      25031  17636709 356.18
## - EXGR_TDVAIND      1      41983  17653660 356.20
## <none>                            17611677 358.14
## - GFCF_VA           1    2898218  20509895 359.80
## - EXGR_SERV_DVASH   1    3414478  21026156 360.40
## - IMGR_DVASH        1    4786317  22397995 361.91
## - BALGR             1   10180442  27792119 367.09
## - FFD_DVA           1   10180790  27792467 367.09
## - DFD_FVA           1   10180795  27792473 367.09
## - REII              1   14853524  32465201 370.82
## - IMGRINT_REII      1   16509716  34121393 372.02
## - EXGR_SERV_FVASH   1   23076912  40688589 376.24
## - CONS_VA           1   24553434  42165111 377.10
## - FEXDVAPSH         1   27839367  45451044 378.90
## - VALU_FFDDVA       1   51966557  69578235 389.12
## - PROD_VASH         1  323660722 341272399 427.28
## - VALU              1  413693556 431305233 432.90
##
## Step:  AIC=356.18
## PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA + CONS_VA + GFCF_VA +
##        EXGR_TDVAIND + EXGR_SERV_DVASH + EXGR_SERV_FVASH + IMGRINT_REII +
##        IMGR_DVASH + VALU_FFDDVA + PROD_VASH + FEXDVAPSH
##
##                    Df Sum of Sq       RSS    AIC
## <none>                            17636709 356.18
## - GFCF_VA           1    2912984  20549692 357.85
## - EXGR_SERV_DVASH   1    3396400  21033109 358.41
## - IMGR_DVASH        1    5202372  22839080 360.38
## - EXGR_TDVAIND      1    5772101  23408809 360.97
```

```
## - BALGR            1  12869586  30506294 367.33
## - DFD_FVA          1  12869977  30506686 367.33
## - FFD_DVA          1  12870095  30506804 367.33
## - REII             1  14988765  32625474 368.94
## - IMGRINT_REII     1  16532149  34168858 370.05
## - EXGR_SERV_FVASH  1  23298197  40934906 374.39
## - CONS_VA          1  24929365  42566074 375.32
## - FEXDVAPSH        1  28268287  45904996 377.14
## - VALU_FFDDVA      1  56686799  74323508 388.70
## - PROD_VASH        1 325776190 343412898 425.43
## - VALU             1 432166365 449803074 431.91
```

summary(mod2)

```
##
## Call:
## lm(formula = PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
##     CONS_VA + GFCF_VA + EXGR_TDVAIND + EXGR_SERV_DVASH + EXGR_SERV_FVASH +
##     IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA + PROD_VASH + FEXDVAPSH,
##     data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1415.1  -721.1  -142.3   625.2  1670.8
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1.454e+06  3.504e+05   4.151 0.003206 **
## BALGR            2.532e+04  1.048e+04   2.416 0.042104 *
## REII             1.501e+00  5.757e-01   2.607 0.031253 *
## VALU             2.135e+00  1.525e-01  14.001 6.57e-07 ***
## FFD_DVA         -2.532e+04  1.048e+04  -2.416 0.042101 *
## DFD_FVA          2.532e+04  1.048e+04   2.416 0.042102 *
## CONS_VA         -5.056e-01  1.503e-01  -3.363 0.009892 **
## GFCF_VA         -1.528e-01  1.329e-01  -1.149 0.283557
## EXGR_TDVAIND     4.983e+03  3.080e+03   1.618 0.144304
## EXGR_SERV_DVASH -1.432e+03  1.154e+03  -1.241 0.249687
## EXGR_SERV_FVASH -8.426e+03  2.592e+03  -3.251 0.011686 *
## IMGRINT_REII     3.459e+03  1.263e+03   2.738 0.025511 *
## IMGR_DVASH      -2.683e+04  1.746e+04  -1.536 0.163051
## VALU_FFDDVA     -9.097e+03  1.794e+03  -5.071 0.000964 ***
## PROD_VASH       -2.841e+04  2.337e+03 -12.156 1.94e-06 ***
## FEXDVAPSH       -4.669e+03  1.304e+03  -3.581 0.007179 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1485 on 8 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:      1
## F-statistic: 4.549e+05 on 15 and 8 DF,  p-value: < 2.2e-16
```

Tentativa com log na variável resposta

```
mod = lm(formula = log(PROD) ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
    CONS_VA + EXGR_SERV_FVASH +
    IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA + PROD_VASH + FEXDVAPSH,
    data = df)
```

```
summary(mod)
```

```
##
## Call:
## lm(formula = log(PROD) ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
##     CONS_VA + EXGR_SERV_FVASH + IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA +
##     PROD_VASH + FEXDVAPSH, data = df)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.024639 -0.010584 -0.000975  0.010961  0.033655
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1.955e+01  1.607e+00  12.165 1.01e-07 ***
## BALGR            7.257e-02  1.438e-01   0.505  0.62373
## REII             2.832e-07  4.413e-06   0.064  0.94999
## VALU            -1.411e-06  1.214e-06  -1.163  0.26959
## FFD_DVA         -7.256e-02  1.438e-01  -0.505  0.62375
## DFD_FVA          7.257e-02  1.438e-01   0.505  0.62373
## CONS_VA          1.598e-06  1.159e-06   1.378  0.19544
## EXGR_SERV_FVASH  4.078e-04  2.929e-02   0.014  0.98914
## IMGRINT_REII    -2.159e-02  1.518e-02  -1.423  0.18249
## IMGR_DVASH      -3.151e-02  1.879e-01  -0.168  0.86986
## VALU_FFDDVA     -2.785e-02  2.382e-02  -1.170  0.26688
## PROD_VASH       -8.002e-02  2.284e-02  -3.504  0.00493 **
## FEXDVAPSH        1.941e-03  1.766e-02   0.110  0.91446
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02149 on 11 degrees of freedom
## Multiple R-squared:  0.9987, Adjusted R-squared:  0.9973
## F-statistic: 710.8 on 12 and 11 DF,  p-value: 4.358e-14
```

Tentativa com sqrt na variável resposta

```
mod = lm(formula = sqrt(PROD) ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
    CONS_VA + EXGR_SERV_FVASH +
    IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA + PROD_VASH + FEXDVAPSH,
    data = df)

summary(mod)
```

```
##
## Call:
## lm(formula = sqrt(PROD) ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
##     CONS_VA + EXGR_SERV_FVASH + IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA +
##     PROD_VASH + FEXDVAPSH, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.9102 -3.7953 -0.4264  3.6012 11.8503
##
## Coefficients:
```

```
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      3.085e+03  5.718e+02   5.396 0.000218 ***
## BALGR            3.252e+01  5.116e+01   0.636 0.537971
## REII             3.726e-04  1.570e-03   0.237 0.816801
## VALU            -1.416e-04  4.320e-04  -0.328 0.749184
## FFD_DVA         -3.252e+01  5.116e+01  -0.636 0.537991
## DFD_FVA          3.252e+01  5.116e+01   0.636 0.537974
## CONS_VA          4.808e-04  4.124e-04   1.166 0.268334
## EXGR_SERV_FVASH -2.371e+00  1.042e+01  -0.227 0.824217
## IMGRINT_REII    -6.964e+00  5.400e+00  -1.290 0.223583
## IMGR_DVASH      -1.969e+01  6.685e+01  -0.295 0.773816
## VALU_FFDDVA     -1.151e+01  8.474e+00  -1.358 0.201591
## PROD_VASH       -3.168e+01  8.125e+00  -3.899 0.002482 **
## FEXDVAPSH        1.646e-01  6.282e+00   0.026 0.979560
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.646 on 11 degrees of freedom
## Multiple R-squared:  0.9997, Adjusted R-squared:  0.9993
## F-statistic:  2682 on 12 and 11 DF,  p-value: < 2.2e-16
```

O modelo linear melhorou significativamente e vamos seguir com estas variáveis. Uma objservação é que o R-squared ficou 1 (100%) nunca tinha me deparado com um cenário destes. Mesmo tentando tratar a variável resposta com **log** e **sqrt**, o modelo teve piora.

Aparentemente, o melhor modelo linear possível é:

2,91BALGR;1,32REII;1,99VALU;-2,91FFD_DVA;2,91DFD_FVA;-3,33CONS_VA;-1,25EXGR_SERV_FVA 1,74IMGR_DVASH;-7,44VALU_FFDDVA;-2,55PROD_VASH;-5,79FEXDVAPSH.

```
mod = lm(formula = PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
    CONS_VA + EXGR_SERV_FVASH +
    IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA + PROD_VASH + FEXDVAPSH,
    data = df)

summary(mod)
```

```
##
## Call:
## lm(formula = PROD ~ BALGR + REII + VALU + FFD_DVA + DFD_FVA +
##     CONS_VA + EXGR_SERV_FVASH + IMGRINT_REII + IMGR_DVASH + VALU_FFDDVA +
##     PROD_VASH + FEXDVAPSH, data = df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2277.1 -1006.9   164.2  1037.6  2280.5
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1.644e+06  1.379e+05  11.922 1.24e-07 ***
## BALGR            2.910e+04  1.234e+04   2.359 0.037908 *
## REII             1.323e+00  3.787e-01   3.493 0.005033 **
## VALU             1.996e+00  1.042e-01  19.157 8.48e-10 ***
## FFD_DVA         -2.910e+04  1.234e+04  -2.359 0.037907 *
## DFD_FVA          2.910e+04  1.234e+04   2.359 0.037907 *
## CONS_VA         -3.339e-01  9.945e-02  -3.358 0.006389 **
```

```
## EXGR_SERV_FVASH -1.252e+04  2.513e+03  -4.982 0.000414 ***
## IMGRINT_REII     2.782e+03  1.302e+03   2.136 0.055967 .
## IMGR_DVASH      -1.745e+04  1.612e+04  -1.082 0.302229
## VALU_FFDDVA     -7.449e+03  2.043e+03  -3.645 0.003852 **
## PROD_VASH       -2.557e+04  1.959e+03 -13.052 4.88e-08 ***
## FEXDVAPSH       -5.799e+03  1.515e+03  -3.828 0.002803 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1844 on 11 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:       1
## F-statistic: 3.688e+05 on 12 and 11 DF,  p-value: < 2.2e-16
```

Testes gráficos

Baseado nos testes gráficos, todos os pressupostos foram atendidos, seguiremos para os testes formais.

```
par(mfrow=c(2,2))
aov(mod)
```
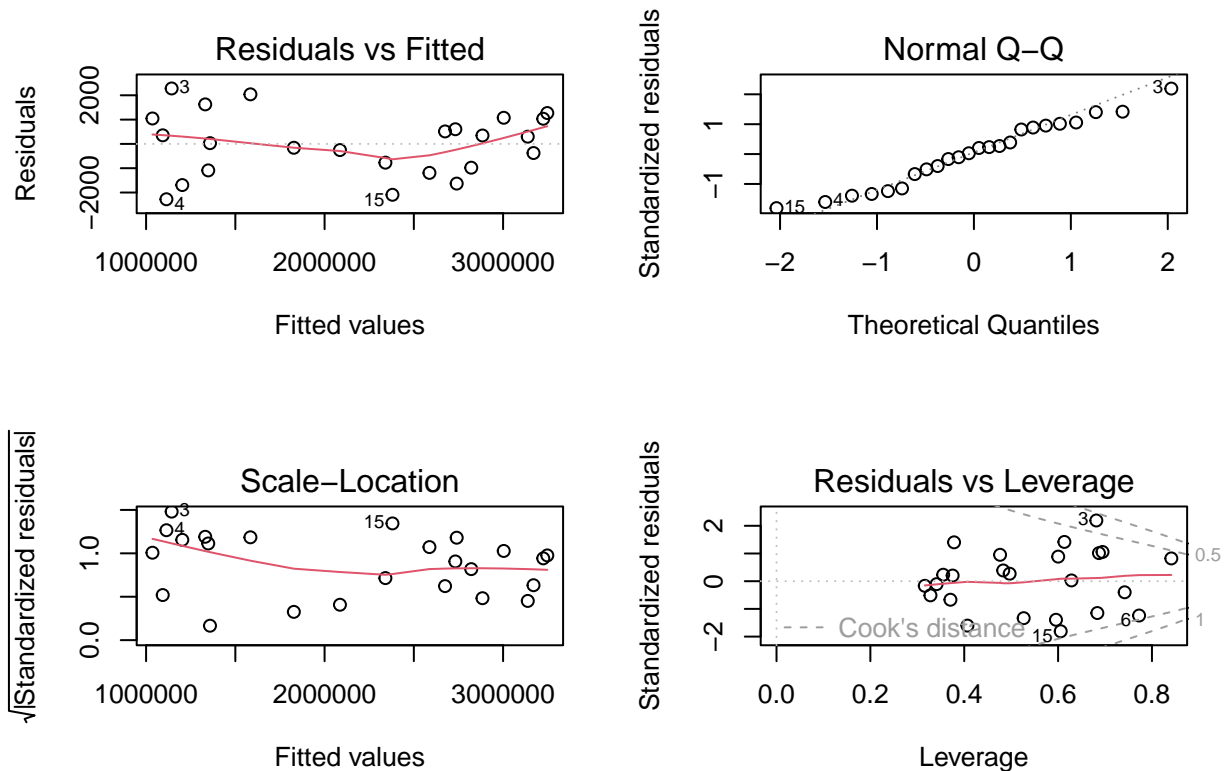
```
## Call:
##    aov(formula = mod)
##
## Terms:
##                      BALGR         REII         VALU       FFD_DVA
## Sum of Squares  8.445488e+12 5.462611e+12 1.133317e+12 2.179003e+08
## Deg. of Freedom            1            1            1            1
##                    DFD_FVA      CONS_VA EXGR_SERV_FVASH IMGRINT_REII
## Sum of Squares  2.597489e+07 1.837669e+08    4.706935e+07 3.761132e+07
## Deg. of Freedom            1            1               1            1
##                  IMGR_DVASH  VALU_FFDDVA    PROD_VASH    FEXDVAPSH
## Sum of Squares  1.235987e+07 9.725231e+08 8.676639e+08 4.982103e+07
## Deg. of Freedom            1            1            1            1
##                  Residuals
## Sum of Squares  3.739639e+07
## Deg. of Freedom           11
##
## Residual standard error: 1843.82
## Estimated effects may be unbalanced
```

```
av=aov(mod)
av
```

```
## Call:
##    aov(formula = mod)
##
## Terms:
##                      BALGR         REII         VALU       FFD_DVA
## Sum of Squares  8.445488e+12 5.462611e+12 1.133317e+12 2.179003e+08
## Deg. of Freedom            1            1            1            1
##                    DFD_FVA      CONS_VA EXGR_SERV_FVASH IMGRINT_REII
## Sum of Squares  2.597489e+07 1.837669e+08    4.706935e+07 3.761132e+07
## Deg. of Freedom            1            1               1            1
##                  IMGR_DVASH  VALU_FFDDVA    PROD_VASH    FEXDVAPSH
## Sum of Squares  1.235987e+07 9.725231e+08 8.676639e+08 4.982103e+07
## Deg. of Freedom            1            1            1            1
```

```
##                     Residuals
## Sum of Squares    3.739639e+07
## Deg. of Freedom             11
##
## Residual standard error: 1843.82
## Estimated effects may be unbalanced
```

```
plot(av)
```


Testando a Normalidade

Não temos evidências suficientes para rejeitar a hipótese nula e inferir que **PROD** segue uma distribuição normal porque o valor p do teste é maior que 0,05.

Anderson-Darling normality test

```
anares<-rstandard(mod)
library(nortest)
ad.test(anares)
```

```
##
##   Anderson-Darling normality test
##
## data:  anares
## A = 0.26968, p-value = 0.6473
```

Shapiro-Wilk normality test

```
shapiro.test(anares)
```

```
##
##   Shapiro-Wilk normality test
##
## data:  anares
```

```
## W = 0.96907, p-value = 0.6441
```

Para confirmar que todos os pontos caem aproximadamente ao longo da linha de referência, podemos assumir a normalidade. Bem como a conclusão acima é apoiada pelo teste de Shapiro-Wilk nos resíduos ANOVA (W = 0,95, p = 0,38) que não encontra nenhuma indicação de que a normalidade seja violada.

Testando a Homocedasticidade

A estatística de teste é **18,693** e o valor p correspondente é **0,0962**. Como o valor de p não é menor que 0,05, não rejeitamos a hipótese nula. Não temos evidências suficientes para dizer que a heterocedasticidade está presente no modelo de regressão.

```
library(zoo)
```

```
##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
library(lmtest)
bptest(mod)
```

```
##
##  studentized Breusch-Pagan test
##
## data:  mod
## BP = 18.693, df = 12, p-value = 0.0962
```

Testando a Autocorrelação

A partir da saída, podemos ver que a estatística de teste é **1,8275** e o valor p correspondente é **0,01281**. Como esse valor de p é menor que 0,05, podemos rejeitar a hipótese nula e concluir que os resíduos nesse modelo de regressão são autocorrelacionados.

```
dwtest(mod)
```

```
##
##  Durbin-Watson test
##
## data:  mod
## DW = 1.8275, p-value = 0.01281
## alternative hypothesis: true autocorrelation is greater than 0
```

Intervalo de confiança

Como o ajuste não foi passou por todos os pressupostos, significa que o modelo não fará uma previsão confiável, porém, segue uma simulação de previsão e intervalo de confiança.

```
pred_in = data.frame(
  BALGR=-38417.8,
  REII=131508.8,
  VALU=1644856.5,
  FFD_DVA=385330.4,
  DFD_FVA=423748.1,
  CONS_VA=1268617.6,
  EXGR_SERV_FVASH=11.64,
```

```
  IMGRINT_REII=41.17,
  IMGR_DVASH=0.942,
  VALU_FFDDVA=23.43,
  PROD_VASH=54.74,
  FEXDVAPSH=14.648
)

predict(mod, pred_in, interval="confidence")
```

```
##       fit     lwr     upr
## 1 3003739 3000356 3007121
```