Modelo Cox - Análisis de Recesión

Juan Leal

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```python
import pandas as pd
import numpy as np
import statsmodels.api as sm
from lifelines import ExponentialFitter, WeibullFitter, CoxPHFitter
```

```python
%store -r df_cox
```

```python
df_cox = df_cox[df_cox['duration']>0]
df_cox
```

	id	duration	event	GDP	Personal_Income	TasaDesempleo
0	Alabama	11	1	12.198912	11.971114	8.328205
1	Alaska	12	0	10.869121	10.417288	7.358974
2	Arizona	12	1	12.573077	12.290408	8.241026
3	Arkansas	1	1	11.632072	11.433963	6.830769
4	California	12	1	14.584087	14.272265	9.984615
5	Colorado	11	0	12.540261	12.232355	7.046154
6	Connecticut	11	0	12.507552	12.276254	7.533333
7	Delaware	10	1	11.122248	10.509325	6.810256
8	Florida	11	1	13.671319	13.479717	8.894872
9	Georgia	11	1	13.068832	12.717952	8.589744
10	Hawaii	10	1	11.236268	10.929349	5.551282
11	Idaho	11	1	11.044827	10.811624	7.364103
12	Illinois	11	1	13.532479	13.198561	8.661538
13	Indiana	10	1	12.660891	12.326050	8.374359

	id	duration	event	GDP	Personal_Income	TasaDesempleo
14	Iowa	10	1	11.982244	11.651380	5.407692
15	Kansas	7	1	11.880154	11.635235	6.023077
16	Kentucky	10	1	12.123189	11.856034	8.812821
17	Louisiana	10	0	12.401599	12.036840	6.058974
18	Maine	10	1	10.995153	10.809568	7.143590
19	Maryland	10	1	12.741541	12.543446	6.156410
20	Massachusetts	10	1	13.017175	12.724240	6.953846
21	Michigan	10	1	12.994679	12.762595	11.120513
22	Minnesota	11	1	12.627655	12.311342	6.658974
23	Mississippi	10	1	11.583667	11.414481	8.466667
24	Missouri	11	1	12.592539	12.295402	7.979487
25	Montana	11	1	10.642129	10.452979	6.115385
26	Nebraska	1	1	11.524910	11.194564	4.058974
27	Nevada	12	0	11.892615	11.517384	10.005128
28	New Hampshire	10	1	11.178430	11.007242	5.120513
29	New Jersey	10	1	13.233785	13.004559	7.671795
30	New Mexico	11	1	11.408459	11.122676	6.174359
31	New York	10	1	14.134413	13.734228	7.269231
32	North Carolina	10	1	13.086742	12.747289	8.835897
33	North Dakota	3	1	10.498917	10.222765	3.476923
34	Ohio	10	1	13.247391	12.941899	8.669231
35	Oklahoma	7	1	11.968447	11.835915	5.374359
36	Oregon	11	1	12.107080	11.826795	8.846154
37	Pennsylvania	11	1	13.398744	13.165731	6.964103
38	Rhode Island	11	1	10.918439	10.686716	9.774359
39	South Carolina	10	1	12.149602	11.912668	9.348718
40	South Dakota	1	1	10.689621	10.391790	4.053846
41	Tennessee	10	1	12.589257	12.303097	8.587179
42	Texas	8	1	14.076833	13.767327	6.689744
43	Utah	11	1	11.797769	11.389435	6.094872
44	Vermont	10	1	10.313918	10.144785	5.569231
45	Virginia	10	1	13.050795	12.781459	5.679487
46	Washington	10	1	12.896822	12.556749	7.789744
47	West Virginia	2	1	11.171769	10.979474	6.730769
48	Wisconsin	1	1	12.557367	12.295293	7.143590
49	Wyoming	10	1	10.606397	10.163633	5.158974

```
#Modelo Exponencial
exp_model = ExponentialFitter()
exp_model.fit(df_cox['duration'], event_observed=df_cox['event'])
```

```
    summary = exp_model.summary
    print(summary)
```

```
              coef   se(coef)   coef lower 95%   coef upper 95%   cmp to   \
lambda_   10.311111   1.53709         7.298471        13.323752     0.0

                  z            p    -log2(p)
lambda_   6.708204   1.970344e-11   35.562761
```

```
    # Weibull
    weibull_model = WeibullFitter()
    weibull_model.fit(df_cox['duration'], event_observed=df_cox['event'])
    summary = weibull_model.summary
    print(summary)
```

```
              coef   se(coef)   coef lower 95%   coef upper 95%   cmp to   \
lambda_   10.380337   0.479432        9.440667        11.320008     1.0
rho_       3.233543   0.462376        2.327302         4.139784     1.0

                   z            p    -log2(p)
lambda_   19.565505   3.043759e-85   280.758034
rho_       4.830575   1.361395e-06    19.486483
```

```
    #CoX
    cox = CoxPHFitter()
    cox.fit(df_cox, duration_col='duration', event_col='event', formula="GDP")
    summary = cox.summary
    print(summary)
```

```
              coef   exp(coef)   se(coef)   coef lower 95%   coef upper 95%   \
covariate
GDP       -0.095301     0.9091    0.14488        -0.37926         0.188659

          exp(coef) lower 95%   exp(coef) upper 95%   cmp to          z   \
covariate
GDP                  0.684368              1.207629      0.0   -0.65779

                 p   -log2(p)
covariate
GDP       0.510673   0.969527
```

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```
    #CoX
    cox = CoxPHFitter()
    cox.fit(df_cox, duration_col='duration', event_col='event', formula="GDP+Personal_Income"
    summary = cox.summary
    print(summary)
```

```
                    coef   exp(coef)   se(coef)   coef lower 95%  \
covariate
GDP             -3.444691    0.031915   2.044796       -7.452417
Personal_Income  3.352013   28.560177   2.051831       -0.669501


                coef upper 95%   exp(coef) lower 95%   exp(coef) upper 95%  \
covariate
GDP                   0.563035                0.000580              1.755994
Personal_Income       7.373528                0.511964           1593.244953


                cmp to          z          p   -log2(p)
covariate
GDP                 0.0  -1.684614   0.092063   3.441233
Personal_Income     0.0   1.633669   0.102328   3.288723
```

```
    #CoX
    cox = CoxPHFitter()
    cox.fit(df_cox, duration_col='duration', event_col='event', formula="GDP+Personal_Income-
    summary = cox.summary
    print(summary)
```

```
                    coef   exp(coef)   se(coef)   coef lower 95%  \
covariate
GDP             -3.207113    0.040473   2.004685       -7.136224
Personal_Income  3.340056   28.220697   2.009346       -0.598189
TasaDesempleo   -0.380338    0.683630   0.135414       -0.645744


                coef upper 95%   exp(coef) lower 95%   exp(coef) upper 95%  \
covariate
GDP                   0.721997                0.000796              2.058539
Personal_Income       7.278301                0.549806           1448.524254
TasaDesempleo        -0.114932                0.524272              0.891427


                cmp to          z          p   -log2(p)
covariate
```

```
GDP                    0.0 -1.599809  0.109641  3.189142
Personal_Income        0.0  1.662260  0.096461  3.373917
TasaDesempleo          0.0 -2.808707  0.004974  7.651351
```

```python
#CoX
cox = CoxPHFitter()
cox.fit(df_cox, duration_col='duration', event_col='event', formula="GDP+TasaDesempleo")
summary = cox.summary
print(summary)
```

```
                   coef   exp(coef)  se(coef)  coef lower 95%  coef upper 95%  \
covariate
GDP            0.131071    1.140049  0.169161       -0.200477        0.462620
TasaDesempleo -0.378820    0.684669  0.135229       -0.643863       -0.113776

               exp(coef) lower 95%  exp(coef) upper 95%  cmp to         z  \
covariate
GDP                       0.818340             1.588230     0.0  0.774833
TasaDesempleo             0.525259             0.892458     0.0 -2.801325

                      p  -log2(p)
covariate
GDP            0.438438  1.189555
TasaDesempleo  0.005089  7.618312
```

```python
# Ordenar estados por GDP
df_sorted = df_cox.sort_values(by='GDP')

# 25 estados con menor GDP
df_low_gdp = df_sorted.iloc[:25].copy()

# 25 estados con mayor GDP
df_high_gdp = df_sorted.iloc[25:].copy()
```

```python
df_high_gdp
```

	id	duration	event	GDP	Personal_Income	TasaDesempleo
0	Alabama	11	1	12.198912	11.971114	8.328205
17	Louisiana	10	0	12.401599	12.036840	6.058974
6	Connecticut	11	0	12.507552	12.276254	7.533333

	id	duration	event	GDP	Personal_Income	TasaDesempleo
5	Colorado	11	0	12.540261	12.232355	7.046154
48	Wisconsin	1	1	12.557367	12.295293	7.143590
2	Arizona	12	1	12.573077	12.290408	8.241026
41	Tennessee	10	1	12.589257	12.303097	8.587179
24	Missouri	11	1	12.592539	12.295402	7.979487
22	Minnesota	11	1	12.627655	12.311342	6.658974
13	Indiana	10	1	12.660891	12.326050	8.374359
19	Maryland	10	1	12.741541	12.543446	6.156410
46	Washington	10	1	12.896822	12.556749	7.789744
21	Michigan	10	1	12.994679	12.762595	11.120513
20	Massachusetts	10	1	13.017175	12.724240	6.953846
45	Virginia	10	1	13.050795	12.781459	5.679487
9	Georgia	11	1	13.068832	12.717952	8.589744
32	North Carolina	10	1	13.086742	12.747289	8.835897
29	New Jersey	10	1	13.233785	13.004559	7.671795
34	Ohio	10	1	13.247391	12.941899	8.669231
37	Pennsylvania	11	1	13.398744	13.165731	6.964103
12	Illinois	11	1	13.532479	13.198561	8.661538
8	Florida	11	1	13.671319	13.479717	8.894872
42	Texas	8	1	14.076833	13.767327	6.689744
31	New York	10	1	14.134413	13.734228	7.269231
4	California	12	1	14.584087	14.272265	9.984615

`df_low_gdp`

	id	duration	event	GDP	Personal_Income	TasaDesempleo
44	Vermont	10	1	10.313918	10.144785	5.569231
33	North Dakota	3	1	10.498917	10.222765	3.476923
49	Wyoming	10	1	10.606397	10.163633	5.158974
25	Montana	11	1	10.642129	10.452979	6.115385
40	South Dakota	1	1	10.689621	10.391790	4.053846
1	Alaska	12	0	10.869121	10.417288	7.358974
38	Rhode Island	11	1	10.918439	10.686716	9.774359
18	Maine	10	1	10.995153	10.809568	7.143590
11	Idaho	11	1	11.044827	10.811624	7.364103
7	Delaware	10	1	11.122248	10.509325	6.810256
47	West Virginia	2	1	11.171769	10.979474	6.730769
28	New Hampshire	10	1	11.178430	11.007242	5.120513
10	Hawaii	10	1	11.236268	10.929349	5.551282

	id	duration	event	GDP	Personal_Income	TasaDesempleo
30	New Mexico	11	1	11.408459	11.122676	6.174359
26	Nebraska	1	1	11.524910	11.194564	4.058974
23	Mississippi	10	1	11.583667	11.414481	8.466667
3	Arkansas	1	1	11.632072	11.433963	6.830769
43	Utah	11	1	11.797769	11.389435	6.094872
15	Kansas	7	1	11.880154	11.635235	6.023077
27	Nevada	12	0	11.892615	11.517384	10.005128
35	Oklahoma	7	1	11.968447	11.835915	5.374359
14	Iowa	10	1	11.982244	11.651380	5.407692
36	Oregon	11	1	12.107080	11.826795	8.846154
16	Kentucky	10	1	12.123189	11.856034	8.812821
39	South Carolina	10	1	12.149602	11.912668	9.348718

```
#CoX
cox_low = CoxPHFitter()
cox_low.fit(df_low_gdp, duration_col='duration', event_col='event', formula="GDP")
summary = cox_low.summary
print(summary)
```

```
               coef   exp(coef)   se(coef)   coef lower 95%   coef upper 95%  \
covariate
GDP       -0.040057    0.960735   0.385824        -0.796258         0.716145

           exp(coef) lower 95%   exp(coef) upper 95%   cmp to         z  \
covariate
GDP                   0.451013              2.046529      0.0 -0.103821

                  p   -log2(p)
covariate
GDP        0.917312   0.124516
```

```
#CoX
cox_high = CoxPHFitter()
cox_high.fit(df_high_gdp, duration_col='duration', event_col='event', formula="GDP")
summary = cox_high.summary
print(summary)
```

```
               coef   exp(coef)   se(coef)   coef lower 95%   coef upper 95%  \
covariate
```

```
GDP        0.096388   1.101186  0.301842      -0.495211        0.687986


          exp(coef) lower 95%  exp(coef) upper 95%  cmp to       z  \
covariate
GDP                 0.609442             1.989705    0.0  0.319332


              p  -log2(p)
covariate
GDP       0.749475  0.416048
```