4

A

-Por cada 0,42% que aumenta el capital aumenta en 1% unidad la productividad, por cada 0,55% que aumenta el trabajo aumenta en 1% unidad la productividad.

B

In [ ]:
```
XX_T <- matrix(c(120, 589.21, 712.78,
                 589.21, 3217.19, 3609.91,
                 712.78, 3609.91, 4470.98), nrow = 3, ncol = 3)
XX_1 <- solve(XX_T)
var_u <- 2.605^2
covariances <- XX_1 * var_u
covariances
```

A matrix: 3 × 3 of type dbl

1.18117956	-0.05351121	-0.14510253
-0.05351121	0.02485620	-0.01153817
-0.14510253	-0.01153817	0.03396659

In [ ]:
```
cat(paste("the covariance beetween Beta2 and Beta3 is: ", covariances[2,3], "\n"))
```

```
the covariance beetween Beta2 and Beta3 is:  -0.011538169416544
```

C

In [ ]:
```
betas <- c(-0.481, 0.4298, 0.5585)
alpha = 0.05

significance <- function(betas, var, alpha=0.05, df=117) {
```

```
    ds <- sqrt(var)
    t_tab <- qt(alpha/2, df, lower.tail=FALSE)
    t_cal <- betas/ds
    p_value <- 2*pt(abs(t_cal),df,lower.tail=FALSE)

    if (abs(t_cal) > t_tab) {
        if (p_value > alpha) {
            cat(paste(" the beta is significant with a t cal of ", t_cal, " and a p-value of: ", p_value, "\n"))
        } else {
            cat(paste(" the beta is not significant with a t cal of ", t_cal, " and a p-value of: ", p_value, "\n"))
        }
    } else {
        cat(paste(" the beta is not significant with a t cal of ", t_cal, " and a p-value of: ", p_value, "\n"))
    }

}
```

In [ ]:
```
for (i in 1:3) {
    cat(paste("for Beta", i))
    significance(betas[i], covariances[i,i], alpha)}
```

```
for Beta 1 the beta is not significant with a t cal of  -0.442575240666563  and a p-value of:  0.658890109613416
for Beta 2 the beta is not significant with a t cal of  2.72614555293414  and a p-value of:  0.00739344188819848
for Beta 3 the beta is not significant with a t cal of  3.03038063267167  and a p-value of:  0.00300707900179368
```

E

In [ ]:
```
significance((betas[2]-betas[3]), (covariances[2,2]+covariances[3,3]-(2*covariances[2,3])), alpha)
```

```
 the beta is not significant with a t cal of  -0.449716576387892  and a p-value of:  0.65374687787077
```

el modelo no es significativo globalmente, ya que el capital y el trabajo no son independientes.

F

la productividad esta siendo explicada en un 79% por el capital y el trabajo.

5

A

In [ ]:
```
library(haven)
```

In [ ]:
```
df <- read_dta('return.dta')
df
```

A tibble: 142 × 11

roe	rok	dkr	eps	netinc	sp90	sp94	salary	return	lsalary	lsp90
<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
18.7	17.4	4.0	48.1	1144	59.375	47.000	1090	-20.842110	6.993933	4.083873
1.6	2.4	27.3	-85.3	35	47.875	43.500	1923	-9.138381	7.561642	3.868593
4.9	4.6	36.8	-44.1	127	39.000	72.625	1012	86.217949	6.919684	3.663562
11.1	8.6	46.4	192.4	367	61.250	142.000	579	131.836700	6.361302	4.114964
5.6	4.5	36.2	-60.4	214	58.000	53.250	600	-8.189655	6.396930	4.060443
3.5	2.9	18.7	-79.8	118	68.250	50.500	735	-26.007330	6.599871	4.223177
12.3	8.5	34.4	39.0	175	33.000	50.250	994	52.272732	6.901737	3.496508
7.5	6.3	57.8	-62.8	1692	43.625	27.875	1227	-36.103149	7.112328	3.775630
15.6	10.5	33.4	-16.2	157	42.750	44.250	913	3.508772	6.816736	3.755369
12.5	9.4	33.4	-19.1	315	37.125	47.750	733	28.619530	6.597146	3.614291
17.4	16.4	16.7	12.8	407	32.375	25.375	1247	-21.621620	7.128496	3.477386
9.7	8.9	18.3	-34.8	165	36.125	38.500	925	6.574394	6.829794	3.586985
12.7	11.8	27.6	-8.6	288	20.625	41.375	602	100.606102	6.400258	3.026504
15.0	12.7	27.3	9.5	147	26.375	25.000	1006	-5.213270	6.913737	3.272417
16.7	12.7	35.0	19.3	177	31.250	22.625	593	-27.600000	6.385194	3.442019
57.0	43.3	12.3	59.5	1845	77.250	51.500	3142	-33.333328	8.052615	4.347047
25.7	11.9	53.9	12.8	1013	64.000	36.250	1893	-43.359379	7.545918	4.158883
22.9	12.0	33.2	9.0	829	38.500	50.875	1740	32.142860	7.461640	3.650658
18.9	13.5	19.9	5.0	475	39.750	37.125	1558	-6.603774	7.351158	3.682610
15.8	10.0	31.4	2.7	230	48.000	44.625	1095	-7.031250	6.998509	3.871201
14.4	12.2	14.5	2.6	335	53.625	55.000	1235	2.564103	7.118826	3.982015
22.3	20.3	0.0	16.0	63	59.500	61.500	569	3.361345	6.343881	4.085976
19.0	14.8	32.9	-42.6	1537	71.375	67.250	930	-5.779335	6.835185	4.267948
25.5	15.5	36.1	9.1	228	27.500	9.625	940	-65.000000	6.845880	3.314186
27.1	23.6	6.6	20.6	174	37.500	33.875	926	-9.666667	6.830874	3.624341

roe	rok	dkr	eps	netinc	sp90	sp94	salary	return	lsalary	lsp90
<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
14.6	10.7	20.4	-3.4	191	34.750	57.125	756	64.388489	6.628041	3.548180
20.5	12.7	41.8	13.4	4237	64.500	51.000	2969	-20.930229	7.995980	4.166665
13.7	10.2	40.2	43.5	1131	58.875	88.625	3836	50.530781	8.252186	4.075417
17.8	15.7	10.9	13.9	66	34.250	36.000	477	5.109489	6.167517	3.533687
10.7	7.5	69.9	4.3	282	24.625	50.375	2600	104.568497	7.863267	3.203762
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
13.8	10.4	34.9	-22.5	101	37.250	42.000	300	12.751680	5.703783	3.617652
15.6	10.4	28.8	-11.7	738	72.750	44.625	997	-38.659790	6.904751	4.287029
21.2	16.9	12.2	13.2	175	46.750	43.625	917	-6.684492	6.821107	3.844814
15.6	12.1	25.0	3.2	226	51.250	29.500	767	-42.439030	6.642487	3.936716
8.1	5.7	46.2	-15.1	128	45.750	60.250	581	31.693991	6.364751	3.823192
21.1	19.8	4.1	5.2	205	42.000	48.000	565	14.285710	6.336826	3.737670
17.0	15.8	0.2	10.9	125	64.500	57.750	722	-10.465120	6.582025	4.166665
32.8	30.2	2.4	10.4	76	37.750	36.000	439	-4.635762	6.084499	3.630985
5.8	8.1	79.5	24.3	130	20.375	22.000	780	7.975460	6.659294	3.014309
23.7	15.3	31.8	20.9	667	35.000	11.375	1571	-67.500000	7.359468	3.555348
11.9	8.9	6.0	-30.4	70	60.250	55.375	526	-8.091287	6.265301	4.098503
16.8	11.2	38.3	11.6	185	38.875	30.125	752	-22.508039	6.622736	3.660351
15.7	9.2	27.9	7.5	1299	68.000	40.375	1296	-40.625000	7.167038	4.219508
12.1	7.1	34.1	-13.8	1134	111.250	49.750	1289	-55.280899	7.161622	4.711780
25.4	12.4	47.7	19.4	280	64.500	66.125	1264	2.519380	7.142036	4.166665
14.0	8.4	30.0	2.1	1156	50.375	28.500	960	-43.424320	6.866933	3.919495
12.8	8.0	27.5	2.5	1131	63.875	40.375	1380	-36.790611	7.229839	4.156928
31.4	29.9	2.2	27.5	191	77.250	37.000	1222	-52.103561	7.108244	4.347047
39.1	37.3	2.8	42.3	267	62.500	74.625	545	19.400000	6.300786	4.135167
20.2	18.6	10.5	16.3	172	19.000	39.500	14336	107.894699	9.570529	2.944439

roe	rok	dkr	eps	netinc	sp90	sp94	salary	return	lsalary	lsp90
<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
2.1	3.6	37.2	-87.0	4	31.875	48.625	889	52.549019	6.790097	3.461822
21.0	16.7	18.8	19.7	65	32.375	23.625	653	-27.027031	6.481577	3.477386
25.3	17.4	32.4	26.1	757	71.000	37.500	1630	-47.183102	7.396335	4.262680
14.9	7.6	39.8	16.6	365	42.875	19.000	334	-55.685131	5.811141	3.758289
12.6	6.7	47.3	-15.9	187	23.875	18.375	447	-23.036650	6.102559	3.172832
12.5	7.3	40.4	-3.5	524	29.250	26.500	732	-9.401710	6.595780	3.375880
13.7	8.7	42.5	-5.7	214	39.375	14.625	506	-62.857140	6.226537	3.673131
9.1	6.9	47.4	-30.1	621	29.125	20.000	884	-31.330469	6.784457	3.371597
13.7	9.5	37.9	12.6	187	32.000	25.875	334	-19.140631	5.811141	3.465736
37.0	15.7	53.9	45.1	3523	41.625	57.500	1316	38.138142	7.182352	3.728701

In [ ]:
```
library(stargazer)
```

In [ ]:
```
model <- lm(return~dkr+eps+netinc+salary, data=df)
stargazer(model, type="text")
```

```
================================================
                        Dependent variable:
                    ---------------------------
                               return
------------------------------------------------
dkr                             0.321
                               (0.201)

eps                             0.043
                               (0.078)

netinc                         -0.005
                               (0.005)

salary                          0.003
                               (0.002)

Constant                      -14.370**
                               (6.894)

------------------------------------------------
Observations                     142
R2                              0.039
Adjusted R2                     0.011
Residual Std. Error       39.193 (df = 137)
F Statistic              1.408 (df = 4; 137)
================================================
Note:                *p<0.1; **p<0.05; ***p<0.01
```

In [ ]:
```r
betas <- coef(model)
betas
```

(Intercept): -14.3702128660481 **dkr:** 0.320544347332856 **eps:** 0.0426985519840328 **netinc:** -0.00510859262669238 **salary:** 0.00349934007625285

In [ ]:
```r
X <- matrix(c(matrix(1,length(df$return),1),df$dkr,df$eps,df$netinc,df$salary),ncol=5)
covmatrix <- cov(X)
covmatrix
```

A matrix: 5 × 5 of type dbl

0	0.0000	0.0000	0.0000	0.0000
0	277.8361	-100.4572	948.8959	-580.7421
0	-100.4572	1862.3002	3048.9490	8237.1845
0	948.8959	3048.9490	523610.3882	203436.5549
0	-580.7421	8237.1845	203436.5549	2371272.8611

In [ ]:
```
covmatrix<-vcov(model)
covmatrix
```

A matrix: 5 × 5 of type dbl

	(Intercept)	dkr	eps	netinc	salary
(Intercept)	47.521938181	-1.006552e+00	-3.044461e-02	-6.453123e-03	-5.675089e-03
dkr	-1.006552104	4.036509e-02	2.282191e-03	-9.020691e-05	9.697012e-06
eps	-0.030444613	2.282191e-03	6.105610e-03	-3.275705e-05	-1.784008e-05
netinc	-0.006453123	-9.020691e-05	-3.275705e-05	2.185331e-05	-1.783145e-06
salary	-0.005675089	9.697012e-06	-1.784008e-05	-1.783145e-06	4.811648e-06

In [ ]:
```
summary(model)
```

```
Call:
lm(formula = return ~ dkr + eps + netinc + salary, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-88.629 -25.421  -4.215  18.326 124.627

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -14.370213   6.893616  -2.085    0.039 *
dkr           0.320544   0.200911   1.595    0.113
eps           0.042699   0.078138   0.546    0.586
netinc       -0.005109   0.004675  -1.093    0.276
salary        0.003499   0.002194   1.595    0.113
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 39.19 on 137 degrees of freedom
Multiple R-squared:  0.03948,   Adjusted R-squared:  0.01143
F-statistic: 1.408 on 4 and 137 DF,  p-value: 0.2347
```

drk, eps, netinc, salary tienen un t calculado inferior al t de la tabla de alpha 5% pero tienen un p valor superior al alpha 5%.

In [ ]:
```
global_var <- covmatrix[2,2]+covmatrix[3,3]+covmatrix[4,4]+covmatrix[5,5]-covmatrix[2,3]-covmatrix[2,4]-covmatrix[2,5]-covmatrix[3,
global_betas <- betas[2]+betas[3]+betas[4]+betas[5]
significance(global_betas, global_var, alpha)
```

```
 the beta is not significant with a t cal of  1.71724199839738  and a p-value of:  0.0885808435311413
```

B

In [ ]:
```
return_estim <- betas[1] + betas[2]*mean(df$dkr) + betas[3]*mean(df$eps) + betas[4]*mean(df$netinc) + betas[5]*mean(df$salary)
cat(paste("the return estim is: ", return_estim, "\n"))
```

```
the return estim is:  -4.04268586593615
```

In [ ]:
```
confint(model, level=0.95)
```

A matrix: 5 × 2 of type dbl

	2.5 %	97.5 %
(Intercept)	-2.800186e+01	-0.738561906
dkr	-7.674264e-02	0.717831336
eps	-1.118148e-01	0.197211868
netinc	-1.435259e-02	0.004135408
salary	-8.382479e-04	0.007836928

C

In [ ]:

```
lnmodel <- lm(return ~ dkr + eps + log(netinc) + lsalary, data=df)
stargazer(lnmodel, type="text")
```

```
================================================
                        Dependent variable:
                    ----------------------------
                               return
------------------------------------------------
dkr                             0.327
                               (0.203)

eps                             0.069
                               (0.080)

log(netinc)                    -4.745
                               (3.386)

lsalary                         7.242
                               (6.313)

Constant                       -36.299
                              (39.374)

------------------------------------------------
Observations                     142
R2                              0.033
Adjusted R2                     0.005
Residual Std. Error       39.324 (df = 137)
F Statistic              1.170 (df = 4; 137)
================================================
Note:                *p<0.1; **p<0.05; ***p<0.01
```

In [ ]:
```
summary(lnmodel)
```

```
Call:
lm(formula = return ~ dkr + eps + log(netinc) + lsalary, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-80.402 -26.729  -4.223  19.475 126.948

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -36.29933   39.37380  -0.922    0.358
dkr           0.32658    0.20265   1.612    0.109
eps           0.06854    0.08035   0.853    0.395
log(netinc)  -4.74530    3.38566  -1.402    0.163
lsalary       7.24181    6.31251   1.147    0.253

Residual standard error: 39.32 on 137 degrees of freedom
Multiple R-squared:  0.03304,   Adjusted R-squared:  0.004812
F-statistic:  1.17 on 4 and 137 DF,  p-value: 0.3266
```

In [ ]:
```
confint(lnmodel, level=0.95)
```

A matrix: 5 × 2 of type dbl

	2.5 %	97.5 %
(Intercept)	-114.15830910	41.5596534
dkr	-0.07414057	0.7273022
eps	-0.09034884	0.2274250
log(netinc)	-11.44021712	1.9496200
lsalary	-5.24073811	19.7243532

por cada unidad que aumenta dkr return varia en 0.32, por cada unidad que aumenta eps return varia 0.06, por cada 1% que aumenta netinc return varia -4.74, por cada 1% que aumenta salary return varia 7.24.

8

A las matrices tendran las siguientes dimensiones:

$$Y_{1\times 28} = X_{4\times 28}\beta + \mu$$

B $Y= \beta_1+\beta_2 output + \beta_3 output^2 + \beta_4 output^3\

\frac{\partial Y}{\partial output} = \beta_2+\beta_3 output + \beta_4 output^2$

se esperaria un signo positivo para β_4

c $Y = \frac{\beta_1+\beta_2 output+\beta_3 output^2+\beta_4 output^3}{output}$

In [ ]:
```
cost <- c(493, 410, 451, 723, 329, 432, 294, 270, 311, 194, 640, 217, 272, 401, 196, 238, 269, 256, 605, 246, 222, 204, 356, 378, 1
output <- c(8.2, 7.39, 7.68, 9.88, 5.65, 7.1, 5.17, 3.34, 5.63, 1.39, 9.3, 2.21, 2.88, 6.94, 3.17, 2.36, 2.33, 2.76, 8.97, 2.77, 3.

prod_df <- data.frame(cost, output, output^2, output^3)
prod_df
```

A data.frame: 28 × 4

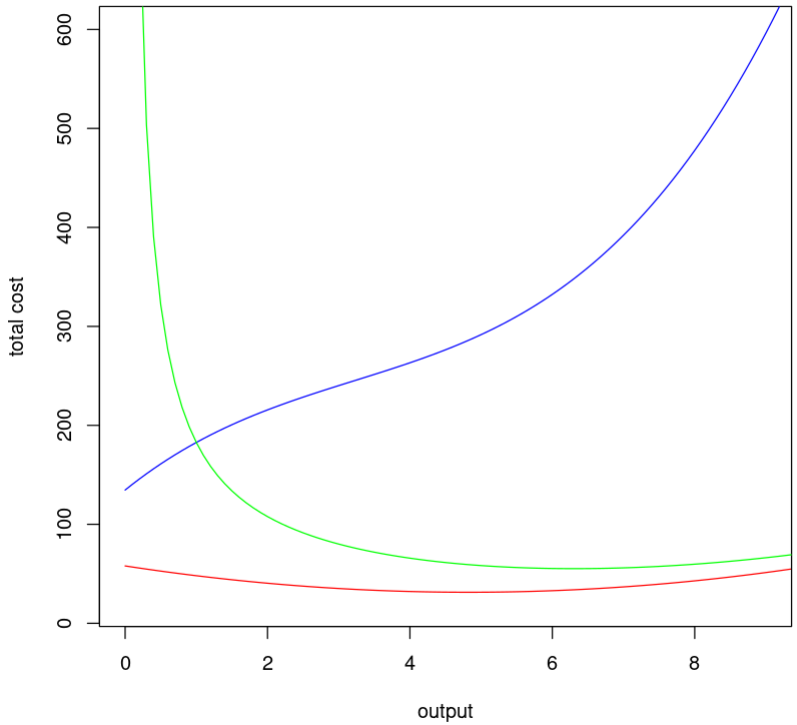
cost	output	output.2	output.3
<dbl>	<dbl>	<dbl>	<dbl>
493	8.20	67.2400	551.368000
410	7.39	54.6121	403.583419
451	7.68	58.9824	452.984832
723	9.88	97.6144	964.430272
329	5.65	31.9225	180.362125
432	7.10	50.4100	357.911000
294	5.17	26.7289	138.188413
270	3.34	11.1556	37.259704
311	5.63	31.6969	178.453547
194	1.39	1.9321	2.685619
640	9.30	86.4900	804.357000
217	2.21	4.8841	10.793861
272	2.88	8.2944	23.887872
401	6.94	48.1636	334.255384
196	3.17	10.0489	31.855013
238	2.36	5.5696	13.144256
269	2.33	5.4289	12.649337
256	2.76	7.6176	21.024576
605	8.97	80.4609	721.734273
246	2.77	7.6729	21.253933
222	3.14	9.8596	30.959144
204	2.47	6.1009	15.069223
356	6.77	45.8329	310.288733
378	7.00	49.0000	343.000000
177	1.69	2.8561	4.826809

cost	output	output.2	output.3
<dbl>	<dbl>	<dbl>	<dbl>
263	4.41	19.4481	85.766121
549	8.60	73.9600	636.056000
267	4.71	22.1841	104.487111

In [ ]:
```
prod_model <- lm(cost ~ output + output.2 + output.3, data=prod_df)
summary(prod_model)
```

```
Call:
lm(formula = cost ~ output + output.2 + output.3, data = prod_df)

Residuals:
    Min      1Q  Median      3Q     Max 
-48.007 -12.594  -3.266  12.776  44.689 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)   
(Intercept) 134.6560    44.8001   3.006  0.00612 **
output       57.9702    29.9702   1.934  0.06496 . 
output.2    -11.0289     5.7646  -1.913  0.06772 . 
output.3      1.1431     0.3359   3.403  0.00234 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 21.93 on 24 degrees of freedom
Multiple R-squared:   0.98,     Adjusted R-squared:  0.9775 
F-statistic: 391.2 on 3 and 24 DF,  p-value: < 2.2e-16
```

In [ ]:
```
betas <- coef(prod_model)

total <- function(x) betas[1] + betas[2]*x + betas[3]*x^2 + betas[4]*x^3
marginal <- function(x) betas[2] + betas[3]*x + betas[4]*x^2
average <- function(x) (betas[1] + betas[2]*x + betas[3]*x^2 + betas[4]*x^3)/x

plot(marginal, 0, 10, xlim=c(0,9), ylim=c(20,600), xlab="output", ylab="total cost", col='red')
plot(total, 0, 10, add= TRUE, col='blue')
plot(average, 0, 10, add=TRUE, col='green')
```



E $Y = 57.97\

57.97= 134.6560+57.97 output -11.0289 output^2+1.1431 output^3\ x=-1.077$ todas las empresas producen de forma improductiva