RLM de RSE y áreas funcionales de la empresa

2024-04-24

Regresión Responsabilidad Social Empresarial

Generación del modelo con 13 variables

Variables:

IRSE = Índice de Responsabilidad Social Empresarial
RH = Recursos humanos
D = Dirección
VE = Valoración del entorno
AM = Análisis del mercado
P = Proveedores
F = Finanzas
GV = Gestión de ventas
PO = Producción-operación
I = Innovación
M = Mercadotecnia
SCE = Satisfacción con la empresa
VC = Ventaja competitiva
AV = Ámbito de ventas

Nota: **todos los valores son parte de un índice, van de 0 a 1.**

```
# Instalamos paquetes para leer nuestro excel
install.packages("xlsx")
```

```
## Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.3'
## (as 'lib' is unspecified)
```

```
library(xlsx)
```

Importamos el excel

```
# Cargamos la libreria
library(readxl)
```

```
datos <- read_excel("Reg_R.xlsx")
datos
```

```
## # A tibble: 178 x 15
##    Empresas  IRSE    RH     D    VE    AM     P     F    GV    PO     I     M
##       <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
##  1        1 0.957 0.933 0.925 0.871 0.867 0.829 0.954 0.829  1    0.825 0.927
##  2        2 0.2   0.2   0.65  0.929 0.2   1     0.754 0.429  0.68 0.3   0.418
##  3        3 0.971 0.717 0.9   0.8   0.667 0.829 1     0.943  1    1     0.764
##  4        4 0.714 0.85  0.875 0.786 0.711 0.686 0.8   0.514  1    0.55  0.618
##  5        5 0.829 0.767 0.7   0.714 0.778 0.857 0.892 0.829  0.84 0.85  0.709
##  6        6 0.843 0.933 0.65  0.643 0.844 0.971 1     0.829  0.92 0.775 0.8
```

```
##  7        7 0.8   0.8   0.625 0.8   0.644 0.6   0.692 0.8    0.8  0.8   0.673
##  8        8 0.786 0.95  0.75  0.786 0.756 0.829 0.769 0.771  0.8  0.725 0.655
##  9        9 0.957 0.9   0.675 0.957 0.867 0.914 0.954 0.743  1    0.6   0.709
## 10       10 0.557 0.2   0.5   0.757 0.622 0.743 0.754 0.457  0.8  0.3   0.655
## # i 168 more rows
## # i 3 more variables: SCE <dbl>, VC <dbl>, AV <dbl>
```

```
# Nuestro modelo con todas las variables (13) es mod
# Corremos el modelo nombrado mod
mod <- lm(IRSE ~ RH + D + VE + AM + P + F + GV + PO + I + M + SCE + VC + AV, data = datos )
summary(mod)
```

```
##
## Call:
## lm(formula = IRSE ~ RH + D + VE + AM + P + F + GV + PO + I +
##     M + SCE + VC + AV, data = datos)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.49757 -0.06071  0.00566  0.06414  0.50727
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.195393   0.083595  -2.337 0.020627 *
## RH           0.216720   0.047922   4.522 1.17e-05 ***
## D            0.122221   0.090968   1.344 0.180946
## VE           0.320176   0.073997   4.327 2.62e-05 ***
## AM           0.260676   0.087491   2.979 0.003327 **
## P           -0.097521   0.092115  -1.059 0.291299
## F            0.010026   0.083201   0.121 0.904232
## GV           0.003901   0.075388   0.052 0.958794
## PO           0.008712   0.086671   0.101 0.920058
## I            0.000325   0.071910   0.005 0.996399
## M            0.019962   0.113009   0.177 0.860008
## SCE          0.101078   0.098557   1.026 0.306601
## VC           0.093350   0.104806   0.891 0.374396
## AV           0.246374   0.072680   3.390 0.000876 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1366 on 164 degrees of freedom
## Multiple R-squared:  0.6468, Adjusted R-squared:  0.6188
## F-statistic:  23.1 on 13 and 164 DF,  p-value: < 2.2e-16
```

Seleccionamos los mejores predictores Utilizamos stepwise mixto.

```
step(object = mod, direction = "both", trace = 1)
```

```
## Start:  AIC=-695.26
## IRSE ~ RH + D + VE + AM + P + F + GV + PO + I + M + SCE + VC +
##     AV
##
##        Df Sum of Sq    RSS     AIC
## - I     1   0.00000 3.0603 -697.26
## - GV    1   0.00005 3.0603 -697.26
## - PO    1   0.00019 3.0604 -697.25
```

```
## - F     1   0.00027 3.0605 -697.25
## - M     1   0.00058 3.0608 -697.23
## - VC    1   0.01480 3.0751 -696.41
## - SCE   1   0.01963 3.0799 -696.13
## - P     1   0.02091 3.0812 -696.05
## - D     1   0.03368 3.0939 -695.32
## <none>              3.0603 -695.26
## - AM    1   0.16565 3.2259 -687.88
## - AV    1   0.21443 3.2747 -685.21
## - VE    1   0.34936 3.4096 -678.02
## - RH    1   0.38162 3.4419 -676.35
##
## Step:  AIC=-697.26
## IRSE ~ RH + D + VE + AM + P + F + GV + PO + M + SCE + VC + AV
##
##        Df Sum of Sq    RSS     AIC
## - GV    1   0.00006 3.0603 -699.26
## - PO    1   0.00019 3.0604 -699.25
## - F     1   0.00027 3.0605 -699.25
## - M     1   0.00064 3.0609 -699.23
## - VC    1   0.01481 3.0751 -698.41
## - SCE   1   0.01971 3.0800 -698.12
## - P     1   0.02098 3.0812 -698.05
## - D     1   0.03431 3.0946 -697.28
## <none>              3.0603 -697.26
## + I     1   0.00000 3.0603 -695.26
## - AM    1   0.16871 3.2290 -689.71
## - AV    1   0.22548 3.2857 -686.61
## - VE    1   0.35215 3.4124 -679.88
## - RH    1   0.39043 3.4507 -677.89
##
## Step:  AIC=-699.26
## IRSE ~ RH + D + VE + AM + P + F + PO + M + SCE + VC + AV
##
##        Df Sum of Sq    RSS     AIC
## - PO    1   0.00022 3.0605 -701.25
## - F     1   0.00025 3.0606 -701.25
## - M     1   0.00092 3.0612 -701.21
## - VC    1   0.01481 3.0751 -700.40
## - SCE   1   0.01966 3.0800 -700.12
## - P     1   0.02094 3.0812 -700.05
## <none>              3.0603 -699.26
## - D     1   0.03475 3.0951 -699.25
## + GV    1   0.00006 3.0603 -697.26
## + I     1   0.00001 3.0603 -697.26
## - AM    1   0.18595 3.2463 -690.76
## - AV    1   0.23193 3.2922 -688.26
## - VE    1   0.35582 3.4161 -681.68
## - RH    1   0.39180 3.4521 -679.82
##
## Step:  AIC=-701.25
## IRSE ~ RH + D + VE + AM + P + F + M + SCE + VC + AV
##
##        Df Sum of Sq    RSS     AIC
```

```
## - F     1   0.00035 3.0609 -703.23
## - M     1   0.00100 3.0615 -703.19
## - VC    1   0.01609 3.0766 -702.32
## - SCE   1   0.02048 3.0810 -702.06
## - P     1   0.02074 3.0813 -702.05
## <none>              3.0605 -701.25
## - D     1   0.03487 3.0954 -701.23
## + PO    1   0.00022 3.0603 -699.26
## + GV    1   0.00009 3.0604 -699.25
## + I     1   0.00002 3.0605 -699.25
## - AM    1   0.18670 3.2472 -692.71
## - AV    1   0.23324 3.2938 -690.18
## - VE    1   0.35602 3.4166 -683.66
## - RH    1   0.40934 3.4699 -680.90
##
## Step:  AIC=-703.23
## IRSE ~ RH + D + VE + AM + P + M + SCE + VC + AV
##
##        Df Sum of Sq    RSS     AIC
## - M     1   0.00117 3.0620 -705.16
## - VC    1   0.01765 3.0785 -704.20
## - SCE   1   0.02014 3.0810 -704.06
## - P     1   0.02067 3.0816 -704.03
## <none>              3.0609 -703.23
## - D     1   0.04170 3.1026 -702.82
## + F     1   0.00035 3.0605 -701.25
## + PO    1   0.00032 3.0606 -701.25
## + GV    1   0.00006 3.0608 -701.23
## + I     1   0.00000 3.0609 -701.23
## - AM    1   0.19422 3.2551 -694.28
## - AV    1   0.23929 3.3002 -691.83
## - VE    1   0.36013 3.4210 -685.43
## - RH    1   0.41551 3.4764 -682.57
##
## Step:  AIC=-705.16
## IRSE ~ RH + D + VE + AM + P + SCE + VC + AV
##
##        Df Sum of Sq    RSS     AIC
## - P     1   0.01955 3.0816 -706.03
## - VC    1   0.01993 3.0820 -706.01
## - SCE   1   0.02400 3.0860 -705.77
## <none>              3.0620 -705.16
## - D     1   0.04858 3.1106 -704.36
## + M     1   0.00117 3.0609 -703.23
## + F     1   0.00052 3.0615 -703.19
## + PO    1   0.00046 3.0616 -703.19
## + GV    1   0.00041 3.0616 -703.18
## + I     1   0.00019 3.0619 -703.17
## - AM    1   0.20740 3.2694 -695.50
## - AV    1   0.25564 3.3177 -692.89
## - VE    1   0.35995 3.4220 -687.38
## - RH    1   0.41638 3.4784 -684.47
##
## Step:  AIC=-706.03
```

```
## IRSE ~ RH + D + VE + AM + SCE + VC + AV
##
##        Df Sum of Sq    RSS     AIC
## - VC    1   0.01650 3.0981 -707.08
## - SCE   1   0.02106 3.1027 -706.82
## <none>              3.0816 -706.03
## - D     1   0.04332 3.1249 -705.54
## + P     1   0.01955 3.0620 -705.16
## + F     1   0.00031 3.0813 -704.05
## + PO    1   0.00006 3.0815 -704.03
## + I     1   0.00005 3.0815 -704.03
## + M     1   0.00005 3.0816 -704.03
## + GV    1   0.00000 3.0816 -704.03
## - AM    1   0.19274 3.2743 -697.23
## - AV    1   0.27652 3.3581 -692.73
## - VE    1   0.34455 3.4262 -689.16
## - RH    1   0.42075 3.5023 -685.25
##
## Step:  AIC=-707.08
## IRSE ~ RH + D + VE + AM + SCE + AV
##
##        Df Sum of Sq    RSS     AIC
## <none>              3.0981 -707.08
## - SCE   1   0.04523 3.1433 -706.50
## - D     1   0.04677 3.1449 -706.41
## + VC    1   0.01650 3.0816 -706.03
## + P     1   0.01612 3.0820 -706.01
## + F     1   0.00203 3.0961 -705.19
## + PO    1   0.00158 3.0965 -705.17
## + M     1   0.00100 3.0971 -705.13
## + I     1   0.00018 3.0979 -705.09
## + GV    1   0.00012 3.0980 -705.08
## - AM    1   0.22611 3.3242 -696.54
## - AV    1   0.29636 3.3945 -692.82
## - RH    1   0.42837 3.5265 -686.02
## - VE    1   0.46428 3.5624 -684.22
##
## Call:
## lm(formula = IRSE ~ RH + D + VE + AM + SCE + AV, data = datos)
##
## Coefficients:
## (Intercept)           RH            D           VE           AM          SCE
##     -0.2344       0.2215       0.1291       0.3360       0.2707       0.1342
##          AV
##      0.2676
```

Los mejores predictores para el modelo son 6

Nombramos nuestro modelo ajustado "mod1"

```
# mod1 = modelo ajustado
mod1 <- (lm(formula = IRSE ~ RH + D + VE + AM + SCE + AV, data = datos))
summary(mod1)
```

```
##
## Call:
## lm(formula = IRSE ~ RH + D + VE + AM + SCE + AV, data = datos)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.49726 -0.06116  0.00905  0.06998  0.47613
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.23438    0.06171  -3.798 0.000203 ***
## RH           0.22153    0.04556   4.863 2.61e-06 ***
## D            0.12906    0.08032   1.607 0.109948
## VE           0.33603    0.06638   5.062 1.06e-06 ***
## AM           0.27069    0.07662   3.533 0.000529 ***
## SCE          0.13417    0.08491   1.580 0.115930
## AV           0.26763    0.06617   4.044 7.92e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1346 on 171 degrees of freedom
## Multiple R-squared:  0.6424, Adjusted R-squared:  0.6299
## F-statistic:  51.2 on 6 and 171 DF,  p-value: < 2.2e-16
```

Mostramos el intervalo de confianza para cada uno de los coeficientes parciales de regresión:

```
confint(lm(formula = IRSE ~ RH + D + VE + AM + SCE + AV, data = datos))
```

```
##                   2.5 %     97.5 %
## (Intercept) -0.35619756 -0.1125603
## RH           0.13159722  0.3114533
## D           -0.02949097  0.2876130
## VE           0.20499851  0.4670567
## AM           0.11943948  0.4219328
## SCE         -0.03344099  0.3017864
## AV           0.13701204  0.3982510
```

Validamos las condiciones para la regresión múltiple lineal

```
# Instalamos nuestro paquetes para graficar
install.packages("ggplot2")
```

```
## Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.3'
## (as 'lib' is unspecified)
```

```
install.packages("gridExtra")
```

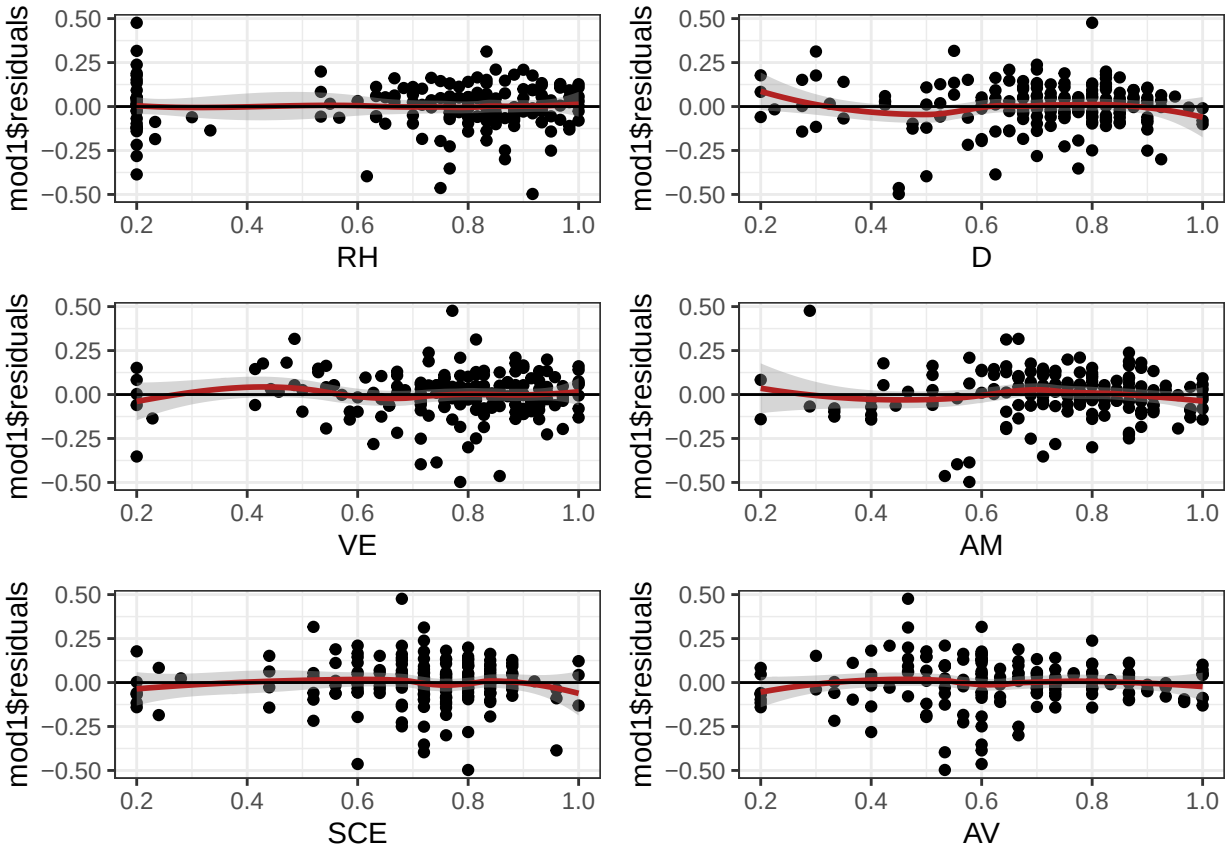
```
## Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.3'
## (as 'lib' is unspecified)
```

Graficamos

```
library(ggplot2)
library(gridExtra)
plot1 <- ggplot(data = datos, aes(RH, mod1$residuals)) +
    geom_point() + geom_smooth(color = "firebrick") + geom_hline(yintercept = 0) +
    theme_bw()
plot2 <- ggplot(data = datos, aes(D, mod1$residuals)) +
```

```
    geom_point() + geom_smooth(color = "firebrick") + geom_hline(yintercept = 0) +
    theme_bw()
plot3 <- ggplot(data = datos, aes(VE, mod1$residuals)) +
    geom_point() + geom_smooth(color = "firebrick") + geom_hline(yintercept = 0) +
    theme_bw()
plot4 <- ggplot(data = datos, aes(AM, mod1$residuals)) +
    geom_point() + geom_smooth(color = "firebrick") + geom_hline(yintercept = 0) +
    theme_bw()
plot5 <- ggplot(data = datos, aes(SCE, mod1$residuals)) +
    geom_point() + geom_smooth(color = "firebrick") + geom_hline(yintercept = 0) +
    theme_bw()
plot6 <- ggplot(data = datos, aes(AV, mod1$residuals)) +
    geom_point() + geom_smooth(color = "firebrick") + geom_hline(yintercept = 0) +
    theme_bw()
grid.arrange(plot1, plot2, plot3, plot4, plot5, plot6)
```

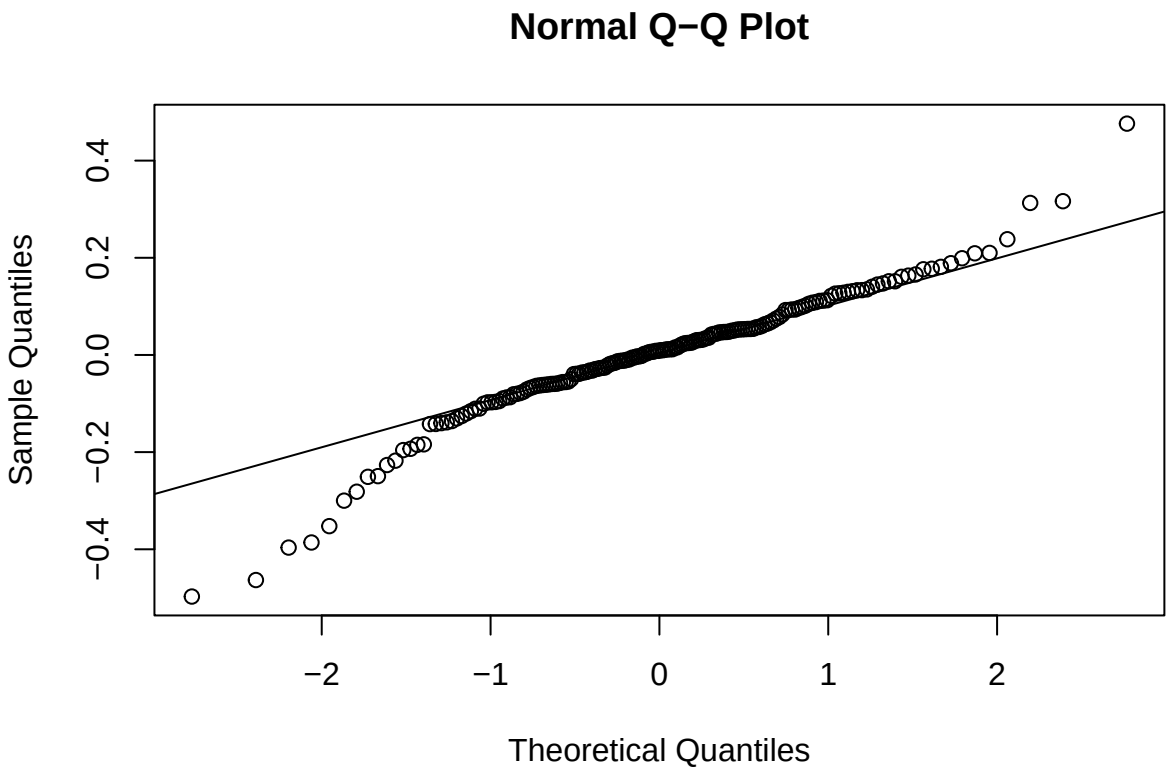
```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```



Se cumple la linealidad para todos los predictores

Distribución normal de los residuos:

```
qqnorm(mod1$residuals)
qqline(mod1$residuals)
```



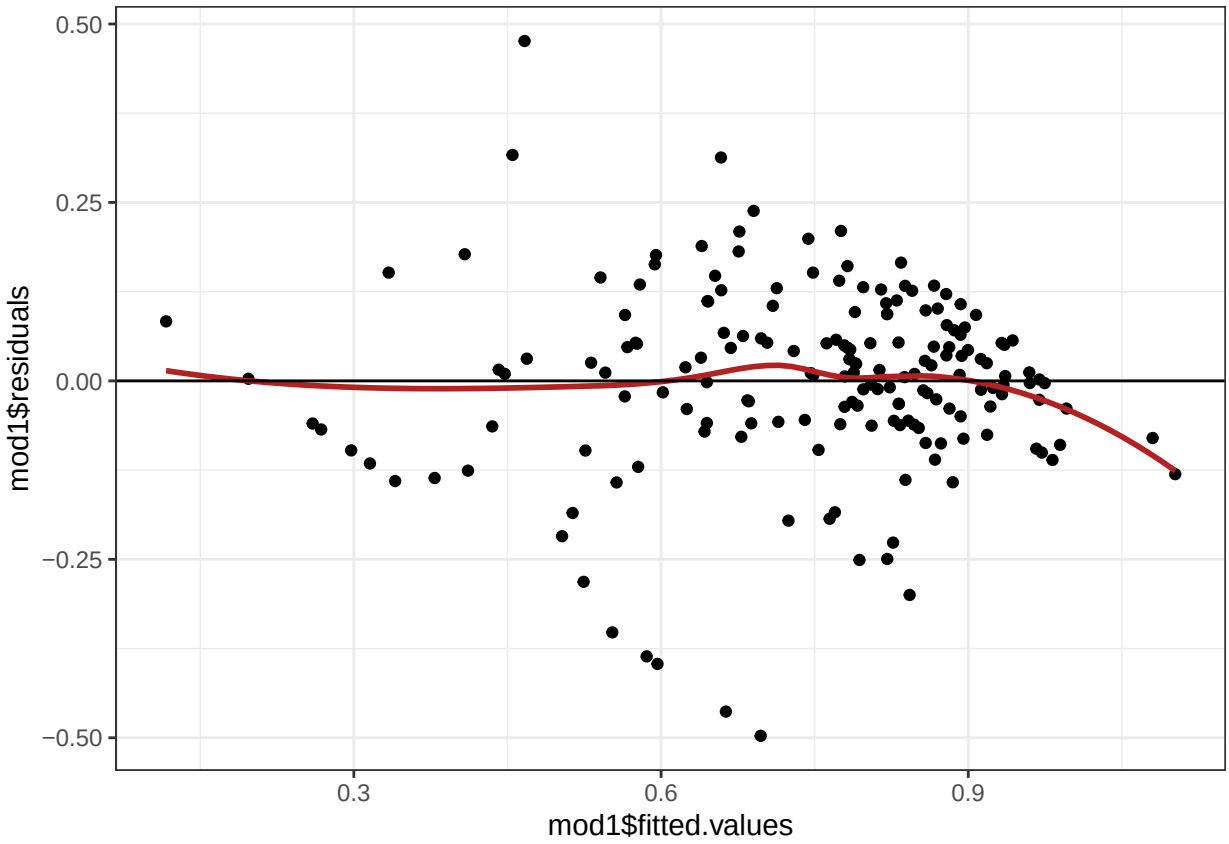

```
shapiro.test(mod1$residuals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  mod1$residuals
## W = 0.94981, p-value = 6.112e-06
```

Tanto el análisis gráfico como es test de hipótesis confirman la normalidad.

```
ggplot(data = datos, aes(mod1$fitted.values, mod1$residuals)) +
geom_point() +
geom_smooth(color = "firebrick", se = FALSE) +
geom_hline(yintercept = 0) +
theme_bw()
```

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```



No hay evidencias de falta de homocedasticidad.

No multicolinialidad: