Financial Econometrics

Multiple regression

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How do firms chose the level of debt they want to hold? In this session you will evaluate four different determinants of the debt level. Below you find a list including the variable name in brackets as well as the economic rational for investigating that variable.

- Tax benefits: interests are tax deductable. The more interests you pay, the lower your effective tax rate. (EffectiveTaxRate)
- Management discipline: higher level of tax will force management to serve debt-associated costs rather than using funding on non-profitable projects. Institutional investors often impose more debt on management due to the disciplining effect. (InstitutionalHoldings)
- Variance of income: the more variable a firm's income is the higher the change of bancruptcy, and the higher the chance that creditors do not get their payments (EBITDA_EV)
- Collateral: Firms with a lot of tangible might have an easier time raising debt, as they can pledge collateral. (NetPPE_TotalAssets)

Please use *Data_lab_multiple_regression.csv*.

Please complete the following tasks:

1. Load the data and winsorize all variables at the 1% level.
2. Estimate regression: Estimate five different regressions models explaining a firm's debt level *MarketDebt_Capital* by the aforementioned determinants. Construct four simple regressions using one determinant per regression and one multiple regression including all four determinantes. Report the results in a stargazer table. Make sure that you report t-values rather than standard errors.
3. Joint hypothesis test for multiple coefficients. Test whether only InstitutionalHoldings and NetPPE_TotalAssets matter, in other words whether EBITDA_EV and EffectiveTaxRate are jointly zero. Construct the appropiate H0 and use *linearHypothesis()* from the *car* package. In addition, compute the relevant F-statistic and p-value manually.
4. Single restriction on multiple coefficients. Test whether the effect of InstitutionalHoldings and NetPPE_TotalAssets is the same. Construct the appropiate H0 and use *linearHypothesis()* from the *car* package. In addition, transform the regression so that the restriction becomes a restriction on a single coefficient.

```r
# Packages
require(DescTools)
require(stargazer)
require(car)
require(lmtest)

# Task 1: load and winsorize the data

debt<-read.csv("C:/Users/s13163/Dropbox/FIE401/data/data_labs/Data_lab_multiple_regression.csv")

# summary stats
summary(debt)
```

```
##  Industry.Name      MarketDebt_Capital EffectiveTaxRate InstitutionalHoldings
##  Length:94          Min.   :0.0300     Min.   :0.0100   Min.   :0.1800
##  Class :character   1st Qu.:0.1725     1st Qu.:0.0625   1st Qu.:0.4100
##  Mode  :character   Median :0.2500     Median :0.1050   Median :0.5350
##                     Mean   :0.2806     Mean   :0.1176   Mean   :0.5317
##                     3rd Qu.:0.3475     3rd Qu.:0.1500   3rd Qu.:0.6500
##                     Max.   :0.9100     Max.   :0.3100   Max.   :1.0600
##    EBITDA_EV       NetPPE_TotalAssets
##  Min.   :0.00000   Min.   :0.0000
##  1st Qu.:0.06000   1st Qu.:0.1000
##  Median :0.08000   Median :0.1900
##  Mean   :0.07926   Mean   :0.2640
##  3rd Qu.:0.09000   3rd Qu.:0.4075
##  Max.   :0.20000   Max.   :0.8600
```

```r
# winsorize
for (i in 2:6)
{
  debt[,i]<-Winsorize(debt[,i],val=quantile(debt[,i],probs=c(0.005, 0.995)))

}

# note I winsorize at the 1% level (0.5% above and below)
# investigate the effect of winsorizing,
# display histogram/summary stats before and after winsorizing
summary(debt)
```

```
##  Industry.Name      MarketDebt_Capital EffectiveTaxRate  InstitutionalHoldings
##  Length:94          Min.   :0.04395    Min.   :0.01465   Min.   :0.1893
##  Class :character   1st Qu.:0.17250    1st Qu.:0.06250   1st Qu.:0.4100
##  Mode  :character   Median :0.25000    Median :0.10500   Median :0.5350
##                     Mean   :0.27970    Mean   :0.11740   Mean   :0.5306
##                     3rd Qu.:0.34750    3rd Qu.:0.15000   3rd Qu.:0.6500
##                     Max.   :0.80770    Max.   :0.29140   Max.   :0.9484
##    EBITDA_EV       NetPPE_TotalAssets
##  Min.   :0.00000   Min.   :0.0000
##  1st Qu.:0.06000   1st Qu.:0.1000
##  Median :0.08000   Median :0.1900
##  Mean   :0.07916   Mean   :0.2637
##  3rd Qu.:0.09000   3rd Qu.:0.4075
##  Max.   :0.19070   Max.   :0.8321
```

```r
# Task 2: regression models
m1 <- lm(MarketDebt_Capital ~ EffectiveTaxRate, data = debt)
m2 <- lm(MarketDebt_Capital ~ InstitutionalHoldings, data = debt)
m3 <- lm(MarketDebt_Capital ~ EBITDA_EV, data = debt)
m4 <- lm(MarketDebt_Capital ~ NetPPE_TotalAssets, data = debt)
m5 <- lm(MarketDebt_Capital ~ EffectiveTaxRate + InstitutionalHoldings
         + EBITDA_EV + NetPPE_TotalAssets, data = debt)

# output
stargazer(list(m1, m2, m3, m4, m5),
          type="text",
          keep.stat=c("n", "rsq", "adj.rsq"), # drop F-test
          report=('vc*t'))
```

```
##
## ================================================================================
##                                        Dependent variable:
##                          ----------------------------------------------------
##                                        MarketDebt_Capital
##                             (1)        (2)        (3)        (4)         (5)
## --------------------------------------------------------------------------------
## EffectiveTaxRate         0.659***                                       0.743***
##                          t = 3.113                                     t = 2.987
##
## InstitutionalHoldings                0.114                           -0.079
##                                     t = 1.169                       t = -0.706
##
## EBITDA_EV                                       0.586                 0.488
##                                                t = 1.386             t = 1.102
##
## NetPPE_TotalAssets                                          0.086      0.057
##                                                            t = 1.280  t = 0.827
##
## Constant                 0.202***  0.219***  0.233***    0.257***    0.181***
##                          t = 7.059 t = 4.060 t = 6.365 t = 11.064 t = 3.149
##
## --------------------------------------------------------------------------------
## Observations                94         94         94          94          94
## R2                         0.095      0.015      0.020      0.017       0.126
## Adjusted R2                0.085      0.004      0.010      0.007       0.087
## ================================================================================
## Note:                                              *p<0.1; **p<0.05; ***p<0.01
```

```r
# Task 3: only InstitutionalHoldings and NetPPE_TotalAssets matter?

# R solution
myH0 <- c("EBITDA_EV=0", "EffectiveTaxRate=0")
linearHypothesis(m5, myH0)
```

```
##
## Linear hypothesis test:
## EBITDA_EV = 0
## EffectiveTaxRate = 0
##
## Model 1: restricted model
```

```
## Model 2: MarketDebt_Capital ~ EffectiveTaxRate + InstitutionalHoldings +
##     EBITDA_EV + NetPPE_TotalAssets
##
##   Res.Df    RSS Df Sum of Sq      F  Pr(>F)
## 1     91 1.8995
## 2     89 1.7140  2   0.18547 4.8153 0.01034 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# manual solution
m5.restricted <- lm(MarketDebt_Capital ~InstitutionalHoldings + NetPPE_TotalAssets,
                    data = debt)
n <- nrow(debt)
k <- 4
Fstat<-((summary(m5)$r.squared - summary(m5.restricted)$r.squared) / 2)  /
  ( (1-summary(m5)$r.squared) / (n - k - 1))
print(Fstat)
```

```
## [1] 4.815294
```

```
pvalue<-1-pf(Fstat, 2, n-k-1)
print(pvalue)
```

```
## [1] 0.01033566
```

```
# Interpretation: we reject the H0 that both EBITDA_EV and EffectiveTaxRate are 0

# Task 4: the effect of InstitutionalHoldings and NetPPE_TotalAssets is the same?

# R solution
myH0 <- c("InstitutionalHoldings=NetPPE_TotalAssets")
linearHypothesis(m5, myH0)
```

```
##
## Linear hypothesis test:
## InstitutionalHoldings - NetPPE_TotalAssets = 0
##
## Model 1: restricted model
## Model 2: MarketDebt_Capital ~ EffectiveTaxRate + InstitutionalHoldings +
##     EBITDA_EV + NetPPE_TotalAssets
##
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1     90 1.7357
## 2     89 1.7140  1   0.02169 1.1263 0.2914
```

```
# manual solution
debt$transformed.variable <- debt$InstitutionalHoldings + debt$NetPPE_TotalAssets

m6 <- lm( MarketDebt_Capital ~  InstitutionalHoldings + transformed.variable +
            EffectiveTaxRate + EBITDA_EV, data = debt)

summary(m6)
```

```
##
## Call:
## lm(formula = MarketDebt_Capital ~ InstitutionalHoldings + transformed.variable +
##     EffectiveTaxRate + EBITDA_EV, data = debt)
```

```
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.22226 -0.07976 -0.02427  0.03385  0.50788
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)            0.18075    0.05741   3.149  0.00223 **
## InstitutionalHoldings -0.13621    0.12835  -1.061  0.29145
## transformed.variable   0.05719    0.06913   0.827  0.41027
## EffectiveTaxRate       0.74259    0.24858   2.987  0.00364 **
## EBITDA_EV              0.48767    0.44267   1.102  0.27359
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1388 on 89 degrees of freedom
## Multiple R-squared:  0.126,  Adjusted R-squared:  0.08667
## F-statistic: 3.206 on 4 and 89 DF,  p-value: 0.01652
```

```
# Interpretation, we fail to reject the HO that the coefficients are equal.
```