Illustration 3 – Question 1

```
. keep if YEAR==1999
. regress LEV_LT SIZE COLLAT PROF GROWTH AGE

      Source |       SS           df       MS      Number of obs   =     4,692
-------------+----------------------------------   F(5, 4686)      =     73.26
       Model |  10.6236513         5  2.12473026   Prob > F        =    0.0000
    Residual |  135.914959     4,686  .029004473   R-squared       =    0.0725
-------------+----------------------------------   Adj R-squared   =    0.0715
       Total |   146.53861     4,691  .031238246   Root MSE        =    .17031

------------------------------------------------------------------------------
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0227699   .0013931    16.34   0.000     .0200387     .025501
      COLLAT |   .0356729   .0112018     3.18   0.001      .013712    .0576337
        PROF |  -.1313503   .0278565    -4.72   0.000    -.1859621   -.0767386
      GROWTH |   5.98e-07   2.20e-06     0.27   0.786    -3.71e-06    4.91e-06
         AGE |  -.0003878   .0001676    -2.31   0.021    -.0007165   -.0000591
       _cons |  -.2246217    .018836   -11.93   0.000    -.2615491   -.1876942
------------------------------------------------------------------------------
```

$$\widehat{LEV\_LT}_i = -0.225 + 0.023SIZE_i + 0.036COLLAT_i - 0.131PROF_1 + 0.000GROWTH_i + 0.000AGE_i$$

Illustration 3 – Question 2

Interpretation of partial effects. Ceteris paribus,

- if total of assets increases 1%, the proportion of long term debt increases, in average, 0.023/100=0.0002.
- each additional year of the firm, reduces the proportion of debt, in average, 0.0004

- if the proportion of collateral increases 0.1 (10pp), the proportion of debt increases, in average, 0.036*0.1=0.0036 (0.36pp in scale 100%)
- if profitability increases 0.1, the proportion of debt decreases, in average, 0.131*0.1=0.0131
- if growth increases 0.1, the proportion of debt decreases, in average, 0.000*0.1=0.0000
    - 3 last effects are response to 0.1 instead of 1, in order to give rise to a meaningfull interpretation

Illustration 3 – Question 2

Intuition for effects:

Positive effects on the long term proportion:

- SIZE: larger firms are typicaly more diversified and have lower probability of failure. Therefore they are issued debt more easily than small firms.
- COLLAT: firms with a higher proportion of collateral are safer in cases of failure. Therefore they are issued debt more easily.
- GROWTH: firms with higher growth are more promissing. Therefore they are issued debt more easily.

Negative effects on the long term proportion:

- PROF: more profitable firms are more likely to generate internal funding. Therefore they use less debt.
- AGE: firms that survived for a long time display less debt needs.

Illustration 3 – Question 3

At the 5% significance level all variables, except GROWTH, are statistically individually significant.

At the 5% significance level, all variables are jointly significant

Illustration 3 – Question 4

To test the joint significace of PROF and GROWTH:

```
. quietly regress LEV_LT SIZE COLLAT PROF GROWTH AGE

. test PROF GROWTH

 ( 1)   PROF = 0
 ( 2)   GROWTH = 0

        F(  2,  4686) =   11.12
             Prob > F =    0.0000
```

At the 5% significance level PROF and GROWTH are statistically significant

Illustration 3 – Question 4

Repetition of the test, for illustrative purposes, without the authomatic command

```
. regress LEV_LT SIZE COLLAT AGE
      Source |       SS           df       MS      Number of obs   =     4,692
-------------+----------------------------------   F(3, 4688)      =    114.19
       Model |  9.97877613         3  3.32625871   Prob > F        =    0.0000
    Residual |  136.559834     4,688  .029129657   R-squared       =    0.0681
-------------+----------------------------------   Adj R-squared   =    0.0675
       Total |   146.53861     4,691  .031238246   Root MSE        =    .17067
…
. display ((0.0725-0.0681)/2/((1-0.0725)/(4692-6)))
11.11504
```

Illustration 3 – Question 5

```
. regress LEV_LT SIZE COLLAT PROF GROWTH AGE SE MedE LE

      Source |       SS           df       MS      Number of obs   =     4,692
-------------+----------------------------------   F(8, 4683)      =     49.76
       Model |  11.4798615         8  1.43498268   Prob > F        =    0.0000
    Residual |  135.058749     4,683   .02884022   R-squared       =    0.0783
-------------+----------------------------------   Adj R-squared   =    0.0768
       Total |   146.53861     4,691  .031238246   Root MSE        =    .16982

------------------------------------------------------------------------------
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0301683   .0021456    14.06   0.000     .0259618    .0343747
      COLLAT |   .0407159   .0113232     3.60   0.000     .0185171    .0629146
        PROF |  -.1208179   .0278736    -4.33   0.000    -.1754634   -.0661725
      GROWTH |   2.28e-07   2.19e-06     0.10   0.917    -4.08e-06    4.53e-06
         AGE |  -.0002906   .0001691    -1.72   0.086     -.000622    .0000409
          SE |  -.0208001   .0068367    -3.04   0.002    -.0342032   -.0073969
        MedE |   -.028482   .0100863    -2.82   0.005    -.0482558   -.0087082
          LE |  -.0873071   .0163264    -5.35   0.000    -.1193145   -.0552997
       _cons |  -.3107104   .0268095   -11.59   0.000    -.3632698   -.2581511
------------------------------------------------------------------------------
```

Illustration 3 – Question 5

```
. test SE MedE LE

( 1)   SE = 0
( 2)   MedE = 0
( 3)   LE = 0

       F(   3,   4683) =     9.90
            Prob > F =     0.0000
```

The new regressors are jointly significant.

Ceteris paribus:

- a small firm, relative to a micro firm, displays in average a long term proportion of debt smaller in 0.021
- a medium firm, relative to a micro firm, displays in average a long term proportion of debt smaller in 0.028
- a large firm, relative to a micro firm, displays in average a long term proportion of debt smaller in 0.087

Illustration 3 – Question 6.1

Model:

$$LEV\_LT = \beta_0 + \beta_1 SIZE + \beta_2 COLLAT + \beta_3 PROF + \beta_4 GROWTH + \beta_5 AGE + \beta_6 (SE * PROF) + \beta_7 (MedE * PROF) + \beta_8 (LE * PROF) + v$$

Effects of firm profitability:

- Micro firms: β_3
- Small firms: $\beta_3 + \beta_6$
- Medium firms: $\beta_3 + \beta_7$
- Large firms: $\beta_3 + \beta_8$

Null hypotheses:

	Small	Medium	Large
Micro	$\beta_6 = 0$	$\beta_7 = 0$	$\beta_8 = 0$
Small		$\beta_6 = \beta_7$	$\beta_6 = \beta_8$
Medium			$\beta_7 = \beta_9$

Illustration 3 – Question 6.1

```
. gen PROF_SE=PROF*SE
. gen PROF_MedE=PROF*MedE
. gen PROF_LE=PROF*LE

. regress LEV_LT SIZE COLLAT PROF GROWTH AGE PROF_SE PROF_MedE PROF_LE
      Source |       SS           df       MS      Number of obs   =     4,692
-------------+----------------------------------   F(8, 4683)      =     51.41
       Model |  11.8295674         8  1.47869593   Prob > F        =    0.0000
    Residual |  134.709043     4,683  .028765544   R-squared       =    0.0807
-------------+----------------------------------   Adj R-squared   =    0.0792
       Total |   146.53861     4,691  .031238246   Root MSE        =     .1696

------------------------------------------------------------------------------
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0276292   .0015862    17.42   0.000     .0245194     .030739
      COLLAT |   .0363435   .0111628     3.26   0.001     .0144591    .0582279
        PROF |   .0095068   .0369042     0.26   0.797    -.0628428    .0818565
      GROWTH |  -2.68e-07   2.20e-06    -0.12   0.903    -4.57e-06    4.04e-06
         AGE |  -.0003792   .0001672    -2.27   0.023     -.000707   -.0000515
     PROF_SE |  -.2026651   .0517991    -3.91   0.000    -.3042157   -.1011145
   PROF_MedE |   -.343819   .0730633    -4.71   0.000    -.4870576   -.2005805
     PROF_LE |  -.7133022   .1360224    -5.24   0.000    -.9799701   -.4466343
       _cons |  -.2892868    .021412   -13.51   0.000    -.3312644   -.2473092
------------------------------------------------------------------------------
```

Illustration 3 – Question 6.1

Effects of firm profitability:

- When profitability increases 0.1 (10 pp for percentage), the proportion of long-term debt in the firm's capital structure decreases, on average:
  - 0.00095 (0.095 pp in percentage) - micro firms
  - -0.0193 - small firms → display _b[PROF]+_b[PROF_SE]
  - -0.0334 - medium firms → display _b[PROF]+_b[PROF_MedE]
  - -0.0704 - large firms → display _b[PROF]+_b[PROF_LE]

Illustration 3 – Question 6.1

Profitability effects differ significantly across groups?

```
. test PROF_SE=PROF_MedE
( 1)  PROF_SE - PROF_MedE = 0
      F(  1,  4683) =    3.84
           Prob > F =    0.0502
```

```
. test PROF_SE=PROF_LE
( 1)  PROF_SE - PROF_LE = 0
      F(  1,  4683) =   14.66
           Prob > F =    0.0001
```

```
. test PROF_MedE=PROF_LE
( 1)  PROF_MedE - PROF_LE = 0
      F(  1,  4683) =    7.44
           Prob > F =    0.0064
```

(p-values)	Small	Medium	Large
Micro	0.000***	0.000***	0.000***
Small		0.0502*	0.000***
Medium			0.006***

Illustration 3 – Question 6.2

Model:

$$
\begin{aligned}
&LEV\_LT \\
&= \beta_0 + \beta_1 SIZE + \beta_2 COLLAT + \beta_3 PROF + \beta_4 GROWTH + \beta_5 AGE + \beta_6 LE \\
&+ \beta_7 (LE * SIZE) + \beta_8 (LE * COLLAT) + \beta_9 (LE * PROF) \\
&+ \beta_{10} (LE * GROWTH) + \beta_{11} (LE * AGE) + w
\end{aligned}
$$

Null hypotheses:

- $H_0: \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$ (no structural break)

```
. gen SIZE_LE=SIZE*LE
. gen COLLAT_LE=COLLAT*LE
. gen GROWTH_LE=GROWTH*LE
. gen AGE_LE=AGE*LE
```

Illustration 3 – Question 6.2

```
regress LEV_LT SIZE COLLAT PROF GROWTH AGE LE SIZE_LE COLLAT_LE PROF_LE GROWTH_LE AGE_LE

      Source |       SS           df       MS      Number of obs   =     4,692
-------------+----------------------------------   F(11, 4680)     =     36.14
       Model |  11.4734211        11  1.04303829   Prob > F        =    0.0000
    Residual |  135.065189     4,680  .028860083   R-squared       =    0.0783
-------------+----------------------------------   Adj R-squared   =    0.0761
       Total |   146.53861     4,691  .031238246   Root MSE        =    .16988

------------------------------------------------------------------------------
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0262108   .0015979    16.40   0.000     .0230782    .0293433
      COLLAT |   .0298537   .0114426     2.61   0.009     .0074207    .0522867
        PROF |  -.1178161   .0283403    -4.16   0.000    -.1733765   -.0622557
      GROWTH |   4.15e-07   2.19e-06     0.19   0.850    -3.89e-06    4.72e-06
         AGE |  -.0003768   .0001822    -2.07   0.039    -.0007339   -.0000196
          LE |  -.0570063   .1411598    -0.40   0.686    -.3337461    .2197334
     SIZE_LE |   -.002168   .0082257    -0.26   0.792    -.0182943    .0139582
   COLLAT_LE |   .1055932    .053384     1.98   0.048     .0009355    .2102509
     PROF_LE |  -.2771129   .1595962    -1.74   0.083    -.5899966    .0357708
   GROWTH_LE |   .0010892   .0006263     1.74   0.082    -.0001386     .002317
      AGE_LE |   .0003647    .000469     0.78   0.437    -.0005547    .0012842
       _cons |  -.2680171   .0213989   -12.52   0.000    -.3099691   -.2260651
------------------------------------------------------------------------------
```

Illustration 3 – Question 6.2

```
. test LE SIZE_LE COLLAT_LE PROF_LE GROWTH_LE AGE_LE

 ( 1)  LE = 0
 ( 2)  SIZE_LE = 0
 ( 3)  COLLAT_LE = 0
 ( 4)  PROF_LE = 0
 ( 5)  GROWTH_LE = 0
 ( 6)  AGE_LE = 0

       F(  6,  4680) =    4.91
            Prob > F =    0.0001
```

The null hypothesis is rejected, which implies that it is better to estimate separate models for each size-based group of firms or, equivalently, the model of the previous page, since:

(see the next page and compare with the interactions model)

Illustration 3 – Question 6.2

```
. regress LEV_LT SIZE COLLAT PROF GROWTH AGE if LE==0
(…)
------------------------------------------------------------------------------
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0262108   .0016006    16.38   0.000     .0230728    .0293487
      COLLAT |   .0298537    .011462     2.60   0.009     .0073825    .0523249
        PROF |  -.1178161   .0283882    -4.15   0.000    -.1734712    -.062161
      GROWTH |   4.15e-07   2.20e-06     0.19   0.850    -3.89e-06    4.72e-06
         AGE |  -.0003768   .0001825    -2.06   0.039    -.0007345    -.000019
       _cons |  -.2680171   .0214351   -12.50   0.000    -.3100405   -.2259936
------------------------------------------------------------------------------

. regress LEV_LT SIZE COLLAT PROF GROWTH AGE if LE==1
(…)
------------------------------------------------------------------------------
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0240427   .0078385     3.07   0.002      .008609    .0394765
      COLLAT |   .1354469   .0506539     2.67   0.008     .0357116    .2351822
        PROF |   -.394929   .1525738    -2.59   0.010    -.6953401   -.0945179
      GROWTH |   .0010896   .0006084     1.79   0.074    -.0001082    .0022875
         AGE |   -.000012   .0004198    -0.03   0.977    -.0008387    .0008146
       _cons |  -.3250234   .1355432    -2.40   0.017     -.591902   -.0581448
------------------------------------------------------------------------------
```

Illustration 3 – Question 7.1 & 7.2

```
. quietly regress LEV_LT SIZE COLLAT PROF GROWTH AGE SE MedE LE


. ovtest

Ramsey RESET test using powers of the fitted values of LEV_LT
       Ho:  model has no omitted variables
                F(3, 4680) =     10.62
                  Prob > F =      0.0000
```

→ Unsuitable model functional form

```
. estat hettest, rhs fstat

 Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: SIZE COLLAT PROF GROWTH AGE SE MedE LE

         F(8 , 4683)  =    20.76
         Prob > F     =   0.0000
```

→ Heteroskedastic erros

Illustration 3 – Question 7.1 & 7.2

RESET test – manual implementation

```
. quietly regress LEV_LT SIZE COLLAT PROF GROWTH AGE SE MedE LE
. predict XB
. gen XB2=XB^2
. gen XB3=XB^3
. gen XB4=XB^4
. quietly regress LEV_LT SIZE COLLAT PROF GROWTH AGE SE MedE LE XB2 XB3 XB4

. test XB2 XB3 XB4

 ( 1)  XB2 = 0
 ( 2)  XB3 = 0
 ( 3)  XB4 = 0

       F(  3,  4680) =   10.62
            Prob > F =    0.0000
```

Illustration 3 – Question 7.1 & 7.2

BP test – manual implementation

```
. quietly regress LEV_LT SIZE COLLAT PROF GROWTH AGE SE MedE LE

. predict uhat, resid

. gen uhat2=uhat^2

. quietly regress uhat2 SIZE COLLAT PROF GROWTH AGE SE MedE LE

. test SIZE COLLAT PROF GROWTH AGE SE MedE LE
 ( 1)   SIZE = 0
 ( 2)   COLLAT = 0
 ( 3)   PROF = 0
 ( 4)   GROWTH = 0
 ( 5)   AGE = 0
 ( 6)   SE = 0
 ( 7)   MedE = 0
 ( 8)   LE = 0

       F(  8,  4683) =   20.76
            Prob > F =    0.0000
```

Illustration 3 – Question 8

```
. regress LEV_LT SIZE COLLAT PROF GROWTH AGE SE MedE LE, robust

Linear regression                               Number of obs     =      4,692
                                                F(8, 4683)        =      60.36
                                                Prob > F          =     0.0000
                                                R-squared         =     0.0783
                                                Root MSE          =     .16982

------------------------------------------------------------------------------
             |               Robust
      LEV_LT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        SIZE |   .0301683   .0024476    12.33   0.000     .0253699    .0349667
      COLLAT |   .0407159   .0120525     3.38   0.001     .0170872    .0643445
        PROF |  -.1208179   .0214538    -5.63   0.000    -.1628775   -.0787583
      GROWTH |   2.28e-07   1.00e-06     0.23   0.821    -1.74e-06    2.20e-06
         AGE |  -.0002906   .0001641    -1.77   0.077    -.0006123    .0000312
          SE |  -.0208001   .0075488    -2.76   0.006    -.0355994   -.0060008
        MedE |   -.028482   .0118234    -2.41   0.016    -.0516614   -.0053026
          LE |  -.0873071   .0180288    -4.84   0.000     -.122652   -.0519622
       _cons |  -.3107104   .0273125   -11.38   0.000    -.3642558    -.257165
------------------------------------------------------------------------------
```

Stata – Panel data

Commands for panel data:

- Prefix **xt**

Initial command:

- **xtset** *identvar tempvar*

Examples:

- **xtdescribe** [*varlist*]
- **xtsum** [*varlist*]
- **xttab** *varname*

Illustration 4

Model:

$$Log(Wage_{it}) = \beta_0 + \beta_1 Schooling_{it} + \beta_2 Exper_{it} + \beta_3 Exper^2{}_{it} + \beta_4 Black_i + \beta_5 Union_{it} + \beta_6 South_{it} + \beta_7 Public_{it} + u$$

Aim:

- Estimating β_5 (impact of colective bargaining on wages)

Sample:

- 545 full-time working males who completed their schooling by 1980 and were observed over the period 1980-1987

Details:

- Verbeek (2008), pp. 375-377

Illustration 4 – Question 1

```
. xtset NR YEAR
       panel variable:  NR (strongly balanced)
        time variable:  YEAR, 1980 to 1987
                delta:  1 unit

. xtdescribe
      NR:  13, 17, ..., 12548                                  n =        545
    YEAR:  1980, 1981, ..., 1987                               T =          8
           Delta(YEAR) = 1 unit
           Span(YEAR)  = 8 periods
           (NR*YEAR uniquely identifies each observation)
Distribution of T_i:   min      5%      25%       50%       75%     95%     max
                         8       8        8         8         8       8       8

     Freq.  Percent    Cum. |  Pattern
 ---------------------------+----------
      545    100.00  100.00 |  11111111
 ---------------------------+----------
      545    100.00         |  XXXXXXXX
```

- Balanced Panel

Illustration 4 – Question 2

```
. xtsum WAGE SCHOOLING EXPER BLACK UNION SOUTH PUBLIC

Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
WAGE     overall |  5.919175   3.202225   .0279014   57.50431 |     N =    4360
         between |             2.455819   1.503564   28.35696 |     n =     545
         within  |             2.057397  -16.42349   35.06652 |     T =       8
                 |                                            |
SCHOOL~G overall |  11.76697   1.746181          3         16 |     N =    4360
         between |             1.747585          3         16 |     n =     545
         within  |                    0   11.76697   11.76697 |     T =       8
                 |                                            |
EXPER    overall |  6.514679   2.825873          0         18 |     N =    4360
         between |             1.654918        3.5       14.5 |     n =     545
         within  |             2.291551   3.014679   10.01468 |     T =       8
                 |                                            |
BLACK    overall |  .1155963   .3197769          0          1 |     N =    4360
         between |              .320034          0          1 |     n =     545
         within  |                    0   .1155963   .1155963 |     T =       8
```

Illustration 4 – Question 2 (cont.)

```
. xtsum WAGE SCHOOLING EXPER BLACK UNION SOUTH PUBLIC

Variable         |      Mean   Std. Dev.       Min        Max |    Observations
-----------------+--------------------------------------------+----------------
UNION    overall |  .2440367    .4295639         0          1 |     N =    4360
         between |              .3294467         0          1 |     n =     545
         within  |              .2759787  -.6309633   1.119037 |     T =       8
                 |                                            |
SOUTH    overall |  .3506881    .4772402         0          1 |     N =    4360
         between |              .4644838         0          1 |     n =     545
         within  |              .1111732  -.5243119   1.225688 |     T =       8
                 |                                            |
PUBLIC   overall |  .0401376    .1963044         0          1 |     N =    4360
         between |              .1388064         0          1 |     n =     545
         within  |              .1389214  -.8348624   .9151376 |     T =       8
```

Illustration 4 – Question 3

```
. xttab UNION

                  Overall             Between            Within
    UNION |    Freq.  Percent      Freq.  Percent        Percent
----------+-----------------------------------------------------
        0 |     3296    75.60       511     93.76          80.63
        1 |     1064    24.40       280     51.38          47.50
----------+-----------------------------------------------------
    Total |     4360   100.00       791    145.14          68.90
                               (n = 545)
```

- Overall, 24,4% of wages resulted from collective bargaining
- For 51,38% of workers (280 out of 545), in at least one year their wages resulted from collective bargaining
- For 47,5% of those 280 workers, wages resulted always from collective bargaining

Illustration 4 – Question 3 (cont.)

```
. xttab SOUTH

                  Overall             Between            Within
    SOUTH |    Freq.  Percent      Freq.  Percent        Percent
----------+-----------------------------------------------------
        0 |     2831    64.93        374    68.62          94.62
        1 |     1529    35.07        212    38.90          90.15
----------+-----------------------------------------------------
    Total |     4360   100.00        586   107.52          93.00
                               (n = 545)
```

- Overall, 35,1% of observations concern cases of individuals living in the South
- 38,9% of workers (212 out of 545) lived at least one year in the South
- 90,15% of those 212 workers lived always in the South

Illustration 4 – Question 3 (cont.)

```
. xttab PUBLIC

                  Overall             Between            Within
    PUBLIC |    Freq.  Percent      Freq.  Percent        Percent
----------+-----------------------------------------------------
         0 |     4185    95.99        543    99.63          96.34
         1 |      175     4.01         62    11.38          35.28
----------+-----------------------------------------------------
     Total |     4360   100.00        605   111.01          90.08
                                  (n = 545)
```

- Overall, 4,01 % of observations concern cases of individuals working in Public Administration
- 11,38% of workers (62 out of 545) worked at least one year in Public Administration
- 35,28% of those 62 workers worked always in Public Administration

Illustration 4 – Question 4.1 - Pooled

```
 . regress WAGE SCHOOLING EXPER EXPER2 BLACK UNION SOUTH PUBLIC, vce(cluster NR)
Linear regression                               Number of obs     =      4,360
                                                F(7, 544)         =      41.86
                                                Prob > F          =     0.0000
                                                R-squared         =     0.1574
                                                Root MSE          =     2.9418

                                  (Std. Err. adjusted for 545 clusters in NR)
------------------------------------------------------------------------------
             |               Robust
        WAGE |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   SCHOOLING |   .6151076   .0607653    10.12   0.000     .4957443    .7344709
       EXPER |   .5637173    .062699     8.99   0.000     .4405556    .6868791
      EXPER2 |  -.0190516   .0046374    -4.11   0.000     -.028161   -.0099423
       BLACK |  -.8307319   .2819856    -2.95   0.003    -1.384646   -.2768179
       UNION |   .9102328   .1801955     5.05   0.000     .5562686    1.264197
       SOUTH |   -.153659    .227973    -0.67   0.501    -.6014743    .2941563
      PUBLIC |  -.2967572   .2922075    -1.02   0.310    -.8707505    .2772361
       _cons |  -4.090845   .7595731    -5.39   0.000      -5.5829   -2.598789
------------------------------------------------------------------------------

. estimates store POOLED
```

Illustration 4 – Question 4.1 – Random Effects

```
. xtreg WAGE SCHOOLING EXPER EXPER2 BLACK UNION SOUTH PUBLIC, vce(cluster NR)

Random-effects GLS regression                   Number of obs      =     4,360
Group variable: NR                              Number of groups   =       545

R-sq:                                           Obs per group:
     within  = 0.1792                                         min =         8
     between = 0.1362                                         avg =       8.0
     overall = 0.1536                                         max =         8

                                                Wald chi2(7)       =    444.91
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

(continues in the next slide)

Illustration 4 – Question 4.1 – Random Effects (cont.)

```
                                 (Std. Err. adjusted for 545 clusters in NR)
------------------------------------------------------------------------------
             |               Robust
        WAGE |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   SCHOOLING |    .628984   .0564469    11.14   0.000     .5183502    .7396178
       EXPER |   .6888584   .0675657    10.20   0.000     .5564322    .8212847
      EXPER2 |  -.0252594   .0043403    -5.82   0.000    -.0337663   -.0167526
       BLACK |  -.8210685   .2853966    -2.88   0.004    -1.380435   -.2617014
       UNION |   .5444092   .1352284     4.03   0.000     .2793664     .809452
       SOUTH |  -.0413904   .2199264    -0.19   0.851    -.4724382    .3896574
      PUBLIC |  -.2358804    .255716    -0.92   0.356    -.7370746    .2653137
       _cons |  -4.710013   .7186157    -6.55   0.000    -6.118474   -3.301553
-------------+----------------------------------------------------------------
     sigma_u |   2.141408
     sigma_e |  1.9932793
         rho |  .53577993   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store RE
```

Illustration 4 – Question 4.1 – Fixed Effects

```
. xtreg WAGE SCHOOLING EXPER EXPER2 BLACK UNION SOUTH PUBLIC, fe vce(cluster NR)
note: SCHOOLING omitted because of collinearity
note: BLACK omitted because of collinearity

Fixed-effects (within) regression               Number of obs     =      4,360
Group variable: NR                              Number of groups  =        545

R-sq:                                           Obs per group:
     within  = 0.1796                                         min =          8
     between = 0.0090                                         avg =        8.0
     overall = 0.0365                                         max =          8

                                                F(5,544)          =      77.00
corr(u_i, Xb)  = -0.1634                        Prob > F          =     0.0000
```

(continues in the next slide)

Illustration 4 – Question 4.1 – Fixed Effects (cont.)

```
                             (Std. Err. adjusted for 545 clusters in NR)
------------------------------------------------------------------------------
             |               Robust
        WAGE |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   SCHOOLING |          0  (omitted)
       EXPER |   .7007947   .0708028     9.90   0.000     .5617143    .8398751
      EXPER2 |  -.0257947   .0044667    -5.77   0.000    -.0345688   -.0170205
       BLACK |          0  (omitted)
       UNION |   .4541499   .1456477     3.12   0.002     .1680491    .7402507
       SOUTH |   .1959752   .4142672     0.47   0.636    -.6177842    1.009734
      PUBLIC |  -.2332215   .2943376    -0.79   0.428    -.8113989     .344956
       _cons |   2.484219   .2793021     8.89   0.000     1.935577    3.032862
-------------+----------------------------------------------------------------
     sigma_u |  2.5677161
     sigma_e |  1.9932793
         rho |  .62397889   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store FE
```

Illustration 4 – Question 4.1 – Table

```
. estimates table POOLED RE FE, b se
```

Variable	POOLED	RE	FE
SCHOOLING	.61510759	.628984	(omitted)
	.06076525	.05644686	
EXPER	.56371732	.68885842	.70079466
	.06269899	.06756565	.07080282
EXPER2	-.01905164	-.02525943	-.02579468
	.00463736	.00434032	.00446673
BLACK	-.83073193	-.82106847	(omitted)
	.28198564	.28539658	
UNION	.91023283	.54440916	.45414989
	.18019551	.13522841	.14564771
SOUTH	-.15365902	-.0413904	.19597517
	.22797304	.2199264	.41426722
PUBLIC	-.29675722	-.23588045	-.23322146
	.29220754	.25571599	.29433762
_cons	-4.0908448	-4.7100134	2.4842194
	.75957307	.71861566	.27930209

legend: b/se

Illustration 4 – Question 4.1 – Table

```
. estimates table POOLED RE FE,b star(0.1 0.05 0.01)
```

Variable	POOLED	RE	FE
SCHOOLING	.61510759***	.628984***	(omitted)
EXPER	.56371732***	.68885842***	.70079466***
EXPER2	-.01905164***	-.02525943***	-.02579468***
BLACK	-.83073193***	-.82106847***	(omitted)
UNION	.91023283***	.54440916***	.45414989***
SOUTH	-.15365902	-.0413904	.19597517
PUBLIC	-.29675722	-.23588045	-.23322146
_cons	-4.0908448***	-4.7100134***	2.4842194***

legend: * p<.1; ** p<.05; *** p<.01

Illustration 4 – Question 4.2

```
. quietly xtreg WAGE SCHOOLING EXPER EXPER2 BLACK UNION SOUTH PUBLIC, fe
. estimates store FEh
. quietly xtreg WAGE SCHOOLING EXPER EXPER2 BLACK UNION SOUTH PUBLIC
. estimates store REh
. hausman FEh REh

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      FEh          REh         Difference          S.E.
-------------+----------------------------------------------------------------
       EXPER |    .7007947     .6888584        .0119362        .0071876
      EXPER2 |   -.0257947    -.0252594       -.0005353        .0006201
       UNION |    .4541499     .5444092       -.0902593        .0371575
       SOUTH |    .1959752    -.0413904        .2373656        .2146316
      PUBLIC |   -.2332215    -.2358804         .002659        .0638298
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       28.86
                Prob>chi2 =      0.0000
```

→ The hypothesis of random effects is rejected.

Illustration 4 – Question 4.3

```
 . regress D.WAGE D.SCHOOLING D.EXPER D.EXPER2 D.BLACK D.UNION D.SOUTH D.PUBLIC, vce(cluster
NR) nocons
note: D.SCHOOLING omitted because of collinearity
note: D.BLACK omitted because of collinearity

Linear regression                               Number of obs     =      3,815
                                                F(5, 544)         =      64.45
                                                Prob > F          =     0.0000
                                                R-squared         =     0.0288
                                                Root MSE          =     2.3181
```

(continues in the next slide)

Illustration 4 – Question 4.3

```
                                    (Std. Err. adjusted for 545 clusters in NR)
------------------------------------------------------------------------------
             |               Robust
      D.WAGE |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   SCHOOLING |
         D1. |          0  (omitted)
             |
       EXPER |
         D1. |   .6019491    .072804     8.27   0.000     .4589378    .7449605
             |
      EXPER2 |
         D1. |  -.0175666   .0050963    -3.45   0.001    -.0275774   -.0075558
             |
       BLACK |
         D1. |          0  (omitted)
             |
       UNION |
         D1. |    .292697   .1263287     2.32   0.021     .0445452    .5408488
             |
       SOUTH |
         D1. |   .0849769   .3899608     0.22   0.828    -.6810365    .8509903
             |
      PUBLIC |
         D1. |  -.0037897   .1961057    -0.02   0.985    -.3890068    .3814274
------------------------------------------------------------------------------
```

Illustration 4 – Question 4.4

```
. xtreg LWAGE SCHOOLING EXPER EXPER2 c.BLACK##i.YEAR UNION SOUTH PUBLIC, re vce(cluster NR)

…
                              (Std. Err. adjusted for 545 clusters in NR)
------------------------------------------------------------------------------
             |               Robust
       LWAGE |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   SCHOOLING |   .0928925   .0109548     8.48   0.000     .0714214    .1143636
       EXPER |   .1105721    .016444     6.72   0.000     .0783424    .1428018
      EXPER2 |  -.0048039   .0007875    -6.10   0.000    -.0063473   -.0032605
       BLACK |  -.0888817   .0714913    -1.24   0.214     -.229002    .0512386
             |
        YEAR |
      1981   |   .0396178   .0289286     1.37   0.171    -.0170812    .0963169
      1982   |   .0461313   .0350288     1.32   0.188    -.0225238    .1147864
      1983   |   .0321001   .0442559     0.73   0.468    -.0546398      .11884
      1984   |   .0526727   .0565513     0.93   0.352    -.0581658    .1635111
      1985   |   .0778807   .0654343     1.19   0.234    -.0503683    .2061296
      1986   |   .0969979   .0753684     1.29   0.198    -.0507214    .2447171
      1987   |   .1510222   .0856029     1.76   0.078    -.0167565    .3188008
```

(continues in the next slide)

Illustration 4 – Question 4.4 (cont.)

```
YEAR#c.BLACK |
       1981  |   .0272047   .0719625     0.38   0.705    -.1138393    .1682486
       1982  |  -.1121196   .0918991    -1.22   0.222    -.2922386    .0679993
       1983  |  -.0685286   .0846309    -0.81   0.418    -.2344021     .097345
       1984  |  -.0541201   .0818181    -0.66   0.508    -.2144806    .1062405
       1985  |  -.1522521   .0853343    -1.78   0.074    -.3195042    .0150001
       1986  |  -.0376476   .0877731    -0.43   0.668    -.2096796    .1343844
       1987  |  -.1414707   .0807227    -1.75   0.080    -.2996843     .016743
             |
       UNION |   .1084207   .0208784     5.19   0.000     .0674999    .1493416
       SOUTH |  -.0061861   .0317151    -0.20   0.845    -.0683466    .0559745
      PUBLIC |   .0311455    .033775     0.92   0.356    -.0350523    .0973433
       _cons |    .008449   .1567611     0.05   0.957    -.2987971    .3156951
-------------+----------------------------------------------------------------
     sigma_u |  .32792944
     sigma_e |   .3508362
         rho |  .46629073   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Illustration 5 – Model

- Trade-Off theory – optimal / target proportion of debt:

$$MDR_{it}^{*} = x'_{i,t-1}\beta + \eta_{it}$$

- Target adjustment model:

$$MDR_{it} - MDR_{i,t-1} = (1-\gamma)\left(MDR_{it}^{*} - MDR_{i,t-1}\right)$$

  - $0 \leq \gamma \leq 1$
  - Adjustment speed: $1 - \gamma$
    - $\gamma = 0 \Longrightarrow$ Firms adjust immediately and completely
    - $\gamma = 1 \Longrightarrow$ No adjustment

- Econometric model:

$$MDR_{it} = MDR_{i,t-1} + (1-\gamma)\left(x'_{i,t-1}\beta + \eta_{it} - MDR_{i,t-1}\right)$$

$$\vdots$$

$$MDR_{it} = \gamma MDR_{i,t-1} + x'_{i,t-1}\theta + \alpha_i + u_{it}$$

Illustration 5 – Model (cont.)

Aim:

- Estimate γ
- Test whether $H_0\colon \gamma = 1$ (trade-off theory not valid)

Sample:

- 5449 firms observed over the period 1986-2001
- Unbalanced panel
- Source: Compustat Industrial Annual Tapes

Details:

- Verbeek (2008), pp. 383-388

```
. xtset gvkey yeara
       panel variable:  gvkey (unbalanced)
        time variable:  yeara, 1986 to 2001, but with gaps
                delta:  1 unit
```

Illustration 5 – Question 1

```
. xtdescribe

   gvkey:  1003, 1004, ..., 233397                          n =       5449
   yeara:  1986, 1987, ..., 2001                            T =         16
           Delta(yeara) = 1 unit
           Span(yeara)  = 16 periods
           (gvkey*yeara uniquely identifies each observation)

Distribution of T_i:   min      5%     25%       50%       75%     95%     max
                         1       1       1         3         8      14      16

     Freq.  Percent    Cum. |  Pattern
 ---------------------------+------------------
      384      7.05    7.05 |  ...............1
      176      3.23   10.28 |  1111111111111111
      167      3.06   13.34 |  1...............
      149      2.73   16.08 |  ..............1.
      136      2.50   18.57 |  11..............
      132      2.42   20.99 |  ............1...
      131      2.40   23.40 |  .............1..
      113      2.07   25.47 |  111.............
       98      1.80   27.27 |  ...........1....
     3963     72.73  100.00 | (other patterns)
 ---------------------------+------------------
     5449    100.00         |  XXXXXXXXXXXXXXXX
```

Illustration 5 – Question 2

```
. quietly regress mdr L.mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, vce(cluster gvkey)

. estimates store POOLED

. quietly xtreg mdr L.mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, vce(cluster gvkey)

. estimates store RE

. quietly xtreg mdr L.mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, fe vce(cluster gvkey)

. estimates store FE
```

Illustration 5 – Question 2 (cont.)

```
. estimates table POOLED RE FE, b star

-----------------------------------------------------------------
    Variable |    POOLED             RE              FE
-------------+---------------------------------------------------
         mdr |
         L1. |   .8835036***    .78734111***    .53498254***
             |
     ebit_ta | -.03233775***   -.03455703***   -.05003294***
          mb |   .0016432*      .00069052       .00227756*
      dep_ta | -.26051795***   -.30137705***   -.12395444
        lnta | -.00067042       .00183328*      .03803015***
       fa_ta |  .02012146***    .02919991***    .05934357***
      rd_dum |  .00688957**      .0096552***    .00005977
       rd_ta | -.12020508***   -.14520778***   -.06567621*
   indmedian |  .03212249**     .06029162***    .16721793***
       rated |  .00713406*      .01103821**     .02058981***
       _cons |  .05818177***    .03798629**    -.60083475***
-----------------------------------------------------------------
                      legend: * p<0.05; ** p<0.01; *** p<0.001
```

Illustration 5 – Question 3.1

```
. xtivreg mdr (L.mdr=L2.mdr) ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, fd
(…)
------------------------------------------------------------------------------
       D.mdr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         mdr |
         LD. |    7.03303   5.494343     1.28   0.201    -3.735684    17.80174
     ebit_ta |
         D1. |   1.207597   .9705551     1.24   0.213    -.6946564     3.10985
          mb |
         D1. |    .244267   .1853757     1.32   0.188    -.1190627    .6075966
      dep_ta |
         D1. |  -1.858345   1.577202    -1.18   0.239    -4.949603    1.232914
        lnta |
         D1. |  -.5214084   .4557998    -1.14   0.253     -1.41476    .3719429
(…)
------------------------------------------------------------------------------
Instrumented:   L.mdr
Instruments:    ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta indmedian rated
                L2.mdr
------------------------------------------------------------------------------
```

Illustration 5 – Question 3.2

```
. xtabond mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta indmedian rated,
twostep vce(robust)

Arellano-Bond dynamic panel-data estimation  Number of obs         =     15039
Group variable: gvkey                        Number of groups      =      2996
Time variable: yeara
                                             Obs per group:    min =         1
                                                               avg =  5.019693
                                                               max =        14

Number of instruments =    115               Wald chi2(10)         =    212.72
                                             Prob > chi2           =    0.0000
Two-step results
```

(continues in the next slide)

Illustration 5 – Question 3.2 (cont.)

```
                                  (Std. Err. adjusted for clustering on gvkey)
------------------------------------------------------------------------------
             |              WC-Robust
         mdr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         mdr |
         L1. |   .3819695   .0731919     5.22   0.000      .238516     .525423
             |
     ebit_ta |    .035684   .0173522     2.06   0.040     .0016744    .0696936
          mb |   .0147128   .0027217     5.41   0.000     .0093784    .0200472
      dep_ta |   .0648811    .109432     0.59   0.553    -.1496016    .2793639
        lnta |    .030107   .0083243     3.62   0.000     .0137916    .0464224
       fa_ta |   .0150317   .0286987     0.52   0.600    -.0412168    .0712801
      rd_dum |  -.0178784   .0122991    -1.45   0.146    -.0419841    .0062273
       rd_ta |    .001471    .035963     0.04   0.967    -.0690151    .0719571
   indmedian |   .0919917   .0453824     2.03   0.043     .0030439    .1809395
       rated |  -.0066174   .0099448    -0.67   0.506    -.0261088    .0128741
       _cons |  -.4235622   .1467658    -2.89   0.004    -.7112179   -.1359065
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).mdr
        Standard: D.ebit_ta D.mb D.dep_ta D.lnta D.fa_ta D.rd_dum D.rd_ta D.indmedian
                  D.rated
Instruments for level equation
        Standard: _cons
```

Illustration 5 – Question 3.3

```
. xtabond mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta indmedian rated,
twostep maxldep(2) vce(robust)

Arellano-Bond dynamic panel-data estimation  Number of obs          =     15039
Group variable: gvkey                        Number of groups       =      2996
Time variable: yeara
                                             Obs per group:     min =         1
                                                                avg =  5.019693
                                                                max =        14

Number of instruments =      37              Wald chi2(10)          =    179.25
                                             Prob > chi2            =    0.0000
Two-step results
```

(continues in the next slide)

Illustration 5 – Question 3.3 (cont.)

```
                                 (Std. Err. adjusted for clustering on gvkey)
------------------------------------------------------------------------------
             |              WC-Robust
         mdr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         mdr |
         L1. |   .4005973   .0886448     4.52   0.000     .2268567     .574338
             |
     ebit_ta |   .0445636   .0197946     2.25   0.024      .005767    .0833603
          mb |   .0165177    .003106     5.32   0.000     .0104301    .0226053
      dep_ta |   .0832717   .1094867     0.76   0.447    -.1313182    .2978616
        lnta |   .0252836   .0090865     2.78   0.005     .0074744    .0430928
       fa_ta |   .0065411   .0306739     0.21   0.831    -.0535787    .0666608
      rd_dum |  -.0135049   .0122092    -1.11   0.269    -.0374345    .0104248
       rd_ta |   .0015315   .0361632     0.04   0.966    -.0693471      .07241
   indmedian |   .0670826   .0493198     1.36   0.174    -.0295825    .1637477
       rated |  -.0098843   .0101263    -0.98   0.329    -.0297315     .009963
       _cons |  -.3367156   .1575827    -2.14   0.033    -.6455719   -.0278593
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/3).mdr
        Standard: D.ebit_ta D.mb D.dep_ta D.lnta D.fa_ta D.rd_dum D.rd_ta
                  D.indmedian D.rated
Instruments for level equation
        Standard: _cons
```

Illustration 5 – Question 3.4

```
. xtdpdsys mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta indmedian rated,
twostep vce(robust)

System dynamic panel-data estimation          Number of obs       =     19573
Group variable: gvkey                         Number of groups    =      3777
Time variable: yeara
                                              Obs per group:   min =         1
                                                               avg =  5.182155
                                                               max =        15

Number of instruments =    129                Wald chi2(10)       =   2185.15
                                              Prob > chi2         =    0.0000
Two-step results
```

(continues in the next slide)

Illustration 5 – Question 3.4 (cont.)

```
------------------------------------------------------------------------------
             |              WC-Robust
         mdr |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         mdr |
         L1. |   1.030104   .0238744    43.15   0.000     .9833112    1.076897
             |
     ebit_ta |   .1285762    .018583     6.92   0.000     .0921541    .1649983
          mb |   .0312589   .0027109    11.53   0.000     .0259457    .0365722
      dep_ta |  -.1036924   .1374032    -0.75   0.450    -.3729978     .165613
        lnta |  -.0127849   .0068955    -1.85   0.064    -.0262999    .0007301
       fa_ta |  -.1085659   .0327925    -3.31   0.001     -.172838   -.0442939
      rd_dum |  -.0061031   .0153821    -0.40   0.692    -.0362514    .0240452
       rd_ta |   .0759739   .0441006     1.72   0.085    -.0104617    .1624096
   indmedian |  -.2372958   .0400293    -5.93   0.000    -.3157518   -.1588397
       rated |  -.0302876   .0120363    -2.52   0.012    -.0538783    -.006697
       _cons |    .273204   .1269921     2.15   0.031     .0243041     .522104
------------------------------------------------------------------------------
Instruments for differenced equation
        GMM-type: L(2/.).mdr
        Standard: D.ebit_ta D.mb D.dep_ta D.lnta D.fa_ta D.rd_dum D.rd_ta D.indmedian
                  D.rated
Instruments for level equation
        GMM-type: LD.mdr
        Standard: _cons
```

Illustration 5 – Question 4.1

```
. quietly xtabond mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, twostep vce(robust)

. estat abond, artests(3)

(…)

Arellano-Bond test for zero autocorrelation in first-differenced
errors
  +-----------------------+
  |Order |  z      Prob > z|
  |------+-----------------|
  |   1  | -6.206  0.0000 |
  |   2  | -3.587  0.0003 |
  |   3  |-3.3325  0.0009 |
  +-----------------------+
   H0: no autocorrelation
```

There is autocorrelation of order higher than 1: the estimators are not consistent.

Illustration 5 – Question 4.2

```
. quietly xtabond mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, twostep

. estat sargan
Sargan test of overidentifying restrictions
        H0: overidentifying restrictions are valid

        chi2(104)     =  436.3939
        Prob > chi2   =    0.0000
```

The hypothesis of exogenous instruments is rejected: the estimators are not consistent.

Illustration 5 – Question 4.3

```
. quietly xtabond mdr ebit_ta mb dep_ta lnta fa_ta rd_dum rd_ta
indmedian rated, twostep vce(robust)

. test L.mdr=1

 ( 1)  L.mdr = 1

           chi2(  1) =   71.30
         Prob > chi2 =    0.0000
```

The hypothesis that $\gamma = 1$ is rejected, which implies that firms seem to adjust their debt ratios: there is no evidence against the trade-off theory.