Monetary Economics II
Problem Set-Part 2
Learning how to use Compustat

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"Estimate Q Models and Euler Equations for the Capital Stock by panel GMM

(a) First estimate a Q-model of investment using variants of equation 16 in lecture 11. Define Q as the sum of the market value of shares plus debt divided by the value of capital stock. Use the beginning of period Q as the regressor. Then, augment the Q-model with a cash flow variable.

I first regress the Investment rate over the average Q, that I derived as the sum of the market value of shares plus debt divided by the value of capital stock.

In the table below the regression shows that there is a positive effect due to an increase of average Q on the investment rate (0.0021).

HDFE Linear regression
Absorbing 1 HDFE group

Number of obs	=	14,337
F(1, 12409)	=	2267.74
Prob > F	=	0.0000
R-squared	=	0.4330
Adj R-squared	=	0.3450
Within R-sq.	=	0.1545
Root MSE	=	0.2812

irate_w	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
aveq_w L1.	.0021369	.0000449	47.62	0.000	.0020489	.0022248
_cons	.2186627	.0032122	68.07	0.000	.2123662	.2249592

In the table below the regression shows that, when considering an augmented Q model regression, including the cash flow variable, the effect remains positive. It is interesting to notice that the effect of cash flow rate on the investments (positive and statistically significant) might imply that there are some firms in the sample which are financially constrained.

```
HDFE Linear regression                            Number of obs   =     12,281
Absorbing 1 HDFE group                            F(   2,  10486) =    1002.60
                                                  Prob > F        =     0.0000
                                                  R-squared       =     0.4431
                                                  Adj R-squared   =     0.3478
                                                  Within R-sq.    =     0.1605
                                                  Root MSE        =     0.2694

------------------------------------------------------------------------------
     irate_w | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      aveq_w |
         L1. |   .0021045   .0000499    42.16   0.000     .0020067    .0022023
             |
      cf_r_w |
         L1. |   .1576598   .0148045    10.65   0.000     .1286402    .1866795
             |
       _cons |   .2318317   .0036566    63.40   0.000     .2246641    .2389993
------------------------------------------------------------------------------
```

(b)-(c)-(d) Estimate the augmented Q-model using the within estimator (Least Square Dummy Variables estimator). Then estimate the model by GMM using xtabound2 in Stata. In both cases allows for common year effects. Then try both the GMM difference estimator and the system estimator and discuss the relative merits.

I now compute the Least Square Dummy Variables estimator, where I control for the fixed effect of firms and years. The results does not seem to change in a relevant way compared to the previous regressions I derived above.

```
HDFE Linear regression                            Number of obs   =     11,784
Absorbing 2 HDFE groups                           F(   2,   8731) =     798.15
                                                  Prob > F        =     0.0000
                                                  R-squared       =     0.5061
                                                  Adj R-squared   =     0.3335
                                                  Within R-sq.    =     0.1546
                                                  Root MSE        =     0.2744

------------------------------------------------------------------------------
     irate_w | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      aveq_w |
         L1. |   .0020752    .000054    38.43   0.000     .0019694    .0021811
             |
      cf_r_w |
         L1. |   .1288872   .0162847     7.91   0.000     .0969654    .1608091
             |
       _cons |   .2318017   .0039638    58.48   0.000     .2240317    .2395716
------------------------------------------------------------------------------
```

I now compute the one step, two step GMM estimator and the one step and two step system GMM. As shown in the table below the coefficients of Average Q remain positive, meaning that there is a positive relation between investment rate and Average Q.

	GMM 1 step	GMM 2 step	S GMM 1 step	S GMM 2 step
Average Q (t-1)	0.004^{***}	0.003^{***}	0.003^{***}	0.004^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
Cash flow rate (t-1)	0.018	0.148	0.250^{***}	0.194
	(0.218)	(0.160)	(0.075)	(0.127)
Observations	9693	9693	12484	12484

GMM 1 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identification, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment). However the Hansen test suggests that the estimate is robust, but weakened by too many instruments. Overall I can say that the estimation is not robust and instruments are correlated.

```
Arellano-Bond test for AR(1) in first differences: z = -16.32  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.47  Pr > z =  0.142

Sargan test of overid. restrictions: chi2(49)   =  80.67  Prob > chi2 =  0.003
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(49)   =  47.12  Prob > chi2 =  0.550
  (Robust, but weakened by many instruments.)
```

GMM 2 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of both Sargan and Hansen test is rejected, meaning that there is over identification, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment).

```
Arellano-Bond test for AR(1) in first differences: z = -15.22  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.68  Pr > z =  0.093

Sargan test of overid. restrictions: chi2(113)  = 298.47  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(113)  = 163.46  Prob > chi2 =  0.001
  (Robust, but weakened by many instruments.)
```

System GMM 1 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identification, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment).

```
Arellano-Bond test for AR(1) in first differences: z = -16.75  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.46  Pr > z =  0.144

Sargan test of overid. restrictions: chi2(67)   = 176.43  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(67)   =  76.88  Prob > chi2 =  0.192
  (Robust, but weakened by many instruments.)
```

System GMM 2 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identifica-

tion, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment).

```
Arellano-Bond test for AR(1) in first differences: z = -15.85  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -1.40  Pr > z =  0.160

Sargan test of overid. restrictions: chi2(67)   = 176.43  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(67)   =  76.88  Prob > chi2 =  0.192
  (Robust, but weakened by many instruments.)
```

(e) Divide the sample into two types of firms based on whether employment emp is lower or greater than 250. Re-estimate the Q-model allowing the coefficients to be different for small and large firms. We suggest you create a dummy that takes value 1 if a firm in period t has lower than 250 employees and 0 otherwise and estimate heterogeneous effect by interacting the lagged dummy for size with both lagged cash rate and lagged Q. Interpret the results. What can you learn from those regressions (if anything) about the role of financing constraints and under which assumptions?

I now report the results of the regressions after having computed small and large firms, based on the level of employees. There are some interesting fact that are emerging from this regression, in particular when referring to the effect of small firm on cash flow rate. It seems that small firm are financially constrained, as shown by the positive sign (Small × Cash flow rate (t-1)). This intuitively makes sense, as smaller firms are much more financially constrained, compared to larger firms. However this proves to be wrong when looking at the 1 step system GMM. Overall, it seems like small firms are impacted more by financial constraint.

	OLS	GMM 1 step	GMM 2 step	S GMM 1 step	S GMM 2 step
Average Q (t-1)	0.002***	0.001**	0.002*	0.001**	0.001**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Cash flow rate (t-1)	0.136***	0.085	0.110	0.152***	0.162***
	(0.017)	(0.064)	(0.070)	(0.029)	(0.028)
Small × Average Q (t-1)	-0.001***	0.001	0.001	0.001	0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Small × Cash flow rate (t-1)	-0.054***	0.009	0.022	-0.026	0.006
	(0.019)	(0.044)	(0.047)	(0.033)	(0.034)
Constant	0.217***			0.214***	0.202***
	(0.004)			(0.012)	(0.011)
Observations	9456	7484	7484	9693	9693

GMM 1 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identifica-

tion, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment). However the Hansen test suggests that the estimate is robust, but weakened by too many instruments. Overall I can say that the estimation is not robust and instruments are correlated.

```
Arellano-Bond test for AR(1) in first differences: z = -12.67  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.84  Pr > z =  0.004

Sargan test of overid. restrictions: chi2(93)   = 239.94  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(93)   = 105.79  Prob > chi2 =  0.172
  (Robust, but weakened by many instruments.)
```

GMM 2 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identification, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment). However the Hansen test suggests that the estimate is robust, but weakened by too many instruments. Overall I can say that the estimation is not robust and instruments are correlated.

```
Arellano-Bond test for AR(1) in first differences: z = -12.35  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.81  Pr > z =  0.005

Sargan test of overid. restrictions: chi2(93)   = 239.94  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(93)   = 105.79  Prob > chi2 =  0.172
  (Robust, but weakened by many instruments.)
```

System GMM 1 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identification, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment).

```
Arellano-Bond test for AR(1) in first differences: z = -12.80  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.94  Pr > z =  0.003

Sargan test of overid. restrictions: chi2(130)  = 386.18  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(130)  = 152.63  Prob > chi2 =  0.085
  (Robust, but weakened by many instruments.)
```

System GMM 2 step

The null hypothesis of Arellano-Bond test is rejected, meaning that there is correlation between instruments. The null hypothesis of Sargan test is rejected, meaning that there is over identifica-

tion, and thus the instrument is not robust (the instruments are not satisfying the orthogonality conditions required for their employment).

```
Arellano-Bond test for AR(1) in first differences: z = -12.69  Pr > z =  0.000
Arellano-Bond test for AR(2) in first differences: z =  -2.82  Pr > z =  0.005

Sargan test of overid. restrictions: chi2(130)  = 386.18  Prob > chi2 =  0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(130)  = 152.63  Prob > chi2 =  0.085
  (Robust, but weakened by many instruments.)
```

(f) Estimate the Euler equation for capital using the parameters of the lecture notes. See equation (18) in lecture (11). First assume perfect competition, then allow for imperfect competition. Use lecture (11) to figure how you can allow for imperfect competition. Assume a common mark-up across firms for simplicity. Estimate by GMM only. Repeat what you have done for the Q-model in previous part.

The Euler equation for K that I need to estimate, taking into account Cobb-Douglas production function, is the following:

$$\frac{I_t}{K_t} = -\frac{1}{b} + \mathbb{E}_t\left\{\beta\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}\left[\frac{1}{b}\pi_{t+1} + \frac{1}{2}\left(\frac{I_{t+1}}{K_{t+1}}\right)^2 + (1-\delta)\left(\frac{I_{t+1}}{K_{t+1}} + \frac{1}{b}\right)\right]\right\}$$

I first assume the case of **perfect competition**, where I compute the following coefficients running GMM regressions:

- β is the discount rate (I assume it is equal to 0.95)
- δ is the depreciation rate (I assume it is equal to 0.05)
- $\frac{1}{b}$ is the constant
- π_{t+1} is operating income rate
- $\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}$ is equal to CF/K

Table 1: Perfect competition

	GMM 1 step	GMM 2 step	S GMM 1 step	S GMM 2 step
$\frac{\beta}{b}\frac{1+\lambda_{t+1}}{1+\lambda_t}\pi_{t+1}$	0.021	0.025	0.002	0.001
	(0.019)	(0.028)	(0.005)	(0.007)
$\frac{\beta}{2}\frac{1+\lambda_{t+1}}{1+\lambda_t}(\frac{I_{t+1}}{K_{t+1}})^2$	0.031	0.039	0.022	0.003
	(0.160)	(0.183)	(0.102)	(0.083)
$\frac{\beta}{b}\frac{1+\lambda_{t+1}}{1+\lambda_t}$	0.025	0.027	-0.015	-0.025
	(0.043)	(0.078)	(0.017)	(0.036)
Constant			0.273^{***}	0.241^{***}
			(0.020)	(0.015)
Observations	7700	7700	9969	9969

I now assume the case of **imperfect competition**, where I compute the following coefficients running GMM regressions:

- β is the discount rate (I assume it is equal to 0.95)
- δ is the depreciation rate (I assume it is equal to 0.05)
- $\frac{1}{b}$ is the constant
- π_{t+1} is given by $\frac{\alpha}{\mu}\frac{Y_{t+1}}{K_{t+1}}$
- $\frac{(1+\lambda_{t+1})}{(1+\lambda_t)}$ is equal to CF/K
- I assume that the markup μ is equal to 1.3, as suggested by Hall (2018)

Table 2: Imperfect competition

	GMM 1 step	GMM 2 step	S GMM 1 step	S GMM 2 step
$\frac{\beta}{b}\frac{1+\lambda_{t+1}}{1+\lambda_t}\pi_{t+1}$	-0.004	-0.003	-0.006	-0.003
	(0.008)	(0.005)	(0.007)	(0.005)
$\frac{\beta}{2}\frac{1+\lambda_{t+1}}{1+\lambda_t}(\frac{I_{t+1}}{K_{t+1}})^2$	-0.052	-0.081	0.016	0.007
	(0.098)	(0.081)	(0.103)	(0.083)
$\frac{\beta}{b}\frac{1+\lambda_{t+1}}{1+\lambda_t}$	0.009	0.002	-0.015	-0.024
	(0.031)	(0.028)	(0.015)	(0.035)
Constant			0.273^{***}	0.241^{***}
			(0.020)	(0.015)
Observations	7700	7700	9969	9969