```
/*-------------------------------------------------------------------------------
Liquidity-Adjusted Capital Asset Pricing Model
-------------------------------------------------------------------------------
This is the code written in Stata for the Master Thesis: Liquidity and Asset
Prices by Alexander Tazo and Heda Tazojeva. Please note that this code is only
meant for the supervisor, Jørgen Haug, and for the external examiner. Below we
provide the code for our main testing model for the sake of brevity. The full
code is over 5000 lines long and can be provided to the examinisers if they
wish so.
For further questions please contact the following Email:

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*/

* SECTION 4: METHODOLIGY

*-----------------------------------------------------
      * Section 4.1  AMIHUD ILLIQUIDITY RATIO
*-----------------------------------------------------


use "C:\Users\ATazo\Desktop\LCAPM\OriginalData.dta",clear

* drop zero issues
drop if SharesIssue == 0

* Winsorize returns
winsor2 ri, replace

* drop uncessary variables
drop Bid-Last
drop Symbol-SecurityName
drop logRegAdj
drop logReturn
drop Vwap
drop OffTurnover

* drop small stocks
drop if AdjLast < 1
* Declare variables in global macros

global daily_date date // here date is the date variable in the dataset
global monthly_date mofd // mofd is monthly variable in the dataset
global year_date year
global firm_marketcap firm_marketcap
global market_total_cap market_total_cap
global shares_outstanding SharesIssue // replace SharesIssue with actual variable name in
the dataset
global share_price AdjLast // replace AdjLast with actual variable name in the dataset
global firm_id SecuritiyID // replace SecuritiyID with actual variable name in the dataset
global trading_volume OffShareTurnover // replace OffTurnover with actual variable name in
the dataset
global daily_returns returns // replace returns with actual variable name in the dataset

* Create a monthly date in Stata format
gen monthly_date = mofd($daily_date)

* Format the data as monthly data
format monthly_date %tm

gen year =year($daily date)


* Find market capitalization for each firm
gen firm_marketcap = $shares_outstanding * $share_price

* Find market wide capitalizaiton
bys $daily_date: egen market_total_cap = total(firm_marketcap)

```

```
* lag the market_total_cap by one month
preserve
keep monthly_date market_total_cap
bys monthly_date: keep if _n == _N
tsset monthly_date
gen lag_market_total_cap = L.market_total_cap
drop market_total_cap
save temp, replace
restore
merge m:1 monthly_date using temp

* Create the variable PM - the ratio of lagged market value to first value of the market in the sample
sum $daily_date
loc firstDate = `r(min)'
sum market_total_cap if $daily_date == `firstDate'


gen PM = lag_market_total_cap / `r(mean)'
* drop uncessary variables
drop market_total_cap _merge
rm temp.dta




*Generate the dollar volume***
gen float dollar_volume = $trading_volume * $share_price

bys $firm_id monthly_date : gen obs =_N
bys $firm_id monthly_date : egen z = count($daily_returns) if $daily_returns==0
bys $firm_id monthly_date : egen zero = min(z)
gen pzret = zero / obs
drop if pzret>.8 & pzret!=.
drop  z
bys $firm id monthly date : egen sumtrades = count($daily date)
drop if sumtrades<15
drop sumtrades
*Scaled Amihud measure of illiquidity, dollar volume converted into thousands

bys $firm_id $daily_date : gen double illiq = 1000000*(abs($daily_returns)/(dollar_volume)) if dollar volume>0

drop if illiq==.
bys $firm_id monthly_date : egen firm_Amihud = mean(illiq)

* winsorize for extreme values
winsor2 firm_Amihud, replace
drop obs zero pzret


* set the normalizaiton parameters
global ac = .25
global bc = .35
globa maxc = 30

gen c = $ac + ($bc * firm_Amihud) * PM

replace c = min(c, $maxc)

save "C:\Users\ATazo\Desktop\LCAPM\illiq.dta", replace

*-------------------------------------------------------------
      * Section 4.3  PORTFOLIOS CONSTRUCTION AND EVALUATION
*-------------------------------------------------------------
use "C:\Users\ATazo\Desktop\LCAPM\illiq.dta",clear

/*We form 5 illiquidity portfolios for each year y during the period 1998 to 2017 by
sorting stocks with price, at the beginning of the year, excluding only stocks less than
```

```
    NOK 1,
137 and return and volume data in year y - 1 for at least 100 days.
138 */
139
140 * Find annual average illiquidity for each stock
141 bys $firm_id year: egen yearly_ILLIQ = mean(c)
142
143 * Find annual standard deviation of daily illiquidity for each stock
144 bys $firm_id year: egen yearly_SD_ILLIQ = sd(c)
145
146 * Find annual mean of firms market capitalizations
147 bys $firm od year: egen yearly size = mean(firm marketcap)
148
149
150
151 * reduce the data to yearly frequency
152 bys $firm_id year : keep if _n == _N
153
154 * keep relevant variables
155 keep $firm_id year yearly_ILLIQ yearly_SD_ILLIQ
156
157 * lag the illiquidty variable by one year
158 tsset $firm_id year
159
160 gen lag_illiq = L.yearly_ILLIQ
161
162 gen lag_SD_illiq = L.yearly_SD_ILLIQ
163
164 * Make 5 portfolios from the illiquidity and market capitalization
165
166 bys year: astile portf_illiq = lag_illiq, nq(5)
167
168 bys year: astile portf_SD_illiq = lag_SD_illiq, nq(5)
169
170 bys year: astile portf_size = yearly_size, nq(5)
171
172 * save in temporary file
173 save temp, replace
174
175 * Merge with the main data set
176 use "C:\Users\ATazo\Desktop\LCAPM\illiq.dta",clear
177
178 merge m:1  $firm id year using temp
179 drop _merge
180
181 *------------------------------------------------------------------
182       *CREATING TABLE 2 Second Part(All values except Betas)
183 *------------------------------------------------------------------
184
185 * Find monthly returns for each stock
186 bys $firm_id monthly_date: asrol ret, stat(product) add(1) gen(monthly_ret)
187 winsor2 monthly_ret, replace
188
189 * Find yearly sd  for each stock
190 bys $firm_id year: asrol ret, stat(sd)  gen(yearly_sd_firms)
191
192
193 * Find monthly turnover for each stock
194 bys $firm_id monthly_date: asrol $trading_volume, stat(sum) gen(monthly_turnover)
195
196 * winsorize it
197 winsor2 monthly turnover, replace
198
199 * Convert monthly turnover to  millions
200 replace monthly_turnover = monthly_turnover / 10000000
201
202 * reduce the data to monthly frequency
203 bys portf illiq monthly date : keep if  n ==  N
204
205 * Find portfolio returns
```

```
206  bys portf_illiq monthly_date: egen illiq_port_ret = mean(monthly_ret)
207
208  * SD Returns
209  bys portf_illiq monthly_date: egen illiq_port_sd = mean(yearly_sd_firms)
210
211
212  * Find portfolio illiquidity
213  bys portf_illiq monthly_date: egen illiq_port_c = mean(c)
214
215  *Standard deviation of portfolio illiquidity
216  bys portf_illiq monthly_date: egen illiq_sd_c = sd(c)
217
218
219  * Turnover
220  bys portf_illiq monthly_date: egen illiq_port_turn = mean(monthly_turnover)
221
222  * Market cap
223  bys portf illiq monthly date: egen illiq port mktcap = mean(firm marketcap)
224
225  * Convert to millions
226  replace illiq_port_mktcap = illiq_port_mktcap / 1000000000
227
228
229  *Need to substract monthly Risk-free rate from the monthly returns
230  merge m:1 mofd using Risk_free_monthly
231  drop _merge
232  replace monthly_ret = monthly_ret - rf1m
233
234  *-------------------------------------------------------------------
235  *               MARKET ILLIQUIDITY AND MARKET RETURNS
236  *-------------------------------------------------------------------
237
238  *Market illiquidity as a mean of cross-sectional illiquidity
239  bys monthly_date : egen market_illiq =mean(c)
240  replace market_illiq = market_illiq * PM
241
242  *Market Returns- From Ødegård Database(or can just average our monthly returns)
243  *bys monthly_date: egen monthly_rm = mean(monthly_ret)
244
245  merge m:1 monthly_date using MonthlyMarketReturns
246  rename ew monthly_rm_EW
247  rename vw monthly_rm_VW
248
249  drop _merge allshare obx
250
251  *-------------------------------------------------------------------
252  *          Output of Second Part of Table 2
253  *-------------------------------------------------------------------
254  preserve
255  * renma evariables for output
256  ren (illiq_port_c illiq_sd_c illiq_port_ret illiq_port_sd illiq_port_turn illiq_port_mktcap)
     \\\
257  (E(s^p) sigma(s^p) E(r^e,p) sigma(r^p) Turn Size)
258
259  tabstat E(s^p) sigma(s^p) E(r^e,p) sigma(r^p) Turn Size, by(portf_illiq)
260
261  restore
262  save Table2_Part2, replace
263
264  *In next part we need to reshape our portfolios to run estimate our Betas
265  *Application of DVECH MGARCH does not work on panal data.
266
267  * keep only relevant data
268  keep portf_illiq monthly_date year PM market_illiq monthly_rm_EW illiq_port_ret illiq_port_c
      illiq_port_sd illiq_port_turn illiq_port_mktcap
269
270  * Save the data in long format
271
272  save "C:\Users\ATazo\Desktop\LCAPM\portf_illiq_long.dta", replace
273
```

```
use"C:\Users\ATazo\Desktop\LCAPM\portf_illiq_long.dta", clear


preserve
keep if portf_illiq == 1

rename (illiq_port_ret illiq_port_c illiq_port_sd illiq_port_turn illiq_port_mktcap) ///
        (P1_ret P1_c  P1_sd P1_turn P1_mcap)
save p1, replace
restore

drop PM market illiq monthly rm year




forv i = 2 / 5 {
preserve
keep if portf_illiq == `i'
* rename all variables
rename (illiq_port_ret illiq_port_c illiq_port_sd illiq_port_turn illiq_port_mktcap) ///
        (P`i'_ret P`i'_c  P`i'_sd P`i'_turn P`i'_mcap)
 save p`i', replace
restore
}

use "C:\Users\ATazo\Desktop\LCAPM\p1.dta",clear
drop portf_illiq
forv i = 2 / 5 {
merge 1:1 mofd using p`i'
cap drop _merge
cap drop portf_illiq
}

save "C:\Users\ATazo\Desktop\LCAPM\illiq_portf.dta", replace

*-------------------------------------------------------------------------------------
* SECTION 4.4 ESTIMATING INNOVATIONS IN ILLIQUIDITY AND RETURNS USING DVECH MGARCH
*-------------------------------------------------------------------------------------


tsset monthly_date
rename market illiq market illiq raw

*Next we standarize illiquidity in each portfolio

forv p = 1 / 5 {

    gen P`p'_cs = ($maxc - $ac)/($bc * PM)

    replace P`p'_cs = P`p'_c  if  P`p'_cs >= P`p'_c
}
egen market_illiq = rowmean(P*_cs)




*Conditional Covariance of Portfolio Returns with Market- i.e Beta 1 Numerator
    cap drop  h1_* h2_* h3_* h4_*
    mgarch dvech (P1_ret monthly_rm_EW =), arch(1) iterate(100)
    predict h1* if e(sample), variance

    mgarch dvech (P2_ret monthly_rm_EW =), arch(1/2) iterate(100)
    predict h2* if e(sample), variance

    mgarch dvech (P3_ret monthly_rm_EW =), arch(1) iterate(100)
    predict h3* if e(sample), variance

    mgarch dvech (P4_ret monthly_rm_EW =), arch(1) iterate(100)
    predict h4* if e(sample), variance
```

```
343
344         mgarch dvech (P5_ret monthly_rm_EW =), arch(1) iterate(100)
345         predict h5* if e(sample), variance
346
347
348     * Denominator of our Betas  in Equations 11-14
349         gen Rm_PIm = monthly_rm_EW - market_illiq
350
351
352     * The conditional variance
353         mgarch dvech (Rm_PIm =), arch(1) iterate(100)
354         predict v1* if e(sample), variance
355
356
357     *Covariance of Portfolio Illiquidity with Market Illiqudity, i.e Beta 2 Numerator
358         cap drop  p1_* p2_* p3_* p4_*
359
360         forv p = 1 / 5 {
361         mgarch dvech (P`p'_c market_illiq =), iterate(100)  arch(1)
362         predict p`p'* if e(sample), variance
363         }
364
365     *Covariance of Portfolio Return with Market Illiqudity-i.e Beta 3 Numerator
366         forv p = 1 / 5 {
367             mgarch dvech (P`p'_ret market_illiq =),  iterate(100) arch(1)
368             predict rp`p'* if e(sample), variance
369         }
370
371
372     *Covariance of Portfolio illiquidity with Market Returns-i.e Beta 4 Numerator
373         forv p = 1 / 5 {
374             mgarch dvech (P`p'_c monthly_rm_EW =), iterate(100)  arch(1)
375             predict prm`p'* if e(sample), variance
376         }
377
378     *-------------------------------------------------------------------------------
379     *      Constructing Betas for our Illiquidity Sorted Portfolios, i.e Table 2-Part1
380     *-------------------------------------------------------------------------------
381
382
383     *Beta 1 for each portfolio: Covariance of Portfolio returns with market return
384     forv p = 1 / 5 {
385         gen B1 P`p' = h`p' monthly rm P`p' ret / v1 Rm PIm Rm PIm
386     }
387
388     *Beta 2 : Portfolio Illiq and Market Illiq
389
390     forv p = 1 / 5 {
391         gen B2_P`p' = p`p'_market_illiq_P`p'_c / v1_Rm_PIm_Rm_PIm
392     }
393
394     *Beta 3 : Portfolio Returns and Market Illiq
395     forv p = 1 / 5 {
396         gen B3_P`p' = rp`p'_market_illiq_P`p'_ret / v1_Rm_PIm_Rm_PIm
397     }
398
399
400     *Beta 4 : Portfolio Illiq and Market Returns
401     forv p = 1 / 5 {
402         gen B4_P`p' = prm`p'_monthly_rm_P`p'_c / v1_Rm_PIm_Rm_PIm
403     }
404
405     Tabstat B1* B2* B3* B4*
406
407     save Table2_Part1
408
409     *------------------------------END OF TABLR 2---------------------------------
410
411     *-------------------------------------------------------------------------------
412     *  GENERALIZED METHOD OF MOMEMNTS(GMM) REGRESSION FOR MAIN TESTING MODEL- TABLE9
```

```
*-------------------------------------------------------------------------------
*Please note that between the estimation of Betas and until the point of running
*GMM there is a lot of work and different tests, while also the need to bring
*back the Betas into the original file.

bys portf_illiq: egen Ec= mean(illiq_port_c)
egen h = mean( illiq_port_turn)

gen hEc= h*Ec
gen Ret_excess =  illiq_port_ret - hEc
gen B_net= B1 + B2 - B3 - B4


gmm (Ret_excess -      {cons}  -{lambda_net}*(B_net)), inst( B_net) winit(identity)
gmm (illiq_port_ret -  {cons}  -{free_h}*(Ec) - {lambda_net}*(B_net)), inst( B1 B_net Ec)
winit(identity)
gmm (illiq_port_ret -  {cons}  -{lambda_1}*(B1)), inst( B1) winit(identity)
gmm (Ret excess -      {cons}  -{lambda 1}*(B1) - {lambda net}*(B net)), inst( B* B net)
winit(identity)
gmm (illiq_port_ret -  {cons}  -{free_h}*(Ec)  -{lambda_1}*(B1) - {lambda_net}*(B_net)),
inst( B_net B* Ec) winit(identity)
gmm (illiq_port_ret -  {cons}  -{lambda_1}*(B1) - {lambda_net}*(B_net)), inst( B* B_net Ec)
winit(identity)
gmm (Ret_excess -      {cons}  -{lambda_1}*(B1) - {lambda_2}*(B2) + {lambda_3}*(B3)\\\
+ {lambda_4}*(B4)), inst( B*) winit(identity)
gmm (illiq_port_ret -  {cons}  -{free_h}*(Ec) -{lambda1}*(B1) - {lambda_2}*(B2)\\\
 + {lambda3}*(B3) + {lambda_4}*(B4)), inst( B1 B2 B3 B4 Ec) winit(identity)


```