Empirical Studies in Finance
HW 1

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For analyses below, monthly average value weighted returns from Jul. 1963 to Dec. 2014 were used for the returns.

(1)

By running 2-stage GMM with weighting matrix $W = I$ for the first stage, the box below can be obtained. Identity matrix was pre-calculated with MATLAB.

		B/M				
		Q1(Lowest)	Q2	Q3	Q4	Q5(Highest)
Size	Q1(Smallest)	-0.1607 (-1.5663)	-0.0782 (-0.8330)	-0.0067 (-0.0762)	0.0268 (0.3143)	-0.0606 (-0.6350)
	Q2	-0.1476 (-1.5481)	-0.0432 (-0.4899)	0.0014 (0.0165)	0.0132 (0.1582)	-0.1012 (-1.0857)
	Q3	-0.0899 (-1.0099)	-0.0199 (-0.2376)	0.0438 (0.5826)	0.0524 (0.6911)	-0.0362 (-0.4168)
	Q4	-0.0142 (-0.1804)	0.0155 (0.1931)	0.0208 (0.2569)	0.0612 (0.8455)	-0.0419 (-0.4951)
	Q5(Biggest)	0.1727 (2.6969)	0.1542 (2.4193)	0.1820 (2.7952)	0.1746 (2.6757)	0.1019 (1.5077)

By considering t-stats of portfolios, one can find that errors of all Biggest portfolio returns except Biggest and Highest (BIG_HiBM) reject null hypothesis of expected residuals being 0. However, for the other 21 portfolio returns, null hypothesis cannot be rejected. Thus, it can be said that overall GMM fit is quite good.

(2)

The box below contains the test results for the null hypotheses of ①, ②, ③, and ④. Wald test, Likelihood Ratio(L.R.) test, Lagrangian Multiplier(L.M.) test were tested against the null hypotheses.

Test Results				
Test	**Type**	**Statistic**	**Pr > ChiSq**	**Label**
Test0	Wald	976.19	<.0001	b
	L.R.	1012.3	<.0001	b
	L.M.	1012.3	<.0001	b
Test1	Wald	0.29	0.5884	s
	L.R.	0.31	0.5794	s
	L.M.	0.31	0.5794	s
Test2	Wald	123.20	<.0001	h
	L.R.	126.92	<.0001	h
	L.M.	126.92	<.0001	h
Test3	Wald	181.13	<.0001	s,h
	L.R.	191.56	<.0001	s,h
	L.M.	191.56	<.0001	s,h

① $H_0 : b = 0$

Since (p-value < 0.0001), ① can be rejected. Thus, b is not 0.

② $H_0 : s = 0$

Since (p-value ≈ 0.58), ② cannot be rejected. Thus, it cannot be said that s is not 0.

③ $H_0 : h = 0$

Since (p-value < 0.0001), ③ can be rejected. Thus, h is not 0.

④ $H_0 : s = 0, h = 0$

Since (p-value < 0.0001), ④ can be rejected. Thus, s and h are not jointly 0.

(3)

Number of Observations		Statistics for System	
Used	618	**Objective**	0.0761
Missing	0	**Objective*N**	47.0345

GMM Test Statistics			
Test	**DF**	**Statistic**	**Prob**
Overidentifying Restrictions	96	47.03	1.0000

"Objective * N" in the box above denotes the Hansen's J test statistics whose null hypothesis is that the overidentifying restrictions of the model are valid. Since the p-value is 1.0000, the null hypothesis cannot be rejected. Thus, it can be concluded that given overidentifying restrictions are valid (i.e. not overidentifying).

(4)

The weighting matrix $W = E[xx']^{-1}$ used in Hansen-Jagannathan distance corresponds to $W = E[RR']^{-1}$ in this case, since the R is a payoff of the unit price 1. $W = E[RR']^{-1}$ was pre-calculated via MATLAB.

Number of Observations		Statistics for System	
Used	618	Objective	0.0761
Missing	0	Objective*N	47.0350

GMM Test Statistics			
Test	DF	Statistic	Prob
Overidentifying Restrictions	96	47.03	1.0000

The table above can be obtained by running 2-stage GMM with weighting matrix $W = E[RR']^{-1}$ for the first stage. Since "Objective" corresponds to the value of objective function with estimated parameters, Hansen-Jagannathan distance is 0.0761.

<SAS CODE>

```
proc import datafile = "E:\Downloads\25_Portfolios_5x5_CSV\25_Portfolios_5x5.csv" out = raw_portfolio_data dbms = csv; run;
proc import datafile = "E:\Downloads\F-F_Research_Data_Factors_CSV\F-F_Research_Data_Factors.csv" out = raw_factor_data dbms = csv; run;
proc import datafile = "E:\Downloads\Ret_Squared.xlsx" out = Return_Squared dbms = xlsx; run;
proc import datafile = "E:\Downloads\Identity_Matrix.xlsx" out = Identity_Matrix dbms = xlsx; run;
* "Return_Squared" matrix and "Identity_Matrix" matrix are pre-calculated via MATLAB ;
data raw_data;
merge raw_portfolio_data raw_factor_data;
run;


proc model data = raw_data ;

parms a b s h;
exogenous Mkt_RF SMB HML;
SDF = a + (b * Mkt_RF) + (s * SMB) + (h * HML);

eq.m1 = SDF * (SMALL_LoBM) - 1; eq.m2 = SDF * (ME1_BM2) - 1; eq.m3 = SDF * (ME1_BM3) - 1;
eq.m4 = SDF * (ME1_BM4) - 1; eq.m5 = SDF * (SMALL_HiBM) - 1;
eq.m6 = SDF * (ME2_BM1) - 1; eq.m7 = SDF * (ME2_BM2) - 1; eq.m8 = SDF * (ME2_BM3) - 1;
eq.m9 = SDF * (ME2_BM4) -1; eq.m10 = SDF * (ME2_BM5) - 1;
eq.m11 = SDF * (ME3_BM1) - 1; eq.m12 = SDF * (ME3_BM2) - 1; eq.m13 = SDF * (ME3_BM3) - 1;
eq.m14 = SDF * (ME3_BM4) - 1; eq.m15 = SDF * (ME3_BM5) - 1;
eq.m16 = SDF * (ME4_BM1) - 1; eq.m17 = SDF * (ME4_BM2) - 1; eq.m18 = SDF * (ME4_BM3) - 1;
eq.m19 = SDF * (ME4_BM4) - 1; eq.m20 = SDF * (ME4_BM5) - 1;
eq.m21 = SDF * (BIG_LoBM) - 1; eq.m22 = SDF * (ME5_BM2) - 1; eq.m23 = SDF * (ME5_BM3) - 1;
eq.m24 = SDF * (ME5_BM4) - 1; eq.m25 = SDF * (BIG_HiBM) - 1;

        fit m1 m2 m3 m4 m5 m6 m7 m8 m9 m10 m11 m12 m13 m14 m15 m16 m17 m18 m19 m20 m21 m22 m23 m24 m25 / gmm KERNEL = (BART,13,0) SDATA = Identity_Matrix OUTS = GMM_OUTS MAXITER = 100 NOPRINT ;
run;

fit m1 m2 m3 m4 m5 m6 m7 m8 m9 m10 m11 m12 m13 m14 m15 m16 m17 m18 m19 m20 m21 m22 m23 m24 m25 / gmm KERNEL = (BART,13,0) out = GMM_2stage outest = GMM_2stage_est SDATA=GMM_OUTS OUTS = GMM_OUTS2 MAXITER = 100 ;

                test b ,/ WALD LR LM;
                test s ,/ WALD LR LM;
                test h ,/ WALD LR LM;
                test s,h ,/ WALD LR LM;  * tests whether parameters are jointly equal to 0 ;
run;
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```
proc print data = GMM_OUTS2; run;

proc print data = GMM_2stage_est; run;

proc means data = GMM_2stage N MEAN STD VAR T PRT VARDEF = DF;
 OUTPUT OUT= descriptive_stat_GMM_2stage N= MEAN= T= PRT= /autoname;
run;


*/////////////////////////////////// Hansen-Jagannathan Distance part ///////////////////////////////////////////;


proc model data = raw_data ;
parms a b s h;
exogenous Mkt_RF SMB HML;
SDF = a + (b * Mkt_RF) + (s * SMB) + (h * HML);

eq.m1 = SDF * (SMALL_LoBM) - 1;  eq.m2 = SDF * (ME1_BM2) - 1;  eq.m3 = SDF * (ME1_BM3) - 1;
eq.m4 = SDF * (ME1_BM4) - 1;  eq.m5 = SDF * (SMALL_HiBM) - 1;
eq.m6 = SDF * (ME2_BM1) - 1;  eq.m7 = SDF * (ME2_BM2) - 1;  eq.m8 = SDF * (ME2_BM3) - 1;
eq.m9 = SDF * (ME2_BM4) -1;  eq.m10 = SDF * (ME2_BM5) - 1;
eq.m11 = SDF * (ME3_BM1) - 1;  eq.m12 = SDF * (ME3_BM2) - 1;  eq.m13 = SDF * (ME3_BM3) - 1;
eq.m14 = SDF * (ME3_BM4) - 1;  eq.m15 = SDF * (ME3_BM5) - 1;
eq.m16 = SDF * (ME4_BM1) - 1;  eq.m17 = SDF * (ME4_BM2) - 1;  eq.m18 = SDF * (ME4_BM3) - 1;
eq.m19 = SDF * (ME4_BM4) - 1;  eq.m20 = SDF * (ME4_BM5) - 1;
eq.m21 = SDF * (BIG_LoBM) - 1; eq.m22 = SDF * (ME5_BM2) - 1; eq.m23 = SDF * (ME5_BM3) - 1;
eq.m24 = SDF * (ME5_BM4) - 1; eq.m25 = SDF * (BIG_HiBM) - 1;

        fit m1 m2 m3 m4 m5 m6 m7 m8 m9 m10 m11 m12 m13 m14 m15 m16 m17 m18 m19 m20
m21 m22 m23 m24 m25   /   gmm  KERNEL  =  (BART,13,0)  SDATA  =  Return_Squared  OUTS  =
GMM_Ret_Sq_OUTS MAXITER = 100 NOPRINT ;
run;

fit m1 m2 m3 m4 m5 m6 m7 m8 m9 m10 m11 m12 m13 m14 m15 m16 m17 m18 m19 m20 m21 m22
m23 m24 m25   /   gmm  KERNEL  =  (BART,13,0)  out  =  GMM_2stage_Ret_Sq  outest  =
GMM_2stage_Ret_Sq_est SDATA = GMM_Ret_Sq_OUTS OUTS = GMM_Ret_Sq_OUTS2 MAXITER = 100
;

                test b ,/ WALD LR LM;
                test s ,/ WALD LR LM;
                test h ,/ WALD LR LM;
                test s,h ,/ WALD LR LM;  * tests whether parameters are jointly equal to 0 ;
run;

proc print data = GMM_Ret_Sq_OUTS2; run;

proc print data = GMM_2stage_Ret_Sq_est;  run;
```

```
proc means data = GMM_2stage_Ret_Sq N MEAN STD VAR T PRT VARDEF = DF;
 OUTPUT OUT= des_stat_GMM_2stage_Ret_Sq N= MEAN= T= PRT= /autoname;
run;
```