Department of Economics
School of Art and Science
University of Pennsylvania

Industrial Organization/Homework 2

Mahdi Shahrabi
Collaborated with Anna Schetkina

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1 Question 1

1.1 (a) (b) (c)

I estimate the equation in problem 1 (a) by including only second lags (specification 1) and by including second and third lags (specification 2). Specification 3 is autocorrelated transmitted shocks without fixed effects (the selected $\rho = 0.758$) and specification 4 (the selected $\rho = 1.159$) is autocorrelated transmitted shocks with fixed effects.

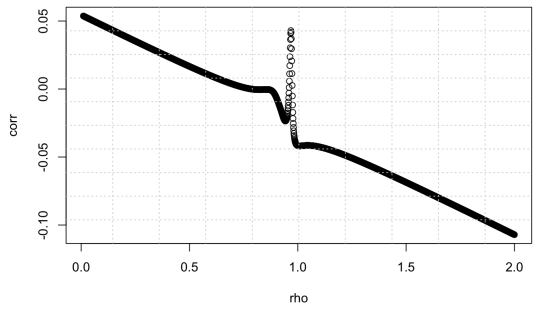


Figure 1: Moment Condition vs ρ for (b)

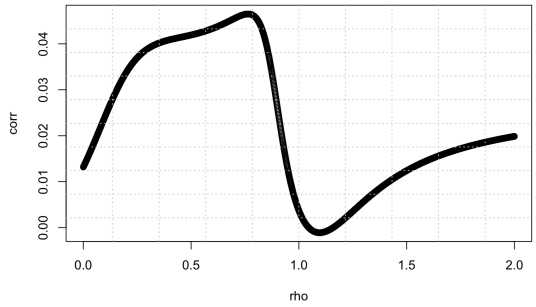


Figure 2: Moment Condition vs ρ for (c)

	(1) IV Regressions with 2L	(2) IV Regressions with 3L	(3) AR Shocks	(4) AR Shocks+FE
lemp	0.221	0.661	0.517***	-1.076
	(0.68)	(1.85)	(3.65)	(-0.25)
ldnpt	0.869**	-0.269	0.439***	4.013
	(2.78)	(-0.68)	(4.54)	(0.56)
ldrst	-0.555	0.409	0.0963	0.221
	(-1.70)	(1.34)	(1.32)	(0.03)
d73	0	0	0	0
	(.)	(.)	(.)	(.)
d78	0	0	0	0
	(.)	(.)	(.)	(.)
d83	-0.633***	0	-0.390***	0
	(-4.46)	(.)	(-11.21)	(.)
d88	0	0	0	0
	(.)	(.)	(.)	(.)
d357_73	0	0	0	0
	(.)	(.)	(.)	(.)
d357_78	0	0	0	0
	(.)	(.)	(.)	(.)
d357_83	1.471***	0	0.853***	0
	(13.80)	(.)	(16.92)	(.)
d357_88	1.087***	0.903***	0.810***	-0.798
	(10.69)	(8.71)	(15.09)	(-0.75)
_cons	0.474***	0.161	0.820***	1.959
	(4.66)	(1.66)	(10.55)	(0.68)
N	682	214	682	214

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1: Question 1

1.2 (d)

In Table (1), we can the see results for different settings. In specifications (1) and (2) the coefficient on R&D capital and the coefficient on capital is negative, which does not make much of sense. Checking the first stage regression F-statistic, we see that the 2-lagged and 3-lagged inputs are not very good IVs.

Moreover, the results of specification (3) seem much more reasonable suggesting that the assumption of no autocorrelation in the transmitted shock is important. The estimated autocorrelation is $\rho = 0.758$, which is a high coefficient, so ignoring it results in a seriously biased estimates.

Also, specification (4) suggest that nothing is significant. We should notice that including fixed effects makes us use only balanced panel for estimation, reducing the sample size threefold. Moreover, we have to use higher-order lags for estimation which makes them weaker instruments. Therefore, in this case, having firm fixed effects creates more problems and makes the inference harder.

2 Question 2

2.1 (a) & (b) & (c)

	(1) h	(2) P	(3) h&P
beta2			
_cons	0.379***	0.403***	0.384***
	(125.92)	(92.99)	(133.29)
beta3			
_cons	0.0414***	0.0327**	0.0706***
	(12.56)	(3.07)	(13.71)
b1			
_cons	1.426***	9.903***	-0.628***
	(71.99)	(163.09)	(-5.51)
b2			
_cons	-0.131***	-7.394***	0.272**
	(-21.72)	(-49.78)	(3.03)
b3			
_cons			1.637***
			(54.08)
b4			
_cons			-0.174***
			(-25.64)
N	1502	1502	1502

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: NLSS

	(1) lemp and dummies
lemp	0.584***
	(44.18)
d73	-0.169***
	(-7.53)
d78	-0.153***
	(-7.35)
d83	-0.220***
	(-10.17)
d88	0
	(.)
d357_73	-3.245***
	(-38.88)
d357_78	-2.037***
	(-35.87)
d357_83	-0.757***
	(-13.16)
d357_88	0.408***
_cons	3.661***
	(65.96)
N	2971

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: For lemp and Dummies

2.2 (d)

As shown in Table 2, the results are almost same in all three specifications. This might be interpreted as additional information brought from exit decisions can substitute for the usual inversion of the investment decision function. Also, the results in Tables 2 and 3 are intuitive. The coefficient on labor is 0.584, and the coefficient on capital is around 0.379. These results are very similar to the results from specification (3) from Problem 1 — the specification that modeled transmitted shocks as AR processes. We can conclude that allowing for a more general process than AR does not add much. And as we have seen in problem 1, allowing for fixed effects even creates additional problems.

3 Appendix

Figure 3: Scan for Codes of Homework 2 in Github!

```
1
2  * UPenn - Fall 2022 - Industrial Organization
3  * Homework 2
4  * September 22th, 2022
5
6  clear all
7  cls
8  cd "/Users/mahdishahrabi/Library/Mobile Documents/com~apple~CloudDocs/PhD/Year 2 - 2022/Term
       3/IO/UPenn_IO_Fall_2022/HW2"
9
10 * Reading Data
11 use "/Users/mahdishahrabi/Library/Mobile Documents/com~apple~CloudDocs/PhD/Year 2 - 2022/
       Term 3/IO/UPenn_IO_Fall_2022/HW2/GMdata.dta"
12 gen d357 = (sic3==357)
13 sort index
14 by index: gen cnt = (_N)
15
16 xtset index yr, delta(5)
17
18
19 *** Modifying Data
20 * Sector and Time Dummy
21 gen d357_73 = (sic3==357) & (yr==73)
22 gen d357_78 = (sic3==357) & (yr==78)
23 gen d357_83 = (sic3==357) & (yr==83)
24 gen d357_88 = (sic3==357) & (yr==88)
25 gen d73 = (yr==73)
26 gen d78 = (yr==78)
27 gen d83 = (yr==83)
28 gen d88 = (yr==88)
29
30 * Making Lagged Values for using as IV
31 sort index yr
32 gen l1_lemp = L1.lemp
33 gen l2_lemp = L2.lemp
34 gen l3_lemp = L3.lemp
35
36 gen l1_ldnpt = L1.ldnpt
37 gen l2_ldnpt = L2.ldnpt
38 gen l3_ldnpt = L3.ldnpt
39
40 gen l1_ldrst = L1.ldrst
41 gen l2_ldrst = L2.ldrst
42 gen l3_ldrst = L3.ldrst
43
44 gen l1_ldsal = L1.ldsal
45 gen l2_ldsal = L2.ldsal
46 gen l3_ldsal = L3.ldsal
47
48 gen l1_ldinv = L1.ldinv
```

```
49
50 ************************    Question 1    ******************************
51
52 * Making panel balances
53 preserve
54
55 ****    (a)    ****
56
57 * Regressions with 2 lagged variables as IV
58 ivregress gmm  D1.ldsal d73 d78 d83 d88 d357_73 d357_78 d357_83 d357_88 (D1.(lemp ldnpt
       ldrst) = l2_lemp l2_ldrst l2_ldnpt), first
59 eststo IV_2L, title("IV Regressions with 2L")
60
61 * Regressions with 3 lagged variables as IV
62 ivregress gmm  D1.ldsal d73 d78 d83 d88 d357_73 d357_78 d357_83 d357_88 (D1.(lemp ldnpt
       ldrst) = l2_lemp l2_ldrst l2_ldnpt l3_lemp l3_ldrst l3_ldnpt), first
63 eststo IV_3L, title("IV Regressions with 3L")
64
65 ****    (b)    ****
66 gen lemp_rho = lemp - 0.785*l1_lemp
67 gen ldnpt_rho = ldnpt - 0.785*l1_ldnpt
68 gen ldrst_rho = ldrst - 0.785*l1_ldrst
69 gen ldsal_rho = ldsal - 0.785*l1_ldsal
70
71
72 * Regressions with 2 lagged variables as IV
73 ivregress gmm ldsal_rho d73 d78 d83 d88 d357_73 d357_78 d357_83 d357_88 (lemp_rho ldnpt_rho
       ldrst_rho = l2_lemp l2_ldrst l2_ldnpt), first
74 eststo IV_b, title("AR Shocks")
75
76 ****    (c)    ****
77 gen lemp_rho2 = (lemp - 1.159*l1_lemp) - (l1_lemp - 1.159*l2_lemp)
78 gen ldnpt_rho2 = (ldnpt - 1.159*l1_ldnpt) - (l1_ldnpt - 1.159*l2_ldnpt)
79 gen ldrst_rho2 = (ldrst - 1.159*l1_ldrst) - (l1_ldrst - 1.159*l2_ldrst)
80 gen ldsal_rho2 = (ldsal - 1.159*l1_ldsal) - (l1_ldsal - 1.159*l2_ldsal)
81
82
83 * Regressions with 2 lagged variables as IV
84 ivregress gmm ldsal_rho2 d73 d78 d83 d88 d357_73 d357_78 d357_83 d357_88 (lemp_rho2
       ldnpt_rho2 ldrst_rho2 = l3_lemp l3_ldrst l3_ldnpt), first
85 eststo IV_c, title("AR Shocks+FE")
86
87 esttab IV_2L IV_3L IV_b IV_c using Q1.tex, replace mtitle rename(D.lemp lemp D.ldnpt ldnpt D
       .ldrst ldrst lemp_rho lemp lemp_rho2 lemp ldnpt_rho ldnpt ldnpt_rho2 ldnpt ldrst_rho
       ldrst ldrst_rho2 ldrst)
88
89 ************************    Question 2    ******************************
90 restore
91
92
93 ****    (a)    ****
94 ****    (i)
95
96 reg ldsal lemp d73 d78 d83 d88 d357_73 d357_78 d357_83 d357_88 c.(ldnpt ldrst ldinv)##c.(
       ldnpt ldrst ldinv)
97 eststo q2_a_i, title("lemp and dummies")
98 esttab q2_a_i using Q2_i.tex,replace mtitle
99
100 ****    (ii)
101 matrix b = e(b)
102 gen pi_hat = (_b[ldnpt]*ldnpt) + (_b[ldrst]*ldrst) + (_b[ldinv]*ldinv) + (_b[ldnpt#ldnpt]*
```

```
    ldnpt*ldnpt) + (_b[ldnpt#ldrst]*ldnpt*ldrst) + (_b[ldnpt#ldinv]*ldnpt*ldinv) + (_b[ldrst
    #ldrst]*ldrst*ldrst) + (_b[ldrst#ldinv]*ldinv*ldrst) + (_b[ldinv#ldinv]*ldinv*ldinv) + (
    _b[_cons])

gen l1_pi_hat = L1.pi_hat
preserve
* Dropping values which are missing

drop if missing(l1_ldnpt)

* NLLS
nl (pi_hat={beta2}*ldnpt + {beta3}*ldrst + {b1}*(l1_pi_hat-{beta2}*l1_ldnpt-{beta3}*l1_ldrst
    ) + {b2}*(l1_pi_hat-{beta2}*l1_ldnpt-{beta3}*l1_ldrst)^2 )
eststo h, title("h^")


****    (b)    ****
restore
sort index yr
by index: gen yr_dif = yr[_n+1] - yr[_n]
gen np = (yr_dif ==5)
replace np = . if yr[_n]==88


* Probit
probit np ldnpt ldrst ldinv
predict P_hat
gen l1_P_hat = L1.P_hat
preserve


* NLLS: P_hat
drop if missing(l1_P_hat)
nl (pi_hat={beta2}*ldnpt + {beta3}*ldrst + {b1}*(l1_P_hat) + {b2}*(l1_P_hat^2))
eststo P, title("P^")

****    (c)    ****


nl (pi_hat={beta2}*ldnpt + {beta3}*ldrst + {b1}*(l1_P_hat) + {b2}*(l1_P_hat^2)+{b3}*(
    l1_pi_hat-{beta2}*l1_ldnpt-{beta3}*l1_ldrst) + {b4}*(l1_pi_hat-{beta2}*l1_ldnpt-{beta3}*
    l1_ldrst)^2)

eststo hp, title("h^ & P^")

esttab h P hp using Q2.tex, replace mtitle
```

IO_HW2

Mahdi Shahrabi (Collaborated with Anna Shchetkina)

9/22/2022

Question 1

```
library(haven)
library(plm)
library(stargazer)
```

```
##
## Please cite as:
##  Hlavac, Marek (2018). stargazer: Well-Formatted Regression and Summary Statistics Tables.
##  R package version 5.2.2. https://CRAN.R-project.org/package=stargazer
```

```
library(AER)
```

```
## Loading required package: car
## Loading required package: carData
## Loading required package: lmtest
## Loading required package: zoo
##
## Attaching package: 'zoo'
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
## Loading required package: sandwich
## Loading required package: survival
```

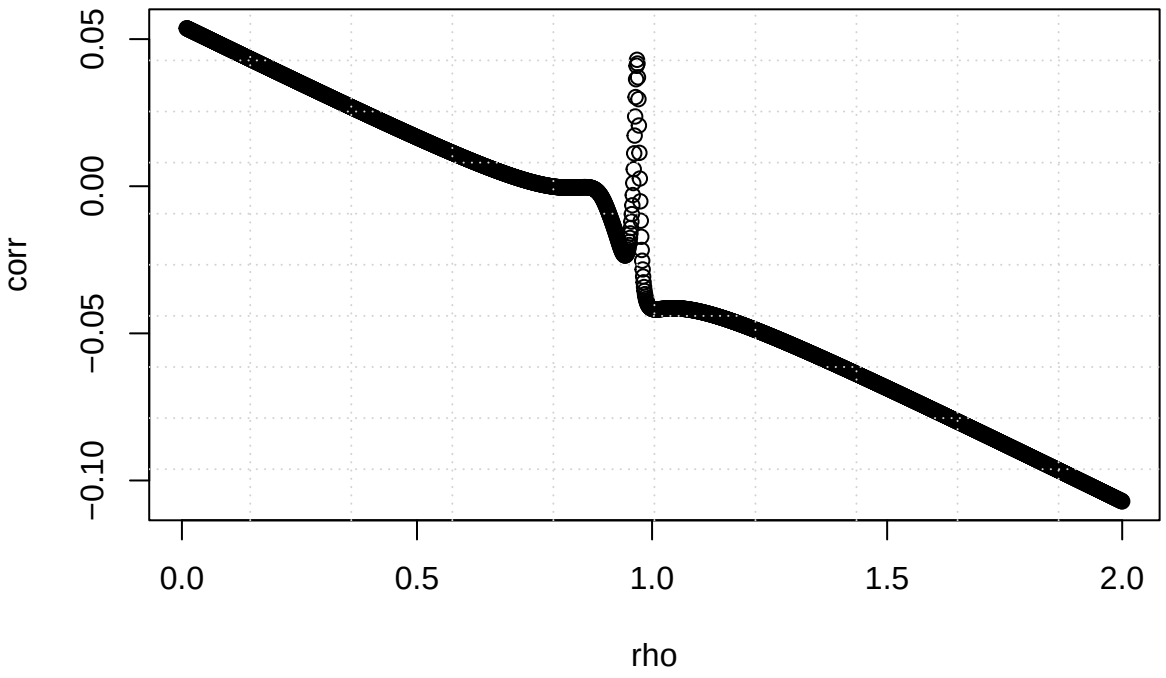
(B)

```
# Reading Data
df<-read_dta('GMdata.dta')
# Set it as panel
data <- pdata.frame(df, index=c("index","yr"))
# Make it balanced
# bdata <- make.pbalanced(data,("shared.individuals"))
bdata <- data

# Making Lagged Values
bdata$L1ldsal <- lag(bdata$ldsal, 5)
```

```
bdata$L2ldsal <- lag(bdata$ldsal, 10)
bdata$L3ldsal <- lag(bdata$ldsal, 15)

bdata$L1lemp <- lag(bdata$lemp, 5)
bdata$L2lemp <- lag(bdata$lemp, 10)
bdata$L3lemp <- lag(bdata$lemp, 15)

bdata$L1ldnpt <- lag(bdata$ldnpt, 5)
bdata$L2ldnpt <- lag(bdata$ldnpt, 10)
bdata$L3ldnpt <- lag(bdata$ldnpt, 15)


bdata$L1ldrst <- lag(bdata$ldrst, 5)
bdata$L2ldrst <- lag(bdata$ldrst, 10)
bdata$L3ldrst <- lag(bdata$ldrst, 15)

# Making time-industry Dummy
bdata$d357_73 <- ifelse(bdata$yr==73 & bdata$sic3==357,1,0)
bdata$L1d357_73<- lag(bdata$d357_73, 5)
bdata$L2d357_73 <- lag(bdata$d357_73, 10)

bdata$d357_78 <- ifelse(bdata$yr==78 & bdata$sic3==357,1,0)
bdata$L1d357_78<- lag(bdata$d357_78, 5)
bdata$L2d357_78 <- lag(bdata$d357_78, 10)

bdata$d357_83 <- ifelse(bdata$yr==83 & bdata$sic3==357,1,0)
bdata$L1d357_83<- lag(bdata$d357_83, 5)
bdata$L2d357_83 <- lag(bdata$d357_83, 10)

bdata$d357_88 <- ifelse(bdata$yr==88 & bdata$sic3==357,1,0)
bdata$L1d357_88 <- lag(bdata$d357_88, 5)
bdata$L2d357_88 <- lag(bdata$d357_88, 10)

# Making Time dummies
bdata$d73 <- ifelse(bdata$yr==73,1,0)
bdata$L1d73<- lag(bdata$d73, 5)
bdata$L2d73 <- lag(bdata$d73, 10)

bdata$d78 <- ifelse(bdata$yr==78,1,0)
bdata$L1d78<- lag(bdata$d78, 5)
bdata$L2d78 <- lag(bdata$d78, 10)

bdata$d83 <- ifelse(bdata$yr==83,1,0)
bdata$L1d83<- lag(bdata$d83, 5)
bdata$L2d83 <- lag(bdata$d83, 10)

bdata$d88 <- ifelse(bdata$yr==88,1,0)
bdata$L1d88<- lag(bdata$d88, 5)
bdata$L2d88 <- lag(bdata$d88, 10)
```

```
R<-seq(0.01,2,0.001)
out<-data.frame()
# bdata<-bdata[!is.na(bdata$L1ldnpt),]
for (rho in R) {
```

```
bdata$ldsal_rho <- (bdata$ldsal - rho*bdata$L1ldsal)
bdata$lemp_rho <- (bdata$lemp - rho*bdata$L1lemp)
bdata$ldnpt_rho <- (bdata$ldnpt - rho*bdata$L1ldnpt)
bdata$ldrst_rho <- (bdata$ldrst - rho*bdata$L1ldrst)

bdata$d73_rho <- (bdata$d73-rho*bdata$L1d73)
bdata$d78_rho <- (bdata$d78-rho*bdata$L1d78)
bdata$d83_rho <- (bdata$d83-rho*bdata$L1d83)
bdata$d88_rho <- (bdata$d88-rho*bdata$L1d88)

bdata$d357_73_rho <- (bdata$d357_73-rho*bdata$L1d357_73)
bdata$d357_78_rho <- (bdata$d357_78-rho*bdata$L1d357_78)
bdata$d357_83_rho <- (bdata$d357_83-rho*bdata$L1d357_83)
bdata$d357_88_rho <- (bdata$d357_88-rho*bdata$L1d357_88)

fit_model <- ivreg(ldsal_rho~lemp_rho+ldnpt_rho+ldrst_rho+d73_rho+d78_rho+d83_rho+d88_rho+d357_73_rho+d
bdata$epsilon <- resid(fit_model)


mc <- cov(na.omit(bdata[c("epsilon","L2ldsal")]))[1,2]
temp <- na.omit(bdata[c("epsilon","L2ldsal")])
mc2 <- abs(mean(temp$epsilon*temp$L2ldsal))

out <- rbind( out,data.frame(rho=rho,corr=mc,corr_abs=abs(mc),mc2=mc2))

}

plot(out[c("rho","corr")])
grid(10,10)
```



```
final<-out[out$corr_abs==min(out$corr_abs),]
final
```

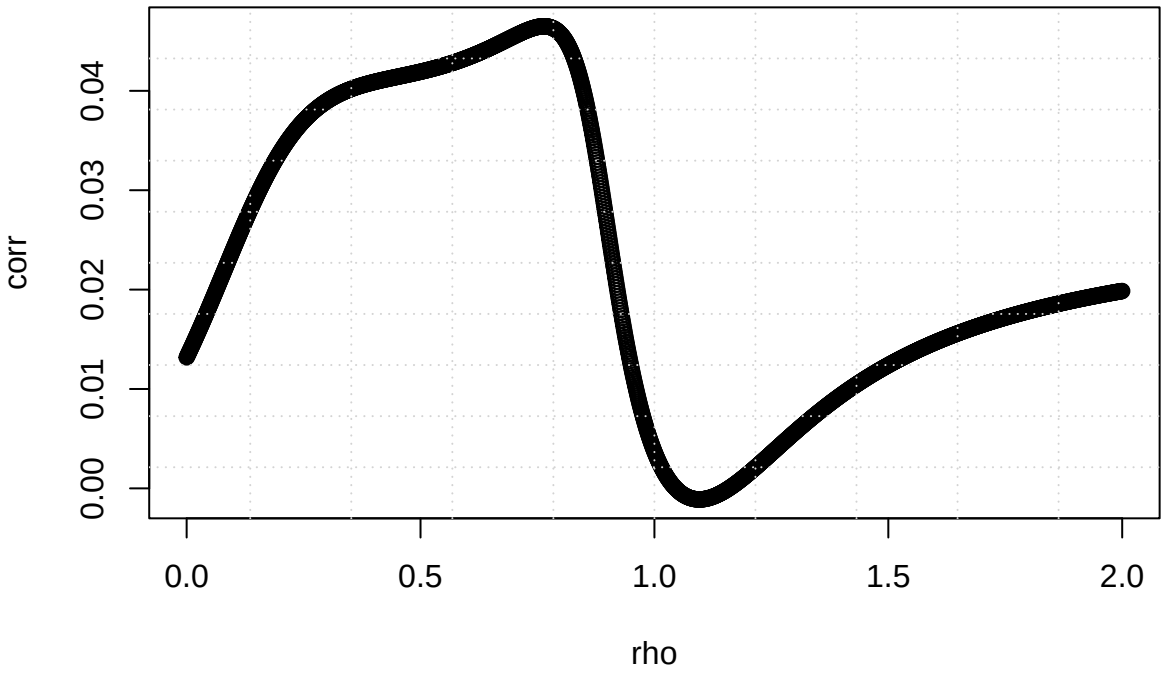
```
##       rho         corr    corr_abs          mc2
## 776 0.785 -7.05121e-07 7.05121e-07 7.040871e-07
```

```
rho<-0.785
bdata$ldsal_rho <- (bdata$ldsal - rho*bdata$L1ldsal)
bdata$lemp_rho <- (bdata$lemp - rho*bdata$L1lemp)
bdata$ldnpt_rho <- (bdata$ldnpt - rho*bdata$L1ldnpt)
bdata$ldrst_rho <- (bdata$ldrst - rho*bdata$L1ldrst)

bdata$d73_rho <- (bdata$d73-rho*bdata$L1d73)
bdata$d78_rho <- (bdata$d78-rho*bdata$L1d78)
bdata$d83_rho <- (bdata$d83-rho*bdata$L1d83)
bdata$d88_rho <- (bdata$d88-rho*bdata$L1d88)

bdata$d357_73_rho <- (bdata$d357_73-rho*bdata$L1d357_73)
bdata$d357_78_rho <- (bdata$d357_78-rho*bdata$L1d357_78)
bdata$d357_83_rho <- (bdata$d357_83-rho*bdata$L1d357_83)
bdata$d357_88_rho <- (bdata$d357_88-rho*bdata$L1d357_88)

fit_model <- ivreg(ldsal_rho~lemp_rho+ldnpt_rho+ldrst_rho+d73_rho+d78_rho+d83_rho+d88_rho+d357_73_rho+d

summary(fit_model)
```

```
##
## Call:
## ivreg(formula = ldsal_rho ~ lemp_rho + ldnpt_rho + ldrst_rho +
##     d73_rho + d78_rho + d83_rho + d88_rho + d357_73_rho + d357_78_rho +
##     d357_83_rho + d357_88_rho | d73_rho + d78_rho + d83_rho +
##     d88_rho + d357_73_rho + d357_78_rho + d357_83_rho + d357_88_rho +
##     bdata$L2ldsal + bdata$L2lemp + bdata$L2ldnpt + bdata$L2ldrst,
##     data = bdata, na.action = na.exclude)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.696640 -0.130528 -0.006865  0.113970  1.152163
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.82049    0.07577  10.829  < 2e-16 ***
## lemp_rho     0.51703    0.13694   3.776 0.000174 ***
## ldnpt_rho    0.43938    0.08724   5.037 6.09e-07 ***
## ldrst_rho    0.09630    0.06944   1.387 0.165999
## d78_rho      0.49663    0.04306  11.533  < 2e-16 ***
## d357_78_rho -2.40128    0.12369 -19.414  < 2e-16 ***
## d357_83_rho -1.03204    0.07461 -13.832  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2161 on 675 degrees of freedom
## Multiple R-Squared: 0.8589,  Adjusted R-squared: 0.8576
## Wald test: 424.9 on 6 and 675 DF,  p-value: < 2.2e-16
```

(C)

```
R<-seq(0,2,0.001)
out<-data.frame()

for (rho in R) {


bdata$ldsal_rho2 <- (bdata$ldsal - rho*bdata$L1ldsal) - (bdata$L1ldsal - rho*bdata$L2ldsal)
bdata$lemp_rho2 <- (bdata$lemp - rho*bdata$L1lemp) - (bdata$L1lemp - rho*bdata$L2lemp)
bdata$ldnpt_rho2 <- (bdata$ldnpt - rho*bdata$L1ldnpt) - (bdata$L1ldnpt - rho*bdata$L2ldnpt)
bdata$ldrst_rho2 <- (bdata$ldrst - rho*bdata$L1ldrst) - (bdata$L1ldrst - rho*bdata$L2ldrst)


bdata$d73_rho2 <- (bdata$d73-rho*bdata$L1d73)-(bdata$L1d73-rho*bdata$L2d73)
bdata$d78_rho2 <- (bdata$d78-rho*bdata$L1d78)-(bdata$L1d78-rho*bdata$L2d78)
bdata$d83_rho2 <- (bdata$d83-rho*bdata$L1d83)-(bdata$L1d83-rho*bdata$L2d83)
bdata$d88_rho2 <- (bdata$d88-rho*bdata$L1d88)-(bdata$L1d88-rho*bdata$L2d88)

bdata$d357_73_rho2 <- (bdata$d357_73-rho*bdata$L1d357_73)-(bdata$L1d357_73-rho*bdata$L2d357_73)
bdata$d357_78_rho2 <- (bdata$d357_78-rho*bdata$L1d357_78)-(bdata$L1d357_78-rho*bdata$L2d357_78)
bdata$d357_83_rho2 <- (bdata$d357_83-rho*bdata$L1d357_83)-(bdata$L1d357_83-rho*bdata$L2d357_83)
bdata$d357_88_rho2 <- (bdata$d357_88-rho*bdata$L1d357_88)-(bdata$L1d357_88-rho*bdata$L2d357_88)


fit_model <- ivreg(ldsal_rho2~lemp_rho2+ldnpt_rho2+ldrst_rho2+d73_rho2+d78_rho2+d83_rho2+d88_rho2+d357_
bdata$epsilon2 <- resid(fit_model)

mc <- cor(na.omit(bdata[c("epsilon2","L3ldsal")]))[1,2]
temp <- na.omit(bdata[c("epsilon2","L3ldsal")])

out <- rbind( out,data.frame(rho=rho,corr=mc,corr_abs=abs(mc)))
}

plot(out[c("rho","corr")])
grid(10,10)
```




```
final<-out[out$corr_abs==min(out$corr_abs),]
final
```

```
##        rho          corr     corr_abs
## 1160 1.159 -4.061012e-06 4.061012e-06
```

```
rho<-1.159
bdata$ldsal_rho2 <- (bdata$ldsal - rho*bdata$L1ldsal) - (bdata$L1ldsal - rho*bdata$L2ldsal)
bdata$lemp_rho2 <- (bdata$lemp - rho*bdata$L1lemp) - (bdata$L1lemp - rho*bdata$L2lemp)
bdata$ldnpt_rho2 <- (bdata$ldnpt - rho*bdata$L1ldnpt) - (bdata$L1ldnpt - rho*bdata$L2ldnpt)
bdata$ldrst_rho2 <- (bdata$ldrst - rho*bdata$L1ldrst) - (bdata$L1ldrst - rho*bdata$L2ldrst)


bdata$d73_rho2 <- (bdata$d73-rho*bdata$L1d73)-(bdata$L1d73-rho*bdata$L2d73)
bdata$d78_rho2 <- (bdata$d78-rho*bdata$L1d78)-(bdata$L1d78-rho*bdata$L2d78)
bdata$d83_rho2 <- (bdata$d83-rho*bdata$L1d83)-(bdata$L1d83-rho*bdata$L2d83)
bdata$d88_rho2 <- (bdata$d88-rho*bdata$L1d88)-(bdata$L1d88-rho*bdata$L2d88)

bdata$d357_73_rho2 <- (bdata$d357_73-rho*bdata$L1d357_73)-(bdata$L1d357_73-rho*bdata$L2d357_73)
bdata$d357_78_rho2 <- (bdata$d357_78-rho*bdata$L1d357_78)-(bdata$L1d357_78-rho*bdata$L2d357_78)
bdata$d357_83_rho2 <- (bdata$d357_83-rho*bdata$L1d357_83)-(bdata$L1d357_83-rho*bdata$L2d357_83)
bdata$d357_88_rho2 <- (bdata$d357_88-rho*bdata$L1d357_88)-(bdata$L1d357_88-rho*bdata$L2d357_88)


fit_model <- ivreg(ldsal_rho2~lemp_rho2+ldnpt_rho2+ldrst_rho2+d73_rho2+d78_rho2+d83_rho2+d88_rho2+d357_
```

```
summary(fit_model)
```

```
##
## Call:
## ivreg(formula = ldsal_rho2 ~ lemp_rho2 + ldnpt_rho2 + ldrst_rho2 +
##     d73_rho2 + d78_rho2 + d83_rho2 + d88_rho2 + d357_73_rho2 +
```

```
##     d357_78_rho2 + d357_83_rho2 + d357_88_rho2 | d73_rho2 + d78_rho2 +
##     d83_rho2 + d88_rho2 + d357_73_rho2 + d357_78_rho2 + d357_83_rho2 +
##     d357_88_rho2 + bdata$L3ldsal + bdata$L3lemp + bdata$L3ldnpt +
##     bdata$L3ldrst, data = bdata, na.action = na.exclude)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -11.98337  -0.94682  -0.02479   1.06170   6.32130
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    1.8973     2.7739   0.684    0.495
## lemp_rho2     -0.7363     3.7953  -0.194    0.846
## ldnpt_rho2     3.8581     6.7006   0.576    0.565
## ldrst_rho2    -0.5971     6.1459  -0.097    0.923
## d357_78_rho2  -0.6458     0.9895  -0.653    0.515
##
## Residual standard error: 2.021 on 209 degrees of freedom
## Multiple R-Squared: -9.679,  Adjusted R-squared: -9.883
## Wald test: 1.109 on 4 and 209 DF,  p-value: 0.3534
```