

Econ History Assignment 2

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Loading the library

```
library(data.table)
library(fixest)
library(stargazer)
library(aod)
library(readxl)
library(countrycode)
library(pROC)
library(lpirfs)
```

Data

```
jst = fread("../data/JSTdatasetR6.csv")
rec = fread("../data/RecessionDummies.csv")
bvx = fread("../data/bvx_crises_list.csv")
```

Part A

Logit

Estimate a logit model with country fixed effects and with five lags of log changes in Money as a predictor for JST crises and document the results in table.

- Test for joint significance of five lags credit growth.
- Repeat with BVX crisis date
- Used 5-year change in the ratio of credit over GDP predictor

```

jst[, tloans_real := tloans/cpi]
jst[, ln_tloans_real := log(tloans_real),]
jst[, ln_diff_tloans := ln_tloans_real - shift(ln_tloans_real, 1, type = "lag"), by = country]

logit_credit = glm(crisisJST ~
  shift(ln_diff_tloans, 1, type = "lag")
  + shift(ln_diff_tloans, 2, type = "lag")
  + shift(ln_diff_tloans, 3, type = "lag")
  + shift(ln_diff_tloans, 4, type = "lag")
  + shift(ln_diff_tloans, 5, type = "lag")
  + factor(country)
, family = binomial(link = "logit"),
data = jst)

stargazer(logit_credit,
  type = "text",
  align = TRUE,
  omit = c("country"),
  dep.var.labels = c("Crisis (JST)"),
  covariate.labels = c("Log-change Money - T-1",
    "Log-change Money - T-2",
    "Log-change Money - T-3",
    "Log-change Money - T-4",
    "Log-change Money - T-5"))

```

JST Crisis

```

##
## =====
##                               Dependent variable:
##                               -----
##                               Crisis (JST)
## -----
## Log-change Money - T-1          0.367
##                               (1.372)
##
## Log-change Money - T-2          6.742***
##                               (1.224)
##
## Log-change Money - T-3          -0.474
##                               (1.051)
##
## Log-change Money - T-4           0.007
##                               (0.978)
##
## Log-change Money - T-5           1.151
##                               (1.101)
##
## Constant                        -4.697***
##                               (0.725)
## -----

```

```
## Observations                2,333
## Log Likelihood              -306.139
## Akaike Inf. Crit.          658.278
## =====
## Note:                       *p<0.1; **p<0.05; ***p<0.01
```

We now test for the joint significance of the lag variables. A first attempt to challenge the joint significance could be a Wald test. The null hypothesis is that the five lags of credit growth are not jointly significant:

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$$

```
wald.test(
  b = coef(logit_credit), # Coefficients from the full model
  Sigma = vcov(logit_credit), # Variance-covariance matrix of coefficients
  Terms = 2:6 # Indices of lagged predictors in the model
)
```

```
## Wald test:
## -----
##
## Chi-squared test:
## X2 = 35.8, df = 5, P(> X2) = 1e-06
```

Complementary, we can test joint significance with the likelihood ratio chi-square test. This tests consists of comparing the full model with a restricted model without the variables we want to test for. Let's first estimate the restricted model.

```
# Test for joint significance of five lags credit growth.
# We run a restricted model which excludes the five lags of credit growth
restricted_model <- glm(
  formula = crisisJST ~ factor(country),
  data = jst,
  family = binomial(link = "logit")
)
```

Now let's run the LR test.

```
lr_stat <- 2 * (logLik(logit_credit) - logLik(restricted_model))
df <- 5
p_value <- pchisq(lr_stat, df = df, lower.tail = FALSE)
cat("Likelihood Ratio Statistic:", lr_stat, "\n")
```

```
## Likelihood Ratio Statistic: 141.4017
```

```
cat("Degrees of Freedom:", df, "\n")
```

```
## Degrees of Freedom: 5
```

```
cat("P-value:", p_value, "\n")
```

```
## P-value: 9.009139e-29
```

In both cases the p-value is close to 0, which means that we can reject the null hypothesis. Therefore, the five lags jointly contribute significantly to predicting the crisis variable.

```

# We merge
setnames(bvx, "countrycode", "iso")
bv_x = bv_x[, country := NULL]
jst = merge(jst, bv_x, all.x = TRUE, by = c("iso", "year"))

# We regress

logit_bv_x = glm(bv_x_crisis ~
  shift(ln_diff_tloans, 1, type = "lag")
  + shift(ln_diff_tloans, 2, type = "lag")
  + shift(ln_diff_tloans, 3, type = "lag")
  + shift(ln_diff_tloans, 4, type = "lag")
  + shift(ln_diff_tloans, 5, type = "lag")
  + factor(country)
, family = binomial(link = "logit"),
  data = jst)

stargazer(logit_bv_x,
  type = "text",
  align = TRUE,
  omit = c("country"),
  dep.var.labels = c("BVX Crisis"),
  covariate.labels = c("Log-change Money - T-1",
    "Log-change Money - T-2",
    "Log-change Money - T-3",
    "Log-change Money - T-4",
    "Log-change Money - T-5"))

```

BVX Crisis

```

##
## =====
##                               Dependent variable:
##                               -----
##                               BVX Crisis
## -----
## Log-change Money - T-1          -0.476
##                               (0.991)
##
## Log-change Money - T-2          5.284***
##                               (1.104)
##
## Log-change Money - T-3          -0.786
##                               (0.913)
##
## Log-change Money - T-4          -0.046
##                               (0.890)
##
## Log-change Money - T-5          2.210**
##                               (0.933)
##
## Constant                        -4.170***

```

```
##                                (0.592)
##
## -----
## Observations                2,334
## Log Likelihood              -393.046
## Akaike Inf. Crit.          832.092
## =====
## Note:                        *p<0.1; **p<0.05; ***p<0.01
```

```
wald.test(
  b = coef(logit_bvx), # Coefficients from the full model
  Sigma = vcov(logit_bvx), # Variance-covariance matrix of coefficients
  Terms = 2:6 # Indices of lagged predictors in the model
)
```

```
## Wald test:
## -----
##
## Chi-squared test:
## X2 = 30.1, df = 5, P(> X2) = 1.4e-05
```

Conclusion: We reject the null hypothesis, variables are jointly significant and able to predict the output variable. Hence, we get approximately the same result between BVX and JST crises classifications.

GDP ratio Used 5-year change in the ratio of credit over GDP as a predictor

```
jst[, `:=` (gdp_real = gdp/cpi), by = c("country")]
jst[, creditgdp := tloans_real/gdp_real, by = c("country")]
jst[, creditgdpchange := creditgdp - shift(creditgdp, 5, type = "lag")]

logit_gdp = glm(crisisJST ~
  creditgdpchange
  + factor(country)
  ,family = binomial(link = "logit"),
  data = jst)

stargazer(logit_gdp,
  type = "text",
  align = TRUE,
  omit = c("country"),
  dep.var.labels = c("Crisis (JST)"),
  covariate.labels = c("Credit-to-GDP 5Y Change"))
```

```
##
## =====
##                                Dependent variable:
##                                -----
##                                Crisis (JST)
## -----
## Credit-to-GDP 5Y Change        3.413***
##                                (0.866)
##
```

```
## Constant -4.483***
## (0.718)
## -----
## Observations 2,348
## Log Likelihood -318.110
## Akaike Inf. Crit. 674.221
## =====
## Note: *p<0.1; **p<0.05; ***p<0.01
```

Model estimation

ROC test Compare in-sample and out of sample ROC, estimating the model until 1984 and predicting crisis for post-1984 years.

```
# we split data in two
pre1984 = jst[year <= 1984,]
post1984 = jst[year > 1984,]

# we test on our pre-1984 data
logit_1984 = glm(crisisJST ~
  shift(ln_diff_tloans, 1, type = "lag")
  + shift(ln_diff_tloans, 2, type = "lag")
  + shift(ln_diff_tloans, 3, type = "lag")
  + shift(ln_diff_tloans, 4, type = "lag")
  + shift(ln_diff_tloans, 5, type = "lag")
  + country
  ,family = binomial(link = "logit"),
  data = pre1984)

# Predict probabilities for training data (in-sample)
pre1984$predicted_prob <- predict(logit_1984, pre1984, type = "response")

# Predict probabilities for testing data (out-of-sample)
post1984$predicted_prob <- predict(logit_1984, post1984, type = "response")

# Compute ROC curve for in-sample data
roc_in_sample <- roc(pre1984$crisisJST, pre1984$predicted_prob)

## Setting levels: control = 0, case = 1

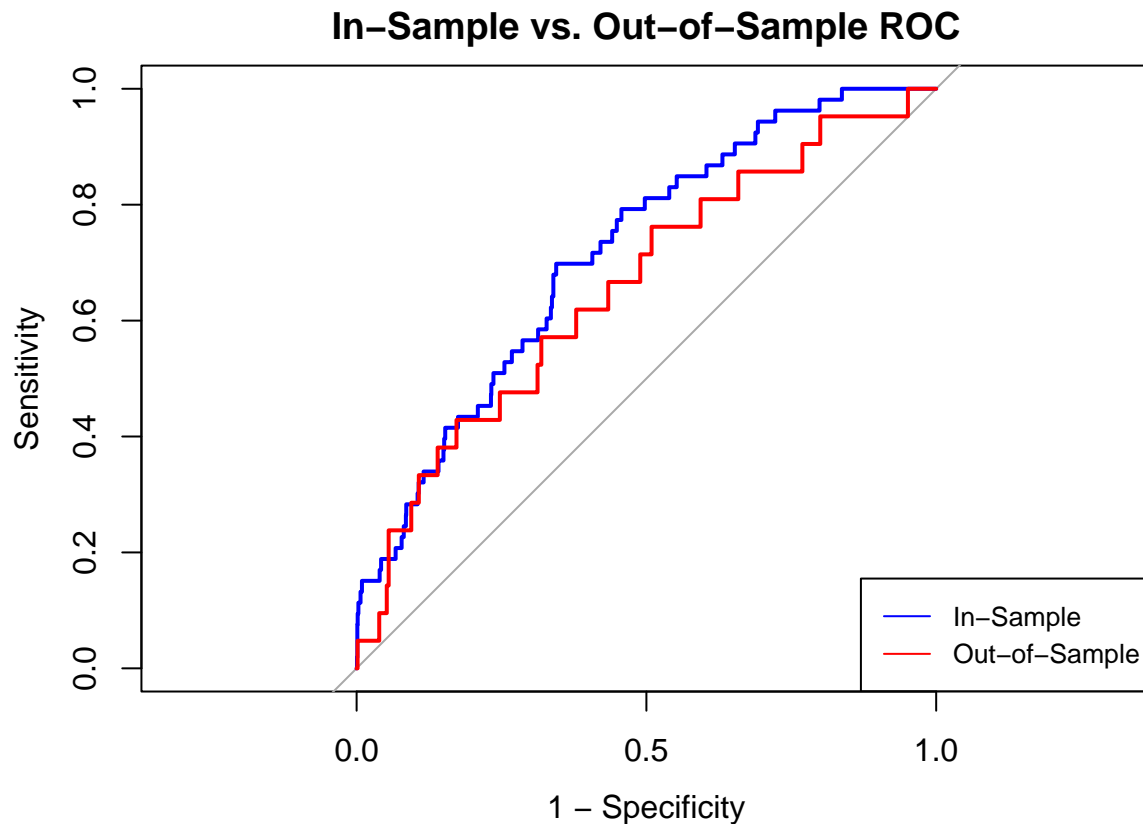
## Setting direction: controls < cases

# Compute ROC curve for out-of-sample data
roc_out_sample <- roc(post1984$crisisJST, post1984$predicted_prob)

## Setting levels: control = 0, case = 1
## Setting direction: controls < cases

# Plot ROC curves
plot(roc_in_sample, col = "blue", main = "In-Sample vs. Out-of-Sample ROC", legacy.axes = TRUE)
plot(roc_out_sample, col = "red", add = TRUE)
```

```
# Add legend
legend("bottomright", legend = c("In-Sample", "Out-of-Sample"),
      col = c("blue", "red"), lty = 1, cex = 0.8)
```



```
# Print AUC values
cat("In-Sample AUC: ", auc(roc_in_sample), "\n")
```

```
## In-Sample AUC: 0.7161041
```

```
cat("Out-of-Sample AUC: ", auc(roc_out_sample), "\n")
```

```
## Out-of-Sample AUC: 0.6581494
```

Money as predictor Compare the baseline model to a logit model with money as a predictor.

```
jst[, money_real := money/cpi]
jst[, ln_money_real := log(money_real),]
jst[, ln_diff_money_real := ln_money_real - shift(ln_money_real, 1, type = "lag"), by = country]

logit_money = glm(crisisJST ~
  shift(ln_diff_money_real, 1, type = "lag")
  + shift(ln_diff_money_real, 2, type = "lag")
```

```

+ shift(ln_diff_money_real, 3, type = "lag")
+ shift(ln_diff_money_real, 4, type = "lag")
+ shift(ln_diff_money_real, 5, type = "lag")
+ factor(country)
,family = binomial(link = "logit"),
data = jst)

stargazer(logit_money,
           type = "text",
           align = TRUE,
           omit = c("country"),
           dep.var.labels = c("Crisis (JST)"),
           covariate.labels = c("Log-change Money - T-1",
                                "Log-change Money - T-2",
                                "Log-change Money - T-3",
                                "Log-change Money - T-4",
                                "Log-change Money - T-5"))

```

```

##
## =====
##                               Dependent variable:
##                               -----
##                               Crisis (JST)
## -----
## Log-change Money - T-1          1.841
##                               (1.728)
##
## Log-change Money - T-2          4.241**
##                               (1.702)
##
## Log-change Money - T-3          -0.692
##                               (1.623)
##
## Log-change Money - T-4          2.127
##                               (1.726)
##
## Log-change Money - T-5          1.703
##                               (1.544)
##
## Constant                        -4.696***
##                               (0.728)
##
## -----
## Observations                    2,399
## Log Likelihood                  -329.416
## Akaike Inf. Crit.              704.833
## =====
## Note:                          *p<0.1; **p<0.05; ***p<0.01

```

```

jst[, diff_debtgdp := debtgdp - shift(debtgdp, 1, type = "lag"), by = c("country")]

```



```
logit_gdp = glm(crisisJST ~
  shift(diff_debtgdp, 1, type = "lag")
+ shift(diff_debtgdp, 2, type = "lag")
+ shift(diff_debtgdp, 3, type = "lag")
+ shift(diff_debtgdp, 4, type = "lag")
+ shift(diff_debtgdp, 5, type = "lag")
+ factor(country)
, family = binomial(link = "logit"),
data = jst)

stargazer(logit_gdp,
  type = "text",
  align = TRUE,
  omit = c("country"),
  dep.var.labels = c("Crisis (JST)"),
  covariate.labels = c("Debt-to-GDP - T-1",
    "Debt-to-GDP - T-2",
    "Debt-to-GDP - T-3",
    "Debt-to-GDP - T-4",
    "Debt-to-GDP - T-5"))
```

Public debt as predictor

```
##
## =====
##               Dependent variable:
##               -----
##               Crisis (JST)
## -----
## Debt-to-GDP - T-1      -1.254
##                        (1.978)
##
## Debt-to-GDP - T-2       0.280
##                        (2.278)
##
## Debt-to-GDP - T-3       1.104
##                        (2.223)
##
## Debt-to-GDP - T-4      -4.237**
##                        (1.777)
##
## Debt-to-GDP - T-5       -0.310
##                        (1.961)
##
## Constant               -4.280***
##                        (0.712)
##
## -----
## Observations           2,328
## Log Likelihood          -323.048
## Akaike Inf. Crit.       692.096
## =====
## Note:                  *p<0.1; **p<0.05; ***p<0.01
```

ROC test

We split again the data before and after 1984 to obtain our ROC test with the newly created variables.

```
pre1984 = jst[year <= 1984,]  
post1984 = jst[year >= 1984,]
```

```
logit_1984 = glm(crisisJST ~  
  shift(ln_diff_money_real, 1, type = "lag")  
  + shift(ln_diff_money_real, 2, type = "lag")  
  + shift(ln_diff_money_real, 3, type = "lag")  
  + shift(ln_diff_money_real, 4, type = "lag")  
  + shift(ln_diff_money_real, 5, type = "lag")  
  + country  
  ,family = binomial(link = "logit"),  
  data = pre1984)  
  
# Predict probabilities for training data (in-sample)  
pre1984$predicted_prob <- predict(logit_1984, pre1984, type = "response")  
  
# Predict probabilities for testing data (out-of-sample)  
post1984$predicted_prob <- predict(logit_1984, post1984, type = "response")  
  
# Compute ROC curve for in-sample data  
roc_in_sample <- roc(pre1984$crisisJST, pre1984$predicted_prob)
```

Money

```
## Setting levels: control = 0, case = 1
```

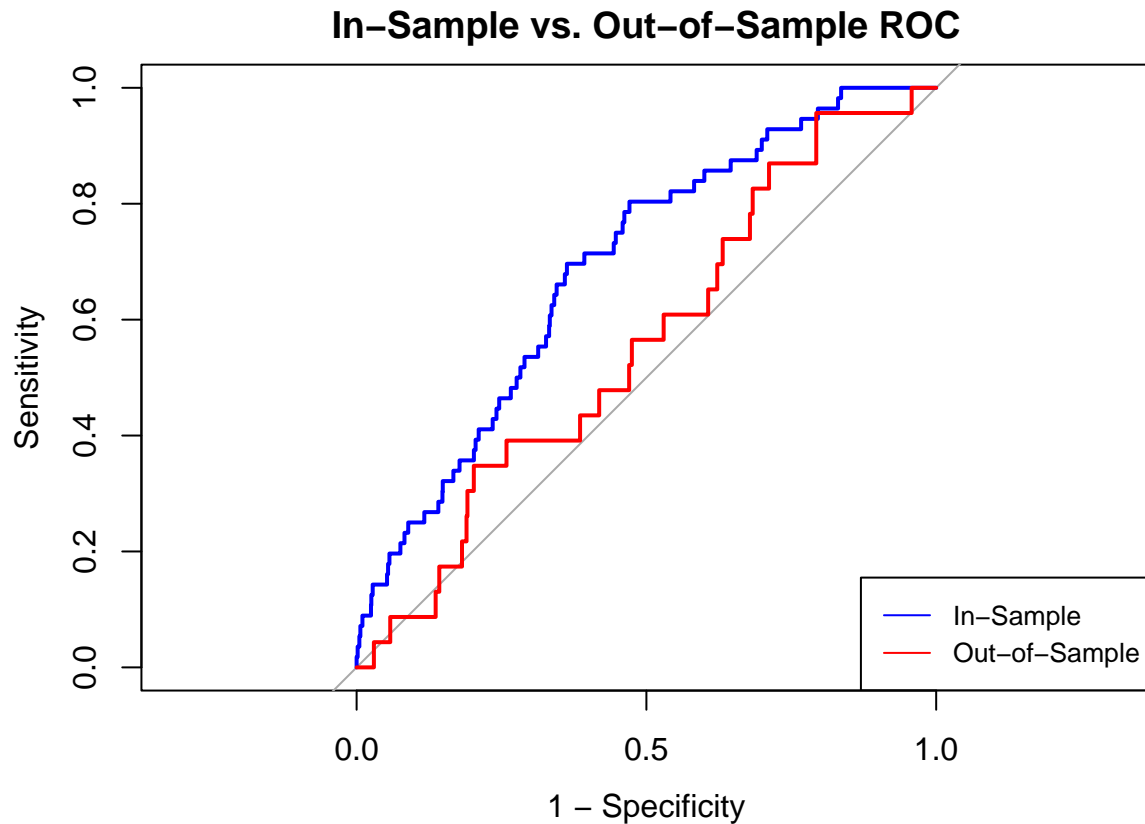
```
## Setting direction: controls < cases
```

```
# Compute ROC curve for out-of-sample data  
roc_out_sample <- roc(post1984$crisisJST, post1984$predicted_prob)
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```
# Plot ROC curves  
plot(roc_in_sample, col = "blue", main = "In-Sample vs. Out-of-Sample ROC", legacy.axes = TRUE)  
plot(roc_out_sample, col = "red", add = TRUE)  
  
# Add legend  
legend("bottomright", legend = c("In-Sample", "Out-of-Sample"),  
  col = c("blue", "red"), lty = 1, cex = 0.8)
```



```
# Print AUC values
cat("In-Sample AUC: ", auc(roc_in_sample), "\n")
```

```
## In-Sample AUC: 0.6912874
```

```
cat("Out-of-Sample AUC: ", auc(roc_out_sample), "\n")
```

```
## Out-of-Sample AUC: 0.5588115
```

```
logit_1984 = glm(crisisJST ~
  shift(diff_debtgdp, 1, type = "lag")
  + shift(diff_debtgdp, 2, type = "lag")
  + shift(diff_debtgdp, 3, type = "lag")
  + shift(diff_debtgdp, 4, type = "lag")
  + shift(diff_debtgdp, 5, type = "lag")
  + country
, family = binomial(link = "logit"),
  data = pre1984)

# Predict probabilities for training data (in-sample)
pre1984$predicted_prob <- predict(logit_1984, pre1984, type = "response")
```

```

# Predict probabilities for testing data (out-of-sample)
post1984$predicted_prob <- predict(logit_1984, post1984, type = "response")

# Compute ROC curve for in-sample data
roc_in_sample <- roc(pre1984$crisisJST, pre1984$predicted_prob)

```

Debt-to-GDP

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```

# Compute ROC curve for out-of-sample data
roc_out_sample <- roc(post1984$crisisJST, post1984$predicted_prob)

```

```
## Setting levels: control = 0, case = 1
```

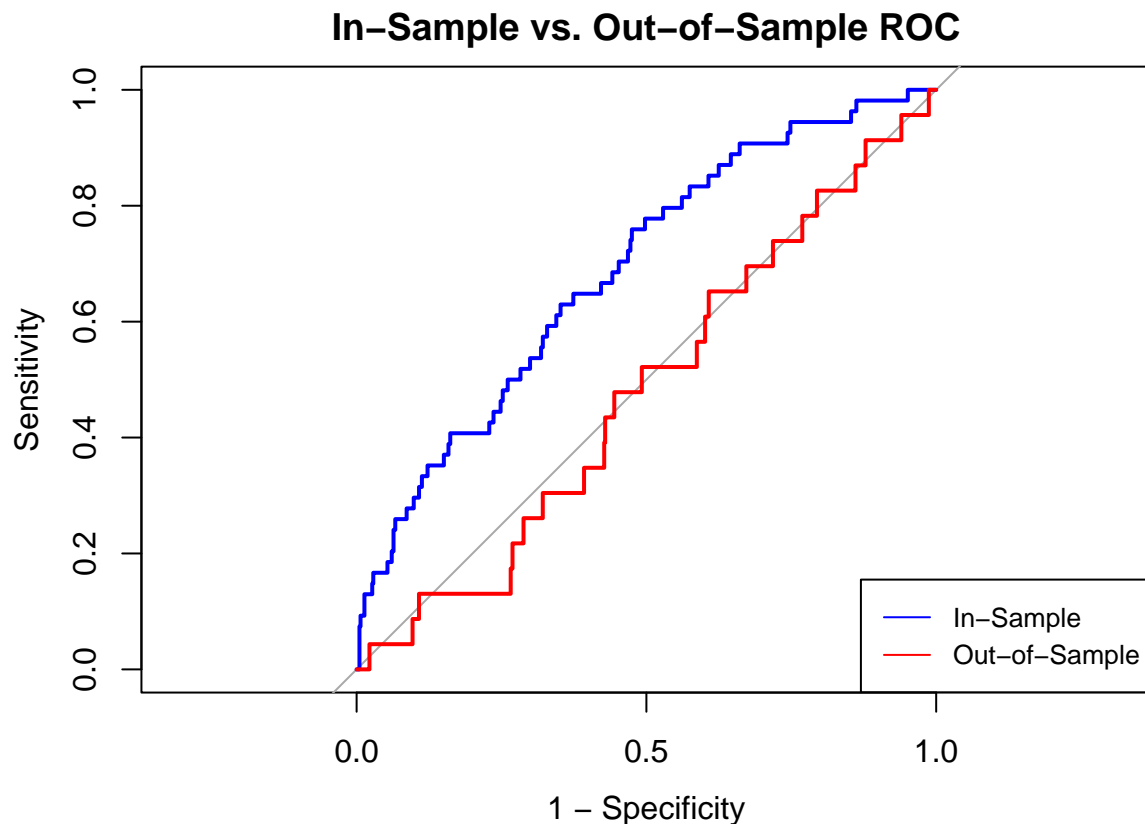
```
## Setting direction: controls > cases
```

```

# Plot ROC curves
plot(roc_in_sample, col = "blue", main = "In-Sample vs. Out-of-Sample ROC", legacy.axes = TRUE)
plot(roc_out_sample, col = "red", add = TRUE)

# Add legend
legend("bottomright", legend = c("In-Sample", "Out-of-Sample"),
      col = c("blue", "red"), lty = 1, cex = 0.8)

```



```
# Print AUC values
cat("In-Sample AUC: ", auc(roc_in_sample), "\n")
```

```
## In-Sample AUC: 0.6879278
```

```
cat("Out-of-Sample AUC: ", auc(roc_out_sample), "\n")
```

```
## Out-of-Sample AUC: 0.4794992
```

Part B - Linear projections

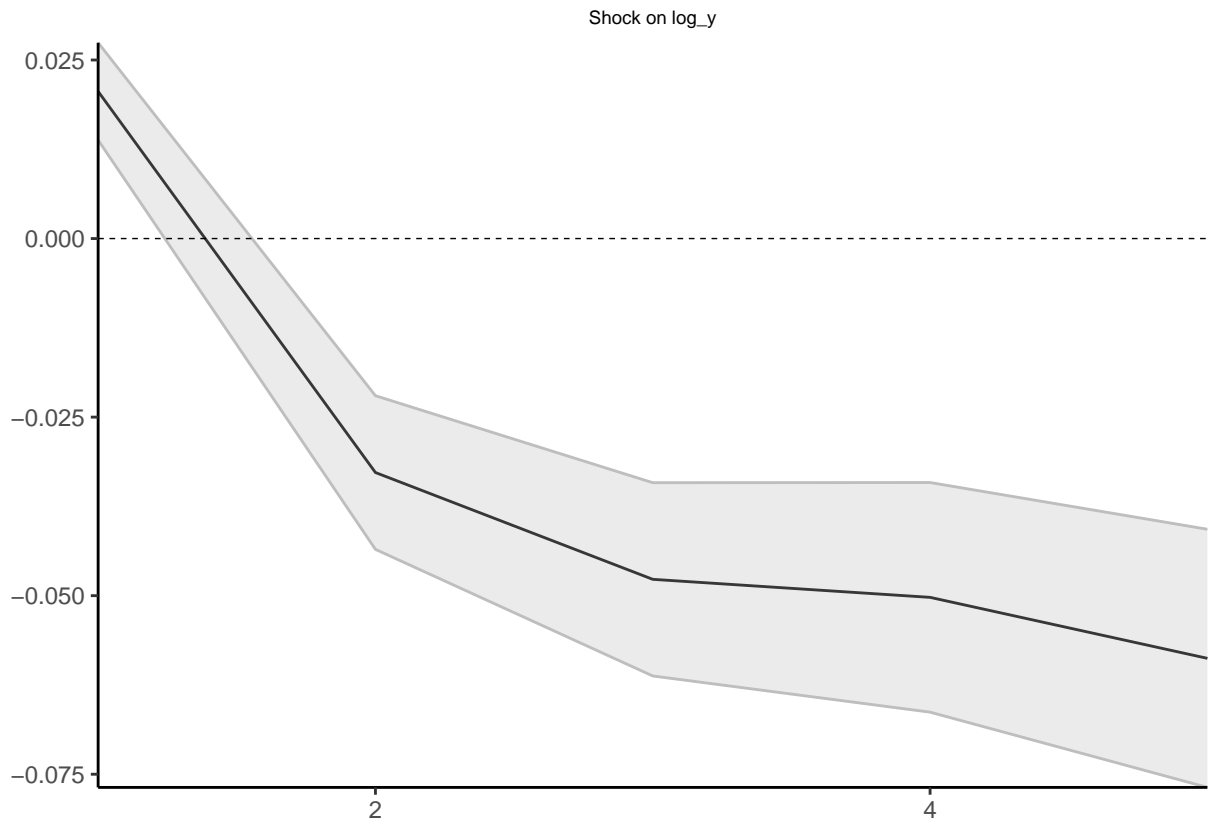
```
jst = merge(jst, rec, by = c("year", "iso"))
jst[, log_y := log(rgdpbarro)]

lp_reg = jst[, .(iso, year, log_y, N, `F`)]
lp_reg[, N := ifelse(is.na(N), 0, N)]
lp_reg[, `F` := ifelse(is.na(`F`), 0, `F`)]
```

Normal Recessions

```
lp_normal <- lp_lin_panel(
  data_set = lp_reg,
  endog_data = "log_y",      # Dependent variable
  cumul_mult = TRUE,         # Cumulative multipliers
  shock = "N",               # Normal recession
  diff_shock = FALSE,        # No differencing of shocks
  c_fd_exog_data = "F",
  panel_model = "within",    # Fixed effects model
  confint = 1.96,             # 95% confidence interval
  hor = 5                     # Horizons: 1 to 5 years
)

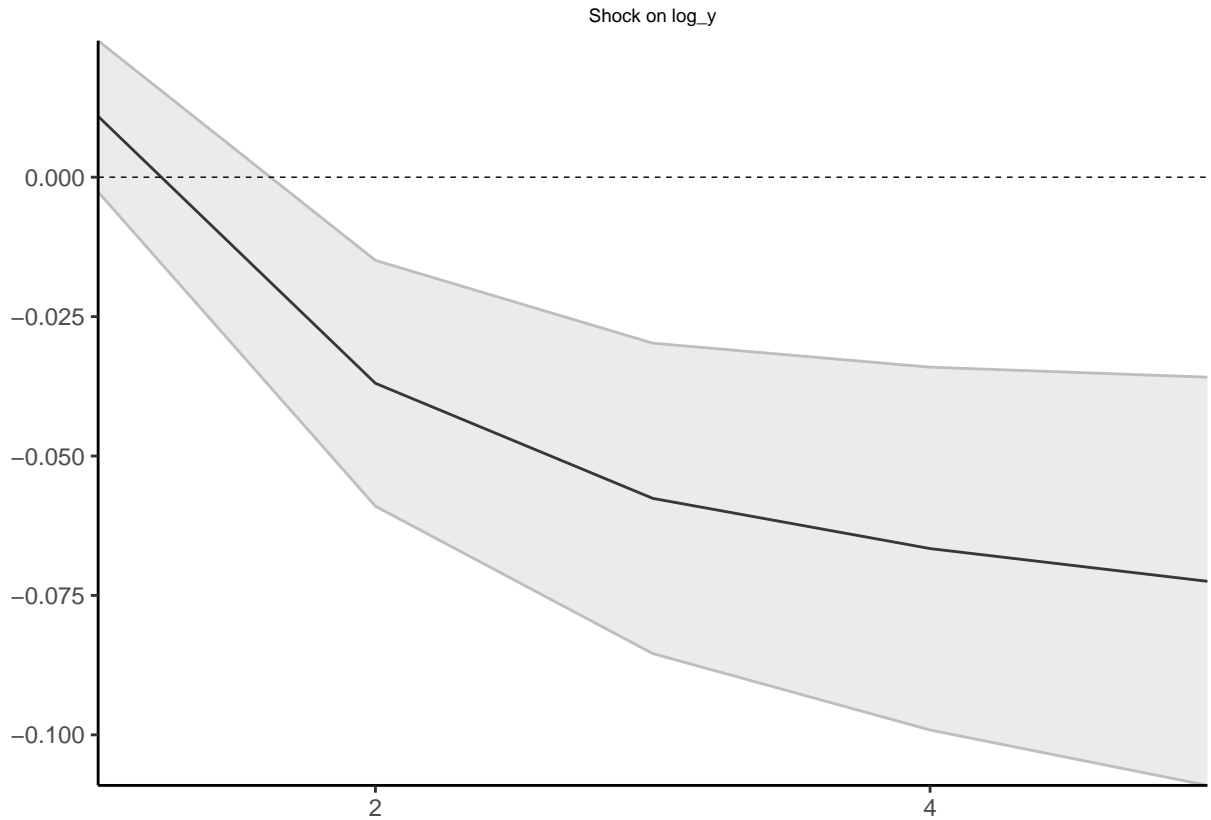
# Plot impulse response functions (IRFs)
plot(lp_normal)
```



Financial Recessions

```
lp_normal <- lp_lin_panel(
  data_set = lp_reg,
  endog_data = "log_y",      # Dependent variable
  cumul_mult = TRUE,        # Cumulative multipliers
  shock = "F",              # Normal recession
  diff_shock = FALSE,       # No differencing of shocks
  c_fd_exog_data = "N",
  panel_model = "within",   # Fixed effects model
  confint = 1.96,           # 95% confidence interval
  hor = 5                   # Horizons: 1 to 5 years
)

# Plot impulse response functions (IRFs)
plot(lp_normal)
```



The graphs reveal key differences in the economic costs of normal and financial recessions over a five-year horizon, with no evidence of recovery in either case. Both types of recessions exhibit a similar initial impact, with GDP per capita dropping sharply at year 1. However, their paths diverge slightly in the following years. In normal recessions, the GDP losses after year 1 remain consistently around -5% to -6% throughout the horizon. In financial recessions, the losses deepen gradually, reaching approximately -7% by year 5. The absence of recovery in both graphs highlights the persistent nature of the economic damage caused by recessions, with financial recessions appearing more costly due to their steadily worsening impact. Overall, the results indicate that neither type of recession allows for meaningful recovery within five years, with financial recessions causing slightly greater and more prolonged economic damage.