Tutorial 3

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QUESTION 1

Motivating the use of Instrumental Variables (IV)

a) In a cross-country regression with average gdpgrowth from 1960-1995 on the LHS and private_credit_1960 on the RHS mention two distinct economic mechanisms why the estimated coefficient might not represent the causal effect of "finance" on subsequent gdp growth.

GDP growth is such a broad phenomenon that it is indeed hard to find causal relationship by just one factor. There can be other factors correlated with private credit affecting GDP growth, which then our estimate of coefficient would be biased. As an example, government may decide to pursue more free-market policies; this free market policies may including strong license requirements, easy company registration policies and provision of more private credit. Presumably, this policy increases GDP growth, so the observed (positive) correlation between GDP growth and private credit reflects other factors as well. Secondly, reverse causality issue may happen here; GDP growth in the country may increase private credit; as output in the economy rises, (I am not sure about the second point, you may change it)

Relating to the lecture slides, we can say that the second mechanism can be that private_credit_1960 variable can be representation for financial development in case of it being in anticipation with future economic growth. Therefore, the financial activity might not represent the causal effect of "finance" on the subsequence gdp growth, but might be leading indicator.

b) Take one of the two mechanisms from a) and use the omitted variable bias formula to determine the direction of the bias introduced. Explain your reasoning.

Taking the first example and looking at the omitted bias formula, we could guess sign of bias in our first regression, where we want to measure effect of finance on GDP growth. As seen, that bias depends on 2 factors, correlation between different free market policies and GDP growth and correlation between free market policies and private credit. Supposedly, both these factors are positive, so then the direction of bias would be upward.

$$\tilde{\beta}_1 = \beta_1 + \beta_2 \delta_{R_i, x_i}$$

c) How could an instrumental variable approach solve the issue of causality?

We can find instrumental variable which can explain exogenous part of private credit. By using exogenous part of private credit, meaning that the part that is uncorrelated with other free market policies, we could then find causal effect of private credit on GDP growth.

QUESTION 2

REGRESSION 1: OLS

a) Run a regression of gdpgrowth on private_credit_1960

Source	SS	df	MS		
Model	.005382947	1	.005382947	Number of obs	= 83
Residual	.045449477	81	.000561105	F(1, 81)	= 9.59
				Prob > F	= 0.0027
Total	.050832424	82	.000619908	R-squared	= 0.1059
				Adj R-squared	= 0.0949
				Root MSE	= .02369

gdpgrowth	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
private_~1960	.0354527	.0114462	3.10	0.003	.0126784	.0582271
_cons	.0076595	.0038916	1.97	0.052	-.0000836	.0154026

With robust

Linear regression

Number of obs	=	83
F(1, 81)	=	10.80
Prob > F	=	0.0015
R-squared	=	0.1059
Root MSE	=	.02369

gdpgrowth	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
private~1960	.0354527	.0107892	3.29	0.002	.0139856	.0569199
_cons	.0076595	.0041493	1.85	0.069	-.0005962	.0159152

b) Very briefly comment on the coefficient of private_credit_1960 and provide a 95% confidence interval for the coefficient.

An increase in private credit to GDP ratio by 1 percentage points leads to 0.035 percentage point increase in GDP growth. 95% confidence interval for the coefficient of private credit is between 0.013 and 0.058. (0.014 and 0.057)

QUESTION 3

The Instruments We now use the national legal origin ([Porta et al., 1998]) of a country as an instrument for its financial development

Set up: Use national legal origin as an instrument for private credit.

b) Compute average private_credit_1960 for each group of legal origin. There are several ways to do this. The variable legor might be useful. Comment your results.

	Mean	Std. err.	[95% conf.	interval]
c.private_credit_1960@Origins				
Common	.2353119	.0552513	.1253994	.3452244
French	.1951101	.0190683	.1571772	.2330431
German	.4901438	.1479131	.1958975	.7843901
Scandinavian	.4786229	.0467151	.3856918	.571554
Socialist	.3475347	.1619722	.0253204	.669749

According to the table, on average, in German civil law countries there is more private credit, followed by Scandinavian law and Socialist countries. On the other hand, French law countries seem to have the lowest share of private credit.

QUESTION 4

Set up: Using french legal origin as an instrument for private credit.

a) Use French legal origin legor_fr as an instrument for private_credit_1960. Compute an IV estimate of the impact of private_credit_1960 on gdpgrowth using the Wald estimator. Explain what you are doing at each step of the calculation.

In order to estimate coefficient of private credit using Wald estimator, firstly we need to calculate an average value (theoretically expected value) of GDP growth for french and non-french legal origins:

	Mean	Std. err.	[95% conf.	interval]
c.gdpgrowth@legor_fr				
0	.0242573	.0034099	.0174739	.0310406
1	.0095311	.0039515	.0016703	.017392

Once we have it we need to find their difference, which is -0.0147262

In the second stage, we need to produce the similar table, but this time for private credit:

	Mean	Std. err.	[95% conf.	interval]
c.private_credit_1960@ legor_fr				
0	.3151728	.0461835	.2232992	.4070464
1	.1951101	.0190683	.1571772	.2330431

Once we have it, we need to find their difference, which is -0.1200627.

Once we have them, we can find coefficient by dividing -0.0147262 to -0.1200627, which is equal to **0.1226542.**

b) Run a Two-Stage-Least-Squares (2SLS) version of Regression 1 using French legal origin legor_fr as an instrument for private_credit_1960.

Instrumental variables 2SLS regression

Number of obs	=	83
Wald chi2(1)	=	4.78
Prob > chi2	=	0.0288
R-squared	=	.
Root MSE	=	.03066

gdpgrowth	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
private_~1960	.122654	.0560942	2.19	0.029	.0127113	.2325967
_cons	-.0143999	.0145838	-0.99	0.323	-.0429837	.0141839

c) Compare the Wald estimate to the 2SLS estimate.

We get the same coefficients.

d) Compare the coefficient on private_credit_1960 to the one in the OLS regression. How does the difference between IV and OLS coefficient compare to your answer in question 1 b)?

Actually, the coefficient of private credit with instrumental variable turned to be higher than that of model without instrumental variable. This observation refutes our answer in part b, which claimed upward bias of simple OLS regression.

e) Provide a 95% confidence interval for the coefficient.

95% confidence interval for the coefficient is from 0.13 to 0.23.

f) Is the model underidentified, exactly identified or overidentified?

In the model, we have one endogenous variable and one instrument (presumably exogeneous), so it is exactly defined. (should we do formal test here???)

g) Test whether legor_fr is a valid instrument. Provide H0, HA, the test statistic, its distribution and the result of the test.

```
Instrumental variables (2SLS) regression          Number of obs   =         83
                                                  Wald chi2(1)    =       4.78
                                                  Prob > chi2     =     0.0288
                                                  R-squared       =          .
                                                  Root MSE        =     .03066
```

gdpgrowth	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
private~1960	.122654	.0560942	2.19	0.029	.0127113	.2325967
_cons	-.0143999	.0145838	-0.99	0.323	-.0429837	.0141839

```
Instrumented:  private_credit_1960
Instruments:   legor_fr
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QUESTION 5

Set up: Using Common law, French civil law, Socialist, and Scandinavian law dummy variables as instrumental variables.

a) Run an 2SLS version of Regression 1 using four out of five legal origin dummies as instruments for private_credit_1960

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Instrumental variables 2SLS regression            Number of obs   =         83
                                                  Wald chi2(1)    =       7.72
                                                  Prob > chi2     =     0.0055
                                                  R-squared       =          .
                                                  Root MSE        =     .02552
```

gdpgrowth	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
private_~1960	.0803088	.0289057	2.78	0.005	.0236547	.1369629
_cons	-.0036878	.0078306	-0.47	0.638	-.0190355	.0116599

```
Instrumented: private_credit_1960
 Instruments: legor_uk legor_fr legor_so legor_sc
```

b**) Why cannot all legal origin dummies be included?**

Because of multicollinearity issues in the first stage regression.

c) Compare the coefficient on private_credit_1960 to the one in question 4 b). Provid a brief comment.

Coefficient in the model is lower than that of model, with one instrumental variable (only french origin).

d) Provide a 95% confidence interval for the coefficient

95% confidence interval for the coefficient of private credit is from 0.024 to 0.14.

e) Is the model underidentified, exactly identified or overidentified?

Assuming that at least of the instruments is exogenous, the model is exactly defined or overdefined.

f) Formally test whether the instruments are valid. Provide H0, HA, the test statistic, its distribution and the result of the test. H)

First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(4,78)	Prob > F
private~1960	0.1820	0.1401	0.1820	4.33977	0.0032

Minimum eigenvalue statistic = 4.33977

Critical Values # of endogenous regressors: 1
Ho: Instruments are weak # of excluded instruments: 4

	5%	10%	20%	30%
2SLS relative bias	16.85	10.27	6.71	5.34

	10%	15%	20%	25%
2SLS Size of nominal 5% Wald test	24.58	13.96	10.26	8.31
LIML Size of nominal 5% Wald test	5.44	3.87	3.30	2.98

According to the table we can not reject the H0-hypothesis (H0: instruments are weak), because our F statistics (4.3) is lower than all threshold required. That means that with tolerance level of 5-, 10-, 20- and 30% of relative bias of OLS regression we can not reject H0-hypothesis.

g) Is the formal test for the exogeneity of instruments useful in this setting?

In our model we have 1 endogenous variable which is private credit, so we need at least 1 exogenous instrument. We think that since we have four instruments this formal testing of exogeneity is not that requiring.

h) Test whether private_credit_1960 is endogenous. Provide H0, HA, the test statistic, its distribution and the result of the test. Why does this matter from an econometric point of view? In your answer, refer to results in previous question(s).

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Tests of endogeneity
Ho: variables are exogenous

Durbin (score) chi2(1)          =  3.50222  (p = 0.0613)
Wu-Hausman F(1,80)              =  3.52435  (p = 0.0641)
```

Durbin score isn't high enough to reject H0-hypothesis. So private credit is not endogenous. From econometric point of view that means we could just do OLS regression.

QUESTION 6

Regression 3: IV with several instruments and several endogenous variables

a) Run an IV version of Regression 1 using four out of five legal origin dummies as instruments for private_credit_1960, but now, add public_banks_1970 as an additional endogenous dependent variable.

```
Instrumental variables (2SLS) regression          Number of obs   =         83
                                                  Wald chi2(2)    =       9.33
                                                  Prob > chi2     =     0.0094
                                                  R-squared       =          .
                                                  Root MSE        =     .02539
```

gdpgrowth	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
private~1960	.0720683	.02952	2.44	0.015	.0142101	.1299264
public_~1970	-.0201259	.0162521	-1.24	0.216	-.0519794	.0117276
_cons	.0095581	.0132331	0.72	0.470	-.0163782	.0354944

```
Instrumented:  private_credit_1960 public_banks_1970
Instruments:   legor_uk legor_fr legor_so legor_sc
```