

EMPIRICAL BANKING AND FINANCE: TUTORIAL № 3

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16.05.2020

Load Data and set WD

```
1 cd "Z:\Downloads"
2 use dataEmpBF_Tutorial3.dta
```

1 Motivating the use of Instrumental Variables (IV)

1.1 Financial development as a leading indicator for subsequent GDP growth

1.1.1 Stock Market Value

The Value of a Stock is determined by the present value of expected future cash flows, when they go up (higher expected GDP growth in the future) the size of the stock market (measured in terms of market capitalisation) increases.

1.1.2 Credit to GDP

When the economic outlook is good then firms invest more and households are likely to make bigger investments, part of these investments will be financed with debt.

On the theoretical side one could connect it to the preference of consumption smoothing, already today agents are going to consume more even so the increase in income will be there in the future. For doing so agents have to increase their debt.

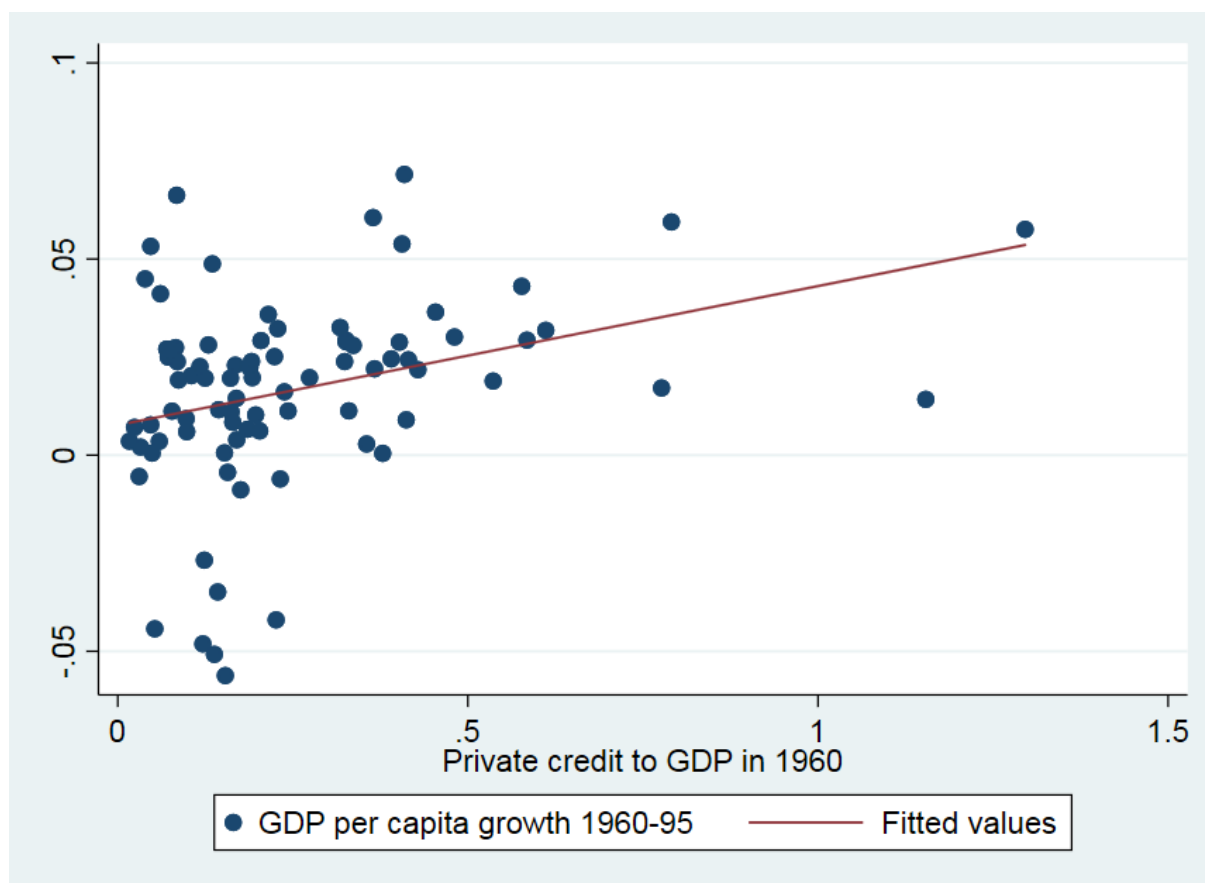
1.2 IV Approach

When we use a valid Instrument for Finance we can be sure that the variation in Finance is not caused by GDP Growth or any other omitted Variable. That way we exclude all relations between Finance and GDP growth except for the one going from Finance to GDP Growth, so the OLS estimate (on the second stage) can be considered as causal.

2 Regression 1: OLS

2.1 Scatterplot GDP growth and private credit

```
1 twoway scatter gdpgrowth private_credit_1960 || lfit gdpgrowth private_↵  
   credit_1960
```



2.2 Regression of GDP growth on private credit with starting GDP level as a control

```
1 reg gdpgrowth private_credit_1960 loggdp_1960, robust
```

```
Linear regression                               Number of obs   =          82  
F(2, 79)                                       =          8.60  
Prob > F                                       =         0.0004  
R-squared                                      =         0.1875  
Root MSE                                       =         .02189
```

gdpgrowth	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
private_credit_1960	.0459333	.011333	4.05	0.000	.0233755	.0684911
loggdp_1960	-.0074107	.0028826	-2.57	0.012	-.0131484	-.0016729
_cons	.0490709	.0161084	3.05	0.003	.0170079	.0811339

2.3 Why control?

```
1 corr private_credit_1960 loggdp_1960
```

	pri~1960	log~1960
private~1960	1.0000	
loggdp_1960	0.3771	1.0000

It makes sense to control for the starting level of GDP per capita since one can expect convergence effects. So we have a relation between subsequent GDP per capita growth and the control variable, besides we see that our control is correlated to our explanatory variable of interest. This implies if we don't include our control variable our estimate for the relationship between Finance and GDP growth would be biased (problem of omitted variable bias).

2.4 Interpretation

The coefficient for private credit in 1960 is highly significant and positive. On average when the private credit to gdp value goes up by one percent point we expect the GDP growth per capita to go up by 0.046 percent points.

The 95 percent confidence interval goes from 0.0234 to 0.0685, zero is not included which means that the coefficient is significant at the 5 percent level (what we already know).

3 The Instrument

3.1 Legal system - a good IV?

The origin of the legal system maybe is not a valid instrumental variable, since it does not only effect the development of the financial system but also the GDP growth via channels other than finance. So the second condition for a valid instrument might be violated, while the first one is very reasonable as the preceeding research shows. Some examples for variables which are important for GDP growth and effected by the legal system are education, probably education is better where the legal system is higher developed. Corruption could be an other example.

3.2 Strength of our IV

In general investors are willing to supply more capital at a lower rate when their rights are better protected (for example the rights of a debt holder are enforced in case of insolvency).

From a theoretical perspective the value of equity is determined by its NPV where state probabilities play an important role. The worse the investor protection the more the probabilities will shift to the bad state and the value of market capitalisation is lower.

For Lenders the rights in case of bankruptcy are very important as well as how likely they are to be enforced, when the legal system is not protecting these rights well debtholders request a higher interest rate and the credit volume is lower.

3.3 Summary statistics of the legal origin variables

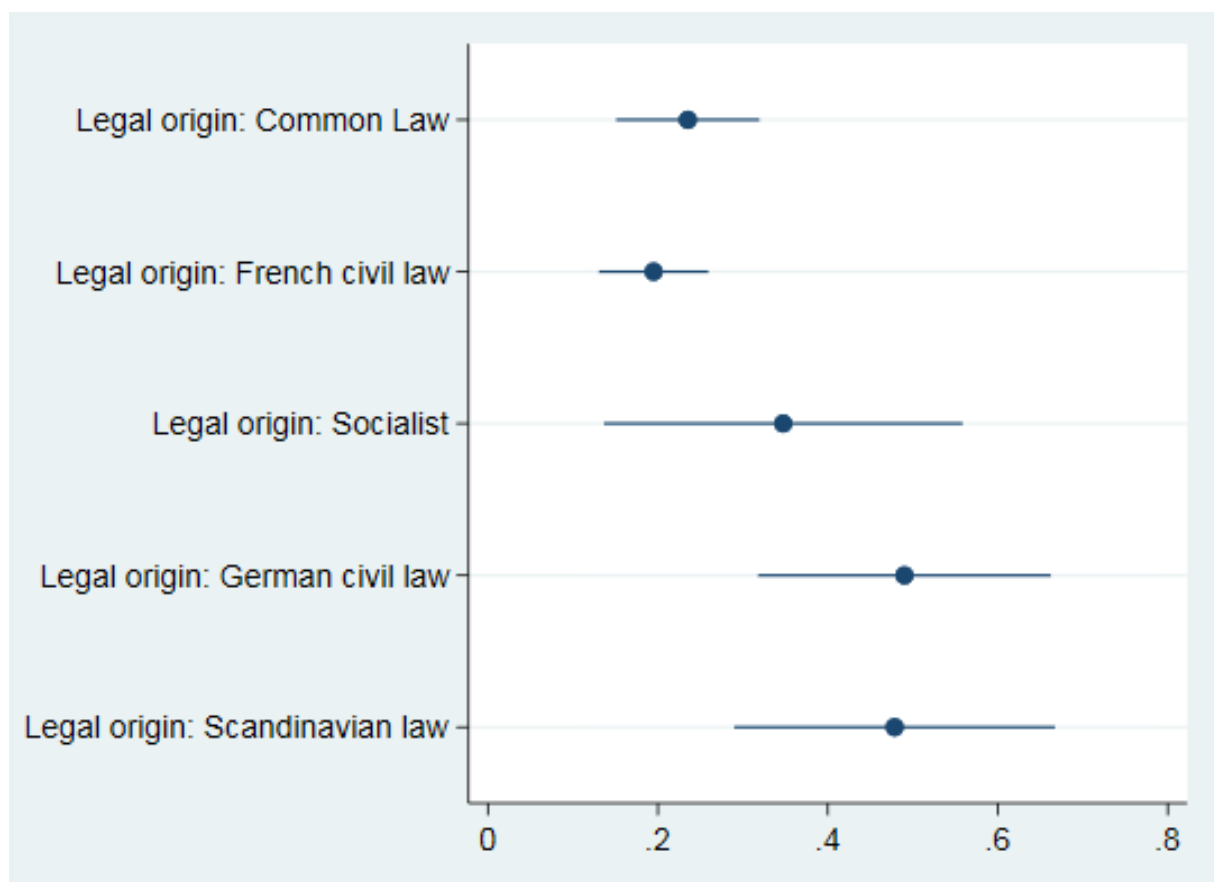
```
1 su legor*
```

Variable	Obs	Mean	Std. Dev.	Min	Max
legor_uk	83	.3012048	.4615705	0	1
legor_fr	83	.5180723	.5027108	0	1
legor_so	83	.0481928	.2154753	0	1
legor_ge	83	.0722892	.2605404	0	1
legor_sc	83	.060241	.2393792	0	1
legor	0				

Since all variables are binary the mean measures the relative share of countries having a particular origin of their legal system. For example, 30 percent of the countries have origin of their legal system in the UK.

3.4 Correlated with variable of interest: Financial development

```
1 ssc install coefplot, replace
2 quietly: reg private_credit_1960 legor_*, noconst
3 coefplot
```



One would desire that the means are different across legal origins, since this implies that our instrument is strong. We observe clear differences in the means across the legal system origins, which indicates that the first assumption for a valid instrument is fulfilled. Besides we see big confidence intervals for all origins but common and french civil law which takes account for the high variance of financial development across countries with the same legal system origin.

4 Regression 2: IV with one instrument

4.1 Regression 1 with `legor_ge` as an instrument

```
1 ivregress 2sls gdpgrowth loggdp_1960 (private_credit_1960 = legor_ge), vce(robust)
```

```
Instrumental variables (2SLS) regression      Number of obs   =      82
Wald chi2(2)                               =      5.33
Prob > chi2                                 =     0.0695
R-squared                                   =      .
Root MSE                                   =     .02627
```

	Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
gdpgrowth						
private_credit_1960	.1175139	.0786977	1.49	0.135	-.0367308	.2717585
loggdp_1960	-.013516	.0064685	-2.09	0.037	-.0261941	-.000838
_cons	.0665602	.0221513	3.00	0.003	.0231445	.109976

```
Instrumented: private_credit_1960
Instruments: loggdp_1960 legor_ge
```

4.2 Comparing IV and OLS estimate

The estimate is still positive and even higher but we should not interpret it since its not significant. This insignificance is probably caused by a bad instrument¹, the share of legal systems with german origin is very low such that we have a very low variance in our predicted values for private credit.

4.3 Confidence interval for private credit

The Conf. Interval goes from -0.0367308 to 0.2717585, it includes zero so the coefficient is not significant.

4.4 Is our model exactly identified?

We have one IV and one endogenous, therefore our model is exactly identified².

¹see first stage estimation statistics below

²stata includes in both stages same controls so in our results it should be over identified. But when we want to estimate conservatively everything is all right

4.5 Tests for valid instrument

```
1 estat firststage
2 estat endog
```

First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	Robust F(1, 79)	Prob > F
private~1960	0.2110	0.1911	0.0802	3.70379	0.0579

Tests of endogeneity

Ho: variables are exogenous

```
Robust score chi2(1)          = 1.89129   (p = 0.1691)
Robust regression F(1, 78)    = 3.34285   (p = 0.0713)
```

- Instrument strength:

When we look at the first stage we see that we can not reject the H_0 that all coefficients are equal to zero at the 5 percent level using a simple F-Test³. We don't have to look on stock-yogo since it's more conservative and will therefore also not reject the H_0 .

- Endogeneity test:

In case of one IV and one endogenous variable its most convenient to use the Durbin test to test the H_0 that private credit is exogenous. The teststatistic is chi-squared distributed. As we can see, observing our teststatistic value or a more extreme value has a probability of over 16 percent under the H_0 , so we can not reject the hypothesis.

5 Regression 2: IV with several instruments

5.1 Regression 1 with all but one dummy as an instruments

```
1 ivregress 2sls gdpgrowth loggdp_1960 (private_credit_1960 = legor_ge legor_uk
   _uk legor_fr legor_so), vce(robust)
```

³teststatistic is F distributed

```
Instrumental variables (2SLS) regression
```

Number of obs	=	82
Wald chi2(2)	=	7.65
Prob > chi2	=	0.0218
R-squared	=	.
Root MSE	=	.02559

gdpgrowth	Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
private_credit_1960	.1117395	.049533	2.26	0.024	.0146567	.2088223
loggdp_1960	-.0130235	.0047082	-2.77	0.006	-.0222515	-.0037955
_cons	.0651494	.0192007	3.39	0.001	.0275166	.1027821

```
Instrumented: private_credit_1960
Instruments: loggdp_1960 legor_uk legor_fr legor_so legor_ge
```

5.2 Why cannot all legal origin dummies be included?

In that case we would run in to problems in the first stage of the estimation. One dummy would always be a linear combination of the constant and the four other dummies (perfect collinearity).

5.3 Compare coefficients of Regression 2 and 3

The coefficient did not change compared to Regression 2 but now it is significant on the 5 percent level due to a stronger stage 1 estimation. A one percent increase in private credit leads to a 0.11 percentpoints higher expected GDP growth per capita.

5.4 95% Conf. Intervall

The 95 percent Confidence Intervall goes from 0.0147 to 0.2088, zero is not included and the coefficient is significant at the five percent level.

5.5 Is the model over identified?

The model is overidentified since we have one endogenous variable and 4 instruments.

5.6 Tests for valid instrument

```
1 estat firststage
2 estat overid
```

```
First-stage regression summary statistics
```

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	Robust F(4, 76)	Prob > F
private~1960	0.2532	0.2041	0.1294	3.35704	0.0138

```
Test of overidentifying restrictions:
```

```
Score chi2(3) = 3.12776 (p = 0.3723)
```

- Instrument strength:

When we look at the first stage we see that we can not reject the H_0 that all coefficients are equal to zero at the 1 percent level using a simple F-Test⁴. We don't have to look on stock-yogo since it's more conservative and will therefore also not reject the H_0 .

- Overidentification test:

Using the chi-squared test by Sargan-Hansen we see that we can not reject the H_0 , that overidentifying restrictions are valid, since the p-value of 37.2 percent is higher than the significance level of 5 or even 10 percent. The H_A would be that not all restrictions are valid.

5.7 Why is the formal test for the exogeneity of instruments useful or not in this setting?

This sort of test makes not much sense in this setup because we have highly correlated instruments. All variables measure the origin.

5.8 Test for endogeneity

```
1 estat endog
```

```
Tests of endogeneity
Ho: variables are exogenous
```

```
Robust score chi2(1)          =  3.44496   (p = 0.0634)
Robust regression F(1,78)     =  6.87689   (p = 0.0105)
```

We can reject⁵ the H_0 that all variables are exogenous. So we stick with the alternative that at least one⁶ variable is endogenous. We can conclude that it was right to use IV instead of OLS.

6 Regression 3: IV with several instruments and several endogenous variables

6.1 Regression 1 with 2 endogenous variables

```
1 ivregress 2sls gdpgrowth loggdp_1960 (private_credit_1960 public_banks_↔
    1970= legor_ge legor_uk legor_fr legor_so), vce(robust)
```

⁴teststatistic is F distributed

⁵at the 10 percent level

⁶here exactly one, since there is just one

Instrumental variables (2SLS) regression	Number of obs	=	82
	Wald chi2(3)	=	10.25
	Prob > chi2	=	0.0165
	R-squared	=	.
	Root MSE	=	.02606

gdpgrowth	Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
private_credit_1960	.1158248	.0514813	2.25	0.024	.0149234	.2167262
public_banks_1970	-.0288516	.0182955	-1.58	0.115	-.0647102	.0070069
loggdp_1960	-.0171429	.0054048	-3.17	0.002	-.0277361	-.0065497
_cons	.1042365	.0314749	3.31	0.001	.0425468	.1659262

Instrumented: private_credit_1960 public_banks_1970
Instruments: loggdp_1960 legor_uk legor_fr legor_so legor_ge

6.2 Interpretation

The coefficient of private credit is nearly unchanged to the previous regression and remains significant at the 5 percent level while the coefficient for public banks is insignificant.

7 Regression 4: Back to OLS

7.1 OLS Regression of GDP growth on legal system origin and private credit

```
1 reg gdpgrowth private_credit_1960 loggdp_1960 legor_uk legor_fr legor_so ↵
    legor_ge, robust
```

Linear regression	Number of obs	=	82
	F(6, 75)	=	4.41
	Prob > F	=	0.0007
	R-squared	=	0.2788
	Root MSE	=	.02117

gdpgrowth	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
private_credit_1960	.0361536	.0113182	3.19	0.002	.0136066	.0587005
loggdp_1960	-.0087616	.0030173	-2.90	0.005	-.0147724	-.0027509
legor_uk	-.007037	.0055718	-1.26	0.211	-.0181367	.0040627
legor_fr	-.0183388	.0064538	-2.84	0.006	-.0311953	-.0054823
legor_so	-.0138444	.0078393	-1.77	0.081	-.0294612	.0017723
legor_ge	.0061037	.0100006	0.61	0.543	-.0138186	.0260259
_cons	.0712299	.0210832	3.38	0.001	.02923	.1132298

7.2 Interpretation

The coefficients for private credit, the starting GDP per capita level, as well as for the differences of french and socialist to scandinavian legal system origin are significant.

- Private credit: A increase of one percent point causes an expected increase of GDP per capita growth of 0.0362 percent points.
- Starting GDP per capita level: A one percent increase in the GDP per capita starting value causes a 0.0088 percent points lower expected GDP per capita growth.

- Legal system origin dummies: Countries with a french legal system origin have a 0.0183 percent points lower expected GDP per capita growth compared with countries with a scandinavian origin. Countries with a socialistic legal system origin have a 0.0138 percent point lower expected GDP per capita growth compared with countries with a scandinavian origin.