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LEGAL ORIGINS, FINANCIAL DEVELOPMENT AND GROWTH: REVISITING THE EVIDENCE IN THE CASE OF WEAK IDENTIFICATION.

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Abstract. This paper reevaluate the strength of legal origins to explain the cross-country difference in financial development, and whether the exogenous component of financial intermediary development influences economic growth. It is found that legal origins are weak instruments. It is shown that even if the cross-country difference in legal and accounting systems helps a little to account for differences in financial development, in most of the cases the positive effects of finance on economic growth is still statistically identifiable.

Introduction

Levine, Loayza and Beck's seminal paper (2000)- henceforth Levine et al.(2000)- has been widely read and has invigorated debate over the relation of financial intermediation and economic growth. A number of researchers have used Levine et al.(2000)'s innovative methods for further research, seen in Levine (2004)'s survey. Even if there is a quite large consensus in the academia debate that financial development (well functioning financial institutions and markets) is a positive determinant of economic growth, Levine et al.(2000)'s endeavor to determine the causal effect of financial institutions on economic performance is difficult as the positive statistical correlation between financial and economic measures may reflect reverse effects of the economy on financial development. Following research by King and Levine (1993), Levine and Zervos (1998), Levine et al. (2000) try to get around the causality issues using an instrumental variable (IV) technique. Levine et al.(2000) argue that cross-country differences in legal systems (e.g., creditor rights, contract enforcement, and accounting standards) explain differences in the level of financial development and that the exogenous component of financial intermediary development is positively associated with economic growth. These findings suggest that legal systems that strengthen creditor rights, contract enforcement, and accounting practices can boost financial development and accelerate economic growth. Over the sample period, the authors claim, the direct effects of legal origins on economic growth faded, while the indirect effect through financial intermediation indicators lasted. This deft argument validates using legal origins as an instrument for finance[1], in an cross-country growth equation determining GDP per capita growth.

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[1]In the Levine et al. (2000)'s data Appendix are fully described the three proxies for finance.

With their econometric model, Levine et al. (2000) find the effect of finance on GDP growth to be large, positive and significant. This is in line with the so-called law and finance view, as proposed by La Porta, Lopez de Silanes, Shleife and Vishny (1998), nested into the context of economic growth.
This paper, attempts to answer the following questions: are Legal Origins good instruments to explain the exogenous variations of financial development? Is financial development still informative under weak instruments[2]? To answer this question, is considered the recent econometric literature of Staiger and Stock (1997) and Stock, Wright and Yogo (2002), Stock and Yogo (2003), Moreira (2002) and Doufur (1997), Andrews, Moreira and Stock (2004).
To assess the strength of legal origins as instruments for fiance it is used the same data set and econometric model as in Levine et al.(2000). The results of Table 3 of Levine et al (2000) are fully replicated because the help of the detailed footnotes of Table 3.
This paper makes two original contributions to the finance and growth literature: the first consists in the use of robust technique to detect whether legal origins are good instruments by looking at the first stage F-statistics.
The second contribution is the implementation of a second stage inference procedure, in order to assess whether financial development affects cross-country growth also in the case of weak identification (weak instruments). The rest of the paper is organized as follows. Section (1) discuss the econometric model, the weak instruments detection and the second stage inference procedure. Section (2) describes the set of instruments, criticize some of their properties and discus the second stage results in the case of weak identification. Section (3) concludes the paper. Appendix A reports full confidence intervals and AR graph for all specification of table 3, Appendix B reports first stage regressions, and second stages tests robust to weak instruments.

1. Econometric Issues

1.1. **The Model.** The econometric model used by Levine et al. (2000) can be summarized by a system of equations:

$$F_i = \beta' Z_i + c'(Conditioning - Set)_i + \widetilde{\nu_i} \tag{1}$$

$$\widehat{Y_i}_{,60-95} = \alpha F_i + \gamma'(Conditioning - Set)_i + \widetilde{\epsilon_i} \tag{2}$$

where Y_i is the per capita GDP growth over the period 60-95, F_i is specification by specification on of the proxies for financial development, Z_i is a vector of three dummy variables representing legal origins, and Conditioning-Set is a set of variables used as proxies for the steady state in the conditional convergence, Barro and Sala-i-Martin (2004) and Levine et al. (2000). Using the standard Frisch-Waugh (1933) theorem to partial out the control variables, this system can be rewritten in a simpler form as:

$$Finance = \beta' z_i + \nu_i \tag{3}$$

[2]This question is considered as identification part. As discussed in Dollar and Kraay (2003), in the case of weak instruments it is not easy to identify the effects of the endogenous regressors on the left hand side variable.

$$\widehat{y}_{i,60-95} = \alpha Finance_i + \epsilon_i \tag{4}$$

where the lower-cased letters are residuals of their upper-case counterparts from an ordinary least squares (OLS) on the control variables[3]. Moreover, letting $\pi = \alpha\beta$ and $\xi = \epsilon_i + \alpha\nu_i$, the reduced form equation for the second-stage equation (4) is given by:

$$\widehat{y}_{i,60-95} = \pi Finance_i + \xi \tag{5}$$

The two stages least squares (2SLS) estimator of α used by Levine et al. (2000) can be expressed as the ratio of the (OLS) estimate π in the reduced form equation, to the (OLS) estimates of β in the first stage equation 1, i.e $\widehat{\alpha}_{2SLS} = \frac{\widehat{\pi}_{OLS}}{\widehat{\beta}_{OLS}}$ [4].

1.2. **IV estimation.** A general adopted solution to the problem of endogeneity and reverse causality is the use of the Instrumental Variables estimator in its easy form of two-stage least squares (2SLS). In econometrics terms what counts are good instruments for financial development in order to find exogenous variations in financial development and explain per-capita GDP growth. From a theoretical point of view, truly exogenous variations do not exist, it is necessary to find source of variation that is orthogonal to other determinants of current economic performance and are highly correlated with the endogenous regressor.

$$E[z_i \epsilon_i] = 0 \tag{6}$$

$$E[z_i Finance_i] \neq 0 \tag{7}$$

These two requirements to be satisfied determine whether an instrument can be defined a good one or bad. The first condition is called orthogonality condition while the second one is called instrument relevance and deals with the instruments correlation with the endogenous regressor. Especially if the correlation requirement is not satisfied an instrument or a set of excluded instruments are said to be weak. Various procedure are available for detecting and handing weak instruments in the linear IV model that are summarized as follows[5]:

- The first-stage $F-statistic$ (Staiger and Stock (1997),Stock and Yogo (2001),
- The first-stage $t-tests$, i.e the β is not significantly different from zero,
- The first stage $adj-R^2$ (Shea (1997)).

[3] $y = (I - X(X'X)^{-1}X')Y$

[4] This model clarification turns out to be important because when dealing with the definition of the instruments for finance, one cannot get confused by defining the conditioning info sets as instruments as legal origins. Legal origins will be considered the only excluded instruments for finance as reported in the system of equations. In Levine et al. (2000) most of the results on the first stage instruments are driven by the inclusion of the Conditioning info set as first stage regressors. The same error is founded and corrected in the Moreira's Stata routine.

[5] A common way to test for the instruments relevance is to use the p-value of the first stage F-statistics. In Staiger and Stock (1997) it is deeply discussed why it is wrong considering the probability value.

Unfortunately, weak instruments pose considerable challenges to inference using IV methods. As Nelson and Startz (1990) show for small samples, the central tendency of the IV estimator is biased away form the true value in the direction of the probability limit of the OLS estimator. The distribution of the IV estimator is bimodal and poorly approximated by its asymptotic distribution. When instruments are relatively weak, violations of the orthogonality condition can impart a greater inconsistency of the IV estimates. Moreover, as shown by Dufour (1997), inference based on α is complicated as conventional 2SLS standard errors based on Wald statistic (point estimate $\pm$ 2xS.E.) become invalid. If for a moment we assume that legal origins can be viewed as a single variable instead of three dummies, the IV parameter can be viewed as the ratio of the reduced form parameter to the first stage parameter, i.e $\widehat{\alpha}_{2SLS} = \frac{\widehat{\pi}_{OLS}}{\widehat{\beta}_{OLS}}$. If we assume that $\pi < 0$ is known with certainty, but β is uncertain, but with 95 % confidence is known to be in interval of the usual form $[\beta_L, \beta_H]$. Now, if $\beta_L < \beta_H < 0$ then the confidence region for α is $[\frac{\pi}{\beta_L}, \frac{\pi}{\beta_H}]$. But if $\beta_L < 0 < \beta_H$ then the confidence region for α can be unbounded of the form $(-\infty, \frac{\pi}{\beta_H}, \frac{\pi}{\beta_L}, +\infty)$. [6].

1.3. **Why do we need good instruments?** The problems when there is weak correlation between the instruments and the endogenous explanatory variable, for instance when the first-stage $F - statistics$ is less than 10[7]),can be summarized as follow:

- TSLS estimates are biased toward OLS, with bias relative to OLS generally well approximated by $1/(first - stageF)$ Staiger (2002),
- TSLS estimators are inconsistent, Staiger and Stock (1997) and asymptotically not normally distributed.
- TSLS confidence intervals are too short[8], particularly with many instruments and/or a first-stage F under 10,
- Over-id test for TSLS tends to over-reject the null.

1.4. **The second stage inference procedure in the case of weak instruments and one endogenous regressor.** In the case of weak instruments, $\widehat{\alpha}_{2SLS}$ is not normally distributed for both small and large samples Staiger and Stock (1997). Therefore the casual effects of financial development on GDP growth cannot be reliably assessed with conventional Wald-type tests always found very significant, Dufour (2003).

Recent econometric literature discusses the problems of weak instruments in IV regressions and solves them by computing ad hoc statistics and confidence intervals directly in the second stage[9]. These test statistics do not suffer to weak instruments.

[6]This simplification make possible to understand how confidence intervals can be unbounded,Albouy (2004)

[7]this is the so called Staiger and Stock (1997) rule of thumb. They suggested that in the case of one endogenous regressor, instruments be deemed "weak" if the first-stage $F - statistic$ is less than ten. The Staiger and Stock rule of thumb corresponds to a 5% level test that the maximum size is no more than 15% (the maximum TSLS size distortion is no more than 10%

[8]For this reason if the instruments are weak one easily rejects the null of the estimated coefficient to be equal zero

[9]Here, the discussion is focused only on one line of research on the problem of weak instruments: construct ad hoc confidence intervals. Moreover, a second line of research proposes ways to obtain

Most of them are constructed by using large samples properties and are efficient under weak instruments asymptotic Staiger and Stock (1997), however some of them work well even for a small sample. Different methods are suggested and most of them are considered here:

- Anderson-Rubin statistics (AR)
- The Conditional-Likelihood ratio statistic, Moreira (2002)
- The Klibergen (2002) k-statistics

Based on the methods developed by Moreira (2001),Staiger and Stock (1997), Nelson and Zivot (1998) and Dufour (2003) valid tests for structural coefficients are constructed. The second stage approach is used to find asymptotic critical value functions for Wald and conditional likelihood ratio tests yielding correct rejection probabilities no matter how weak the instruments are. Together with the Anderson-Rubin and Lagrange Multiplier, the conditional Wald and likelihood ratio tests are used to construct confidence intervals, by inverting the test statistics. The latter have correct coverage probability even when instruments may be weak, and are still informative when instruments are good. The Wald, Likelihood ratio and the LM test are no closed-solution quadratic forms, and so confidence intervals are recovered by Montecarlo simulations[10].
The Anderson-Rubin statistic is pivotal and is distributed as a χ^2 with k degree of freedom as the number of instruments. For applied works and a small number of instruments the preferred statistics is the Anderson-Rubin[11], which has well known properties for small samples (i.e finite-sample pivotality) and it is shown to be totally unaffected by the presence of weak instruments, the exclusion of relevant instruments, and the error distribution in the reduced form for the endogenous explanatory variable, Dufour (2003). Zivot, Startz and Nelson (1998) show that all confidence regions will either take a bounded form $[\alpha_L, \alpha_H]$, or an unbounded form $(-\infty, \alpha_L] \bigcup [\alpha_H, +\infty)$, where the latter occurs whenever there are very weak instruments[12].

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unbiased (less biased) estimates of the structural parameter of interest in the presence of weak instruments. Some of the estimators that have been proposed include Angrist and Krueger's (1995) split sample estimator, the jackknife IV estimator, the Donald and Newey's (2001) bias adjusted two stages least squares estimator and the recent Hahn, Hausman and Kuersteiner's (2001) jackknife two stages least squares estimator. This line of research is moving to correct the finite sample bias of the two stages estimator by the use of bootstrap method of estimation.

[10]In the Moreira's approach if it is assumed known the error covariance matrix there is a power gains in the conditional tests. The assumption that the error structure is known is rather implausible, and the extension of the method to the case where the error structure is unknown is obtained at the expense of using a large-sample approximation. Like Kleibergen's procedure, this method yields an asymptotically similar test, Kleibergen (2002). Further, only asymptotic distributional theories have been supplied for these statistics, so that the level of the procedure may not be controlled in finite samples. It is possible to see that none of these statistics is pivotal in finite samples (i.e., their finite-sample distributions involve unknown nuisance parameters) Dufour (2003).

[11]As pointed by SWY (2002) the AR statistic looses his nice properties in the case of a large set of instruments

[12]Later will be showed that unbounded confidence regions comes out when the first stage F-statistics is very small so that far from ten. Wald C.I and AR C.I are reported in Appendix D

2. Legal Origins

Following Levine at al. (2000), it is used a set of dummy variables representing differences in legal systems and origins as instruments for financial development. Countries are divided into four groups with predominantly English, French, German or Scandinavian legal origins. As in La Porta et al. (1998), the effect of different legal origins can be viewed through differences in the legal rules covering: property rights, safe creditors, the efficiency of contract enforcement, and the quality of accounting standards.
These characteristics are taken as an "exogenous endowment" by the theory, since "English, French, and German systems were spread primarily through conquest and imperialism during the 17th and 18th centuries". By considering legal origins as not affected by the GDP growth in the selected period, it is satisfied only one of the two requirements for a set of instruments to be defined good[13].
The second requirement is the correlation between the set of instruments and the endogenous regressor. To control for the effect of legal origins on GDP growth, only through financial development, it is estimated the system of equation (3) and (4). In the application three different Conditioning-Info sets will be assessed: the simple one, the policy info set and the full conditioning info set[14]. Table (1) assigns a code to each one of the regressions of table 3 of the Levine et al. (2000). In order to simplify the tables the first column it is assigned a code for the different regression specifications. The second column reports the set of excluded instruments. The third column contains the included exogenous regressors.

Table 1. Financial Intermediation and growth: cross-section regressions, 1960-1995. Dependent Variable: Real per capita GDP growth 1960-1995, instruments Legal Origins.

Reg.Code	**Set of Instruments**	**Exog.regressors**	**Proxy for finance**
3.1	Legal Origins	Simple Conditioning info set	Private Credit
3.2	L.O	S.C	Commercial-Central Bank
3.3	L.O	S.C	Liquid Liabilities
3.4	L.O	Policy Conditioning info set	Private Credit
3.5	L.O	P.C	Commercial-Central Bank
3.6	L.O	P.C	Liquid Liabilities
3.7	L.O	Full Conditioning info set	Private Credit
3.8	L.O	F.C	Commercial-Central Bank
3.9	L.O	F.C	Liquid Liabilities

[13]It is worth mentioning the assumption that legal origins only affects growth through finance. This apparently innocuous assumption is one of the weakest points of the Levin et al.(2000)'s econometric model. Many authors like Acemoglu, Johnson and Robinson (2001), consider legal traditions as determinants of countries institutional development. By considering a simple correlation between legal origins and institutions it turns out that the orthogonality condition do not hold anymore. Even if a lot o tests are developed, only the theoretical model that the researches has in mind can deliver strong assumptions on the disturbances' composition and so on the orthogonality condition.

[14]Object f this paper is not enter into the detail of what are the best proxies for the steady state to be used in the growth regressions. For this choice is fully adopted the authors'methodology.

Table (2) reports: in the first column the regression code, in the second column the number of instruments, in the third column the computed value of the first-stage F-statistics for the excluded instruments. The fourth and fifth columns report the thresholds and critical values as displayed in Table (1).

TABLE 2. Regressions results and strength of instruments

			Relative bias > 10%	
Regression Code	Number of Instruments (K)	(F) statistic	Threshold μ^2/K	F statistic 5 % critical value
*3.1	3	5.73	3.71	9.08
*3.2	3	1.45	3.71	9.08
*3.3	3	5.82	3.71	9.08
*3.4	3	3.21	3.71	9.08
*3.5	3	0.79	3.71	9.08
*3.6	3	3.54	3.71	9.08
*3.7	3	3.08	3.71	9.08
*3.8	3	0.97	3.71	9.08
*3.9	3	3.63	3.71	9.08

In table (3) are reported only the computed p-value of the first-stage $F-statistics$ for the first stage regression. Notice that Levine et al.(2000) and the Moreira's (2001) Stata routine, use these probability values as a discriminant of weak or strong instruments. In all Levine et al.(2000) results , by using this methodology, weak instruments are never found .

TABLE 3. Regressions Reported p-value

Regression Code	First-stage F-statistic p-value
3.1	0.0000
3.2	0.0002
3.3	0.0000
3.4	0.0000
3.5	0.0000
3.6	0.0000
3.7	0.0000
3.8	0.0000
3.9	0.0000

A (*) is assigned to the regression having a value of the first-stage F-statistic that does not exceed those thresholds values. It is shown that even if the orthogonality condition is satisfied as in Levine et al.(2000)[15], no one of the indexes of financial development is instrumented with strongly correlated variables. Highlight that it is wrong to consider as instruments the exogenous regressors used in the structural

[15]In the above Tables are not reported the p-values and the test statistics for the OIR test, this is done in Appendix B and are found for all the specifications the same results.

equations-i.e, the different conditioning sets-. For instance, none of the results of Table 3 of Levine et al. (2000) is robust to weak instruments.

2.1. **Revisiting the evidence with the second stage inference procedure.** Table (4) reports the correct size of test statistics based on the second stage inference procedure, considering only the case of regression (3.7)[16].

Table 4. Size-Correct test statistics

Statistic	Computed value	95% Critical value	Asy. Critical value*
Anderson-Rubin	14.0219	7.8147	
Likelihood ratio	12.7764	6.3010	3.8415
Lagrange Multiplier	10.2764	3.8415	
Wald	8.9251	3.9714	3.8415

The set of excluded instruments presents a first-stage $F - statistic$ less than 9.08, so instruments used to explain exogenous variations of financial development are said to be weak[17]. From the application of the second stage inference procedure it is possible to reject the null hypothesis H_0: $\widehat{\beta}^{TSLS} = 0$ at 5% significance level, based on Anderson-Rubin, Lagrange Multiplier, Likelihood Ratio and Wald tests. Each computed statistics exceeds its corresponding 95% critical value. In Appendix B are reported the computations for all the regression: (3.1), (3.2), (3.4),(3.5),(3.6),(3.8),(3.9). Using the second stage inference procedure, it is possible to reject the null hypothesis of the estimated parameter to be equal zero. Moreover, to interpret the magnitude of the estimated coefficient is suggested to consider different estimators that are unbiased or less unbiased in the case of weak instruments.

2.2. **Confidence Regions.** For specification (3.7) are reported both Wald and AR confidence regions, the graph of the AR test statistics and its critical value. For the specification (3.7) even if weak instruments are detected, i.e. first stage F-statistics of 3.08, both Wald and AR confidence intervals are bounded, table 5. The latter are larger showing the effects of weak correlation between legal origins and Private Credits. So main conclusion is that even if there are weak instruments it is possible to identify the positive effects of finance on growth.

[16]In Appendix B are reported the second stage and ad hoc confidence interval for the whole set of regressions

[17]In this paper are omitted all the details on the source of the critical values and the complete tabulations. All the mentioned results are drawn from Stock and Yogo (2001).

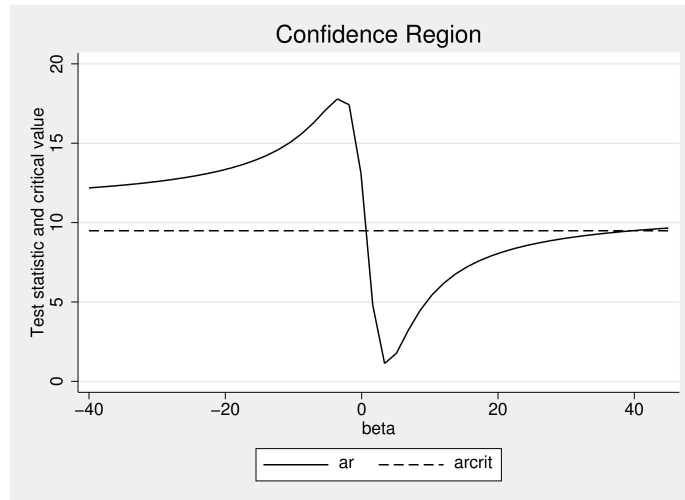

FIGURE 1. Full Conditioning Information Set: Private Credit

TABLE 5. Correct Confidence Intervals: Full Conditioning Information Set for Private Credit

3.7	Lower		Upper
$C.I^{WALD}$	[0.7393	,	6.0984]
$C.I^{AR}$	[1.6326	,	39.7959]

A different result comes out if one considers as proxy for finance Commercial-Central Bank. For the three Conditioning-Info sets, all the first stage F-statistics are less than 1.5, representing the smallest one. As follow is reported the confidence intervals and the AR graph for specification (3.8).

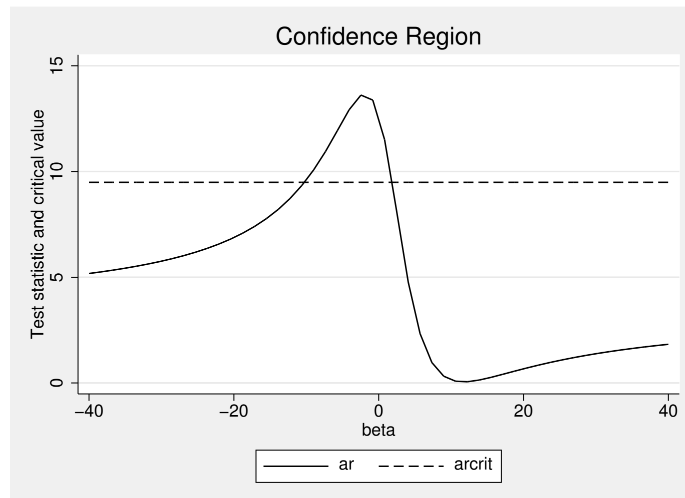

FIGURE 2. Full Conditioning Information Set: Commercial-Central Bank

Table 6. Correct Confidence Intervals: Full Conditioning Information Set for Commercial-Central Bank

3.8	Lower		Upper
$C.I^{WALD}$	[-1.9440	,	24.9813]
$C.I^{AR}$	$(-\infty$, -8.9795]	$\bigcup$	[2.4485,$+\infty$)

Under very weak instruments-i.e. when the first stage F-statistics is small and far from the critical value- it happen that the AR confidence intervals are unbounded not including zero. This represent the fact that only small values of beta are not statistically significant. As discussed in Zivot, E., Startz, R., Nelson, C.R (1998), confidence intervals can assume this unbounded form. In this application unbounded confidence intervals are discovered when comparing first stage F-statistics less than 1.5[18]. As discussed in Albouy (2004), in the cases,even if the zero is not included in the confidence intervals, of unbounded confidence intervals it is not possible to identify the effects of finance on growth.

Conclusions

This paper reconsiders the results of "Financial Intermediation and Growth: Causality and Causes" Levine et al. (2000), by focusing on the use of instrumental variables growth regressions. Particular attention is given to the correlation between the instruments and the endogenous regressor that is found weak. It is shown that the common procedure used, to select the instruments, is not robust to the problem of weak correlation because it gives misleading results. With a second stage inference procedure is replicated, verified and, except for the Commercial-Central Bank proxy for financial development, confirmed the claim of Levine et al. (2000): "financial development positively affects economic growth", now consistent with the problems given by the inclusion of weak instruments.

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[18] Appendix A reports Confidence Intervals and AR graph for specifications (3.1)-(3.9)

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