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Finance and growth: A comment on De Haas and Popov (2023)

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Finance and green growth: A comment on De Haas and Popov (2023)*

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Abstract

De Haas and Popov (2023) estimate the effect of country-level financial sector size and structure on decarbonization to show that countries with relatively more equity versus debt financing have more emission-efficient economies. We uncover multiple coding errors that change the magnitude and the precision of the coefficients of interest. These coding errors include misreporting of standard errors, and misspecifying generalized method of moments (GMM) estimators. We further provide robustness tests of the results to (1) restricting the sample to consistent sets of countries across the country and country-by-industry samples, and (2) using a limited information maximum likelihood (LIML) estimator to address a weak-instrument problem. We find that the results from the robustness checks are qualitatively different from the original results but similar to the corrected results.

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1 Introduction

De Haas and Popov (2023) use a 48-country, 16-industry, 26-year panel to test how the size of the financial sector, and the importance of equity markets affect CO_2 emissions. They apply OLS, 2SLS, and GMM estimators on a country-level panel, and a country-by-industry panel. De Haas and Popov (2023)'s conclusion indicates that "a robust result across the OLS, 2SLS and GMM estimations is that the equity share of domestic financial systems correlates strongly and negatively with total CO_2 emissions". Using similar methods, a sector-level analysis also provides evidence that "in economies that get relatively more of their funding from stock markets, CO_2 emissions in relatively more CO_2-intensive sectors decline faster."

This comment revisits the results of De Haas and Popov (2023) from three angles. First, we show that several coding errors, and in particular failing to cluster standard errors, decrease the precision of the author's results. Second, we test for the importance of consistent sets of countries across samples. We find that correcting for inconsistent country samples changes the magnitude of the results. Third, we provide weak instrument tests to show that the revised results are robust to the presence of weak instruments in the analysis. The data and codes we use were obtained from the replication package provided in a footnote to the title of paper, accessible at https://zenodo.org/record/7220094.

2 Regressions

For the reproducibility and robustness exercises, we use the same regression framework as the authors, namely based on their equations (1), (2), and (3). The specifications are either at the country-by-year level for the country panel or at the country-by-year-by-sector level for the country-industry panel.

For their country-level panel, we regress country-level CO_2 emissions divided by GDP on one-year lagged size of the financial sector as share of GDP, and the share of the equity market in the financial sector. The size of the financial market and share of equity financing are the author's variables of interest. This model is estimated in three different ways. It is first estimated as a two-way fixed effects model, which relies on the conditional exogeneity of the financial sector size and structure. Recognizing the endogeneity of both of their variables of interest, it is also estimated as a 2SLS estimator where financial sector size and structure are both instrumented using three instruments, namely measures of bank deregulation, equity market liberalization, and current account openness. Lastly, the authors also estimated their model using an Arello-Bond GMM procedure where they instrument for these two endogenous variables using lagged variables.

For the country-industry model, the authors use similar OLS, 2SLS, and Arrelano-Bond GMM estimators. Relative to the country-panel models, they include richer sets of fixed effects such as country-year, industry-country, and industry-year fixed effects. Their dependent variable becomes CO_2 emission per GDP by industry, country, and year. Their two variables of interest are also now interacted with a time-invariant industry-specific measure of CO_2 intensity to capture the industry's propensity to pollute. For the 2SLS estimator, their instruments are also interacted with the sector-specific CO_2 intensity measure.

3 Reproducibility

In this section we describe coding errors that we uncovered while reproducing the main results in the study. We describe two types of coding errors and important omitted information, and how they affect the main conclusions.

Tables 1 and 2 reproduce the results for the main outcome variable, CO_2 emissions per GDP, for the OLS, 2SLS, and GMM estimators used in the study for the country and country-industry panels.

3.1 Standard errors

There are inconsistencies between how standard errors are calculated in the provided scripts, and how they are described in the main text. For their country panel, the authors mention in the text that they cluster their standard errors at the country-level. However, in their script, they either only adjusted their standard errors to account for heteroskedasticity or do not make standard error adjustments. Standard errors in Table 1 are clustered at the country-level for the first four columns, and account for heteroskedasticity for the GMM estimator. As a result, the precision of the coefficients of interest is reduced. The results are either statistically insignificant or only significant at the 10% level.

Specifically, the authors in the paper emphasize that the precision of their results across models for the share of equity markets provides evidence for the contribution of equity financing to decarbonizing an economy. Under the proper standard error adjustment, the precision goes from significant at the 1% level to 10% or insignificant. We view this as changing the takeaway of Table 1 as providing at best suggestive evidence of the importance of equity versus debt financing to decarbonize economies.

The standard errors for the country-industry panel reported in the manuscript and in the provided script matched for the OLS and 2SLS specifications. However, in the case of the GMM estimation, the author did not adjust their standard errors, and therefore are assuming homoskedasticity. In Table 2 we adjust the GMM standard errors to account for heteroskedasticity. As shown, Stata is not able to produce robust standard errors for the GMM estimator.

3.2 GMM estimator

One strategy used by the authors to account for the endogeneity of the size and the structure of a country's financial sector is to employ a GMM estimator whereby they instrument their two endogenous variables with their lagged values. When reproducing their GMM estimators for their country and country-industry panels, we uncovered that the authors improperly specified the GMM program in Stata. Indeed, they failed to specificy the endogenous variables in the command. The last columns of Tables 1 and 2 reproduce the impact of financial sector size and structure on CO_2 emission intensity using the proper Arello-Bond GMM specification. While the sign of the coefficients of interest do not change, the magnitudes of all point estimates reduce by a factor of 2 to 4.

3.3 First-stage results

De Haas and Popov (2023)'s models have two endogenous variables in both the country-level and country-industry analyses. Since the authors have two first-stages for each model, it is more sensible to report F-statistics for the strength of their instruments for each first stage. Instead, the authors either fail to report their first-stage F-statistics or they only report one F-statistic. In Tables 1 and 2, we report the F-statistics for each of the first stages for the country and country-industry panels. In the case of Table 1, each F-statistics is below 10, which is an indication of weak instruments. For Table 2, only the instrument for the financial structure is above 10, which also suggests testing for the effects of weak instrument bias on the coefficients of interest.

4 Robustness checks

After finding several coding errors during our reproducibility exercise, we decided to focus on two robustness checks. First, following the low F-statistics of their first-stages, we conduct weak instrument tests to determine whether their 2SLS estimators are biased. Second, through the reproduction of their results, we understood that due to data constraints, inconsistent sets of countries in their country and country-industry analyses are used. Therefore, as a second exercise, we restrict the sample of the country-industry panel such that it matches the set of countries included in the country panel.

4.1 Weak instrument test

The 2SLS results for the country and country-industry panels exhibit signs of weak instruments. In both cases, the F-statistics of the first-stages are below or around

10. One approach to test the potential bias introduced by weak instruments is to compare the 2SLS estimator with the unbiased limited information maximum likelihood (LIML) estimator. If the two estimators report statistically different point estimates, this suggests the 2SLS estimator is biased. Table 3 implements LIML estimators for the country and the country-industry panels.

For the country panel, the coefficient on the size of the financial sector changes sign, however, is of small magnitude and insignificant for both the 2SLS and LIML estimators. The coefficient on the share of equity financing is qualitatively similar across both specifications. In the case of the country-industry panel, the coefficients of interest across the 2SLS and LIML estimators are qualitatively similar. We view this as evidence that the potential weak instrument problem in this paper is not biasing the 2SLS estimator, especially for the structure of the financial sector coefficient.

4.2 Consistent samples

Due to data constraints, the authors use different samples of countries across their country and country-industry panels. Indeed, in their country sample, the authors note in their code that they drop China since there are not sufficient data on "No. environmental laws and policies". However, they do not drop China in their country-industry panel models. The authors do not further discuss these choices in the code or in the main text. Therefore, as a replication exercise, we drop China from the country-industry sample in order to keep a consistent country sample across both panels. Table 4 presents the coefficients of interest for the interacted financial market size and structure when dropping China. Relative to the results presented in Table 2, which corrects for the coding errors, the results are qualitatively similar to the corrected results.

5 Conclusion

In this paper, we reproduce and test the robustness of the results in De Haas and Popov (2023). The authors use country and country-industry panel data combined with OLS, 2SLS and GMM estimators to study the impact of the size and structure of countries' financial sector on CO_2 emissions per GDP. During the reproduction exercise, we uncovered multiple coding errors. Solving these errors reduces the magnitude and precision of the author's main results. In terms of robustness checks, we tested for the bias introduced by weak instruments, and the effect of consistent sets of countries across both panels. The results without the coding errors are qualitatively robust to these robustness exercises.

References

De Haas, R. and Popov, A.: 2023, Finance and green growth, *The Economic Journal* **133**(650), 637–668.

6 Tables

Table 1: Replicated Table 2- Finance and aggregate carbon emission

	CO_2 emissions/GDP	Financial development	Equity share	CO_2 emissions/GDP	CO_2 emissions/GDP
	OLS		2SLS		GMM
		First stage		Second stage	
	(1)	(2)	(3)	(4)	(5)
Financial development	0.0094			0.0470	0.0377**
	(0.0349)			(0.3335)	(0.0158)
	[0.7901]			[0.8879]	[0.0168]
Equity share	-0.1890*			-0.8688*	-0.0106
	(0.1095)			(0.4973)	(0.0306)
	[0.0912]			[0.0806]	[0.7286]
Log GDP per capita	-1.3712			-0.8778	-0.143
	(1.0649)			(1.6534)	(0.1021)
	[0.2045]			[0.5955]	[0.1615]
Log GDP per capita squared	0.0481			0.0208	0.0052
	(0.0563)			(0.0918)	(0.0055)
	[0.3975]			[0.8205]	[0.3434]
Log (Population)	1.1554			0.8301	-0.2463**
	(1.0604)			(1.4638)	(0.0983)
	[0.2817]			[0.5707]	[0.0123]
Recession	-0.0030			-0.0471	0.0033
	(0.0083)			(0.0365)	(0.0048)
	[0.7214]			[0.1966]	[0.4962]
No. environmental laws and policies	-0.0010			-0.0005	0.0004
	(0.0008)			(0.0014)	(0.0003)
	[0.2122]			[0.7364]	[0.1438]
Entry barriers		-0.0618	-0.0327		
		(0.0688)	(0.0227)		
		[0.3748]	[0.1570]		
Equity market liberalization		-0.1746*	0.0220		
		(0.0921)	(0.0414)		
		[0.0652]	[0.5984]		
Current account liberalization		0.0021	0.0019**		
		(0.0028)	(0.0009)		
		[0.4642]	[0.0447]		
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R-squared	0.95	0.91	0.68	0.93	
No. Observations	1,013	914	914	914	956
Kleibergen-Paap LM statistic				2.664	
p-value				0.264	
F statistic		1.54	2.25		

Notes: All regressions have the same controls as table 2 from De Hass and Popve (2023) correcting for standard errors in parentheses clustered at country as specified in the text. P-values are reported in brackets.* significant at 10% ** significant at 5% *** significant at 1%.

Table 2: Replicated Table 3- Finance and sector-level carbon emissions

	CO_2 emissions/GDP		
	OLS	2SLS	GMM
	(1)	(2)	(3)
Financial development × CO2 intensity	-0.0003	0.0050	0.0001
	(0.0003)	(0.0067)	(.)
	[0.3509]	[0.4555]	[.]
Equity share × CO2 intensity	-0.0044**	-0.0185**	-0.0013
	(0.0019)	(0.0092)	(.)
	[0.0195]	[0.0442]	[.]
Sector share	0.0229***	0.0193***	0.0037
	(0.0061)	(0.0063)	(.)
	[0.0002]	[0.0022]	[.]
Country × Sector FE	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes
R-squared	0.93	0.90	
No. Observations	7,540	6,804	6,721
First-stage F-statistic for financial size		4.203	
First-stage F-statistic for financial structure		22.432	

Notes: All regressions have the same controls as Table 3 from De Haas and Popov (2023) correcting for (1) heteroskedasticity and (2) recognizing endogenous variables in the GMM estimate reposted in column (3). P-values are reported in brackets * significant at 10% ** significant at 5% *** significant at 1%.

Table 3: LIML regressions

	CO_2 emissions/GDP	
	LIML	LIML
	(1)	(2)
Financial development	0.0480	
	(0.3369)	
	[0.8867]	
Equity share	-0.8712	
	(0.5005)	
	[0.0818]	
Log GDP per capita	-0.8741	
	(1.6590)	
	[0.5983]	
Log GDP per capita squared	0.0206	
	(0.0922)	
	[0.8229]	
Log (Population)	0.8273	
	(1.4680)	
	[0.5730]	
Recession	-0.0473	
	(0.0367)	
	[0.1980]	
No. environmental laws and policies	-0.0005	
	(0.0014)	
	[0.7384]	
Financial development × CO2 intensity		0.0032
		(0.0062)
		[0.6061]
Equity share × CO2 intensity		-0.0236**
		(0.0088)
		[0.0073]
Sector share		0.0151*
		(0.0061)
		[0.140]
No. Observations	914	6,597

Notes: This Table reports LIML estimates for column (4) of Table 2, and column (2) of Table 3 from De Haas and Popov (2023). P-values are reported in brackets.* significant at 10% ** significant at 5% *** significant at 1%.

Table 4: Finance and sector-level carbon emissions: Excluding China

	CO_2 emissions/GDP		
	OLS	2SLS	GMM
	(1)	(2)	(3)
Financial development × CO2 intensity	-0.0002	0.0022	0.0001
	(0.0003)	(0.0050)	(.)
	[0.5918]	[0.6592]	[.]
Equity share × CO2 intensity	-0.0043**	-0.0220***	-0.0014
	(0.0018)	(0.0074)	(.)
	[0.0180]	[0.0030]	[.]
Sector share	0.0195***	0.0152**	0.0034
	(0.0057)	(0.0060)	(.)
	[0.0007]	[0.0109]	[.]
Country × Sector FE	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes
R-squared	0.90	0.85	
No. Observations	7,333	6,597	6,532
First-stage F-statistic for financial size		7.694	
First-stage F-statistic for financial structure		34.037	

Notes: All regressions have the same controls as Table 3 from De Haas and Popov (2023) correcting for (1) sample by excluding China (2) heteroskedasticity and recognizing endogenous variables in the GMM estimate reposted in column (3). P-values are reported in brackets * significant at 10% ** significant at 5% *** significant at 1%.