

Flechtner, Svenja; Gräbner, Claudius

Working Paper

The heterogeneous relationship between income and inequality: a panel co-integration approach

ICAE Working Paper Series, No. 91

Provided in Cooperation with:

Johannes Kepler University Linz, Institute for Comprehensive Analysis of the Economy (ICAE)

Suggested Citation: Flechtner, Svenja; Gräbner, Claudius (2019) : The heterogeneous relationship between income and inequality: a panel co-integration approach, ICAE Working Paper Series, No. 91, Johannes Kepler University Linz, Institute for Comprehensive Analysis of the Economy (ICAE), Linz

This Version is available at:

<https://hdl.handle.net/10419/193630>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

The heterogeneous relationship between income and inequality: a panel co-integration approach

Svenja Flechtner and Claudius Gräbner

The heterogeneous relationship between income and inequality: a panel co-integration approach*

Svenja Flechtner^{a,b,e} and Claudius Gräbner^{c,d,e}

^a*University of Siegen, Germany. Faculty III, Kohlbettstr. 15, D-57072 Siegen.*

^b*Forum for Macroeconomics and Macroeconomic Policy (FMM).*

^c*Institute for Comprehensive Analysis of the Economy (ICAE), Johannes Kepler University, Linz, Aubrunnerweg 3a, 4040 Linz, Austria.*

^d*Institute for Socio-Economics, University of Duisburg-Essen, Lotharstr. 65, 47057 Duisburg, Germany.*

^e*ZOE. Institute for Future-Fit Economies, Thomas-Mann-Str. 36, 53111 Bonn, Germany.*

February 27, 2019

Abstract

We study the relationship between per-capita income and income inequality with a heterogeneous panel co-integration approach. We extend previous studies in two respects: first, we compile a more extensive data set for 61 countries over 26-51 years and consider measures for both pre-tax and post-tax income inequality; second, we take into account country heterogeneity rather than relying on average panel estimates alone. We find a negative group-mean based relationship using pre-tax income inequality, but no such relationship for post-tax income inequality. Moreover, we find estimates on the country level to be heterogeneous in both cases.

Key messages

- The long-run relationship between income inequality and GDP per capita is analyzed using heterogeneous panel co-integration techniques.
- We find a negative group-mean based relationship using pre-tax income inequality.
- No such relationship is found using post-tax income.
- Estimates on the country level are heterogeneous in both cases.

Keywords: Development, Inequality, Growth, Panel co-integration

JEL Codes: O11, O4, O15, D30

*CG acknowledges funds of the Oesterreichische Nationalbank (OeNB, Anniversary Fund, project number: 17383). Both authors declare no competing interests. For correspondence, you can contact the authors via email: CG: claudius@claudius-graebner.com and SF: svenja.flechtner@uni-siegen.de.

Table 1: Unit root tests (IPS)

	GDP per capita (log)				Gini index, pre-tax (log)				Gini index, post-tax (log)			
W-t-bar	8.576	-	1.171	4.108	0.317	1.275	4.3933	2.416	-	-	2.597	-
p-value	1.00	0.038	0.879	1.000	0.625	0.899	1.000	0.992	0.937	0.522	0.995	0.305
Panel means	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time trend	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Panel-specific means removed			yes	yes			yes	yes			yes	yes
# of lags (AIC)	1.34	1.53	1.75	1.69	1.59	1.69	1.56	1.78	2.08	2.12	2.64	2.64

Number of panels: 59; AR parameter: panel-specific.

1 Introduction

Evidence on the long-run relationship between a country’s level and distribution of income has been inconclusive (see e.g. [Neves et al, 2016](#)). Recent advances in panel co-integration techniques may lead to more clarity, since they are more robust against common problems in panel regressions ([Herzer and Vollmer, 2012](#)). Two recent studies followed such an approach: [Herzer and Vollmer \(2012\)](#) used a sample of 46 countries for the period 1970-1995 and [Malinen \(2012\)](#) for 53 countries between 1970-1999. Both identify a negative long-run relationship between inequality and per-capita income.

We extend their work in two respects. First, we compile a more extensive data set covering 61 countries over 26 (minimum) to 51 (maximum) years and use measures for both pre-tax and post-tax income inequality. We find a statistically significant negative relationship with pre-tax, but not post-tax inequality. Our second contribution puts this finding into perspective. We quantify the effect heterogeneity at the country level and find estimates on the country level to be highly heterogeneous in both cases. This indicates that looking exclusively at overall panel estimates based on group-mean comparisons shallows important country heterogeneity.

2 Data and econometric approach

We measure within-country inequality with Gini indices for pre- and post-tax income, both from [Solt \(2016\)](#), and per-capita income using expenditure-side real GDP at chained PPPs from [Feenstra et al \(2015\)](#). We use annual rather than averaged data, for the reasons summarized in, *inter alia*, [Herzer and Vollmer \(2012\)](#). The panel is unbalanced.

The analysis follows the typical steps of a panel co-integration approach. First, the H_0 that all panels contain unit roots is evaluated using the Im—Pesaran—Shin (IPS) test ([Im et al,](#)

Table 2: Tests for a co-integration relationship between inequality and income

GDP per capita (log) and Gini index, pre-tax income (log)			
	Pedroni		Westerlund
Augmented Dickey-Fuller t/ Variance statistics*	6.3804	12.9906	-6.0977
p-value	0.000	0.000	0.000
Panel means included	yes	yes	yes
Time trend included	no	yes	no
AR-parameter	panel-specific		same

GDP per capita (log) and Gini index, post-tax income (log)			
	Pedroni		Westerlund
Augmented Dickey-Fuller t/ Variance statistics*	5.1360	12.3008	-6.0259
p-value	0.000	0.000	0.000
Panel means included	yes	yes	yes
Time trend included	no	yes	no
AR-parameter	panel-specific		same

Number of panels: 59. *We report variance statistics for the Westerlund and augmented Dickey-Fuller statistics for the Pedroni test. Other statistics from the Pedroni test (variance ratio, Phillips-Perron t) yield similar results.

2003). This test is suitable for unbalanced panels and does not rely on a common autoregressive parameter for all countries, which is sensible considering unobserved heterogeneity. The test estimates the equation

$$\Delta y_{i,t} = \phi_i y_{i,t-1} + \mathbf{z}'_{i,t} \gamma_i + \epsilon_{i,t}, \quad (1)$$

where i indicates countries and t the time-series. The autoregressive parameter ϕ is country-specific and in case $\phi_i = 0 \forall i$, all panels contain a unit root. The IPS test confirms that all time-series contain unit roots (see table 1): we cannot reject H_0 under a variety of specifications.¹

Second, we employ two different methods to test for a potential co-integration relationship between inequality and income (see table 2). We reject the H_0 of no co-integration relationships, with H_1 being that all (Pedroni test) or some (Westerlund test) panels are co-integrated.

We can then estimate the bi-variate relationship between inequality and income. We employ a dynamic OLS estimator for heterogeneous co-integrated panels with homogeneous long-run covariance structure across cross-sectional units (Pedroni, 2001) and estimate the equation

¹The only exception is the test for GDP with panel means and time trends without panel-specific means, which remains inconclusive. However, previous empirical and theoretical work has provided numerous arguments for GDP time series having unit roots.

$$\log(\text{GDP per capita}_{it}) = \alpha_i + \delta_i t + \beta_i \log(\text{Gini})_{it} + \sum_{j=-q}^q \phi_{ij} \Delta \log(\text{Gini})_{it+j} + \epsilon_{it}, \quad (2)$$

where $i = 1, 2, \dots, N$ indicates countries; $t = 1, 2, \dots, T$ indicates years; ϕ is the coefficient for leads and lags (included to account for serial correlation and endogeneity); q is the number of leads and lags in the regression; and β and γ are the slope coefficients.

We follow [Pedroni \(2001\)](#) and compute the β coefficients as averages over the entire panel using

$$\hat{\beta}_{GM}^* = \left[\frac{1}{N} \sum_{i=1}^N \left(\sum_{t=1}^T z_{i,t} z'_{i,t} \right)^{-1} \left\{ \sum_{t=1}^T z_{i,t} (y_{i,t} - \bar{y}_i) \right\} \right], \quad (3)$$

where $z_{i,t}$ is the vector of regressors, and the group-mean t statistics as

$$t_{\hat{\beta}_i^*} = (\hat{\beta}_i^* - \beta_0) \left\{ \hat{\sigma}_i^{-2} \sum_{t=1}^T (x_{i,t} - \bar{x}_i)^2 \right\}^{\frac{1}{2}}. \quad (4)$$

Our specification differs from both [Herzer and Vollmer \(2012\)](#) – who include a control for investment – and [Malinen \(2012\)](#) – who includes further controls for education. We restrain from adding controls for the following reasons. First, the estimator we use requires only the assumption that all integrated variables are included into the estimation. Detecting co-integration for inequality and income implies that no further integrated variables need to be considered (see e.g. [Johansen, 2000](#); [Herzer and Vollmer, 2012](#)). Second, controls for, say, education (as in [Malinen, 2012](#)) would absorb all effects of inequality on income operating through the channel of education. Since we are not concerned with the particular mechanisms underlying the long-run relationship between inequality and income, such an absorption runs counter to the objective of our analysis.

3 Results and discussion

We have three main results. First, the results in table [3](#) confirm the significant negative long-term relationship between pre-tax income inequality and GDP per capita found in [Malinen \(2012\)](#) and [Herzer and Vollmer \(2012\)](#). Second, no such relationship can be found once post-tax income inequality is used instead. Third, the nature of the relationship is heterogeneous across countries (figure [1](#)). There are three groups. Some countries (such as China or Norway) show a consistent statistically significant positive relationship between inequality and income. Some other countries experience a consistent significantly negative relationship, e.g. Canada

Table 3: Co-integration relationships, Pedroni’s PDOLS group-mean based estimator

	GDP per capita (log)
Gini, post-tax (log)	0.0819 [0.625]
Gini, pre-tax (log)	-1.644** [0.691]

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Countries with a consistently positive and negative relationship. We classify a country as having a consistently positive (negative) relationship between inequality and income if the relationship between *both* the post-tax and the pre-tax Gini and income is positive (negative) and statistically significant. Countries not mentioned show ambiguous results.

Consistently positive relationship	Argentina, China, Great Britain, Guatemala, Hong Kong, India, Japan, Norway, Pakistan, Philippines, Poland, Singapore, Sri Lanka, Switzerland, Turkey
Consistently negative relationship	Canada, Costa Rica, Greece, Iran, Ireland, Italia, Jordan, Malaysia, Netherlands, Nigeria, Panama, South Korea

or Malaysia. Table 4 lists the countries with consistently positive and negative relationships. Finally, there are also countries, such as Germany or Brazil, for which we cannot find consistent statistically significant patterns.

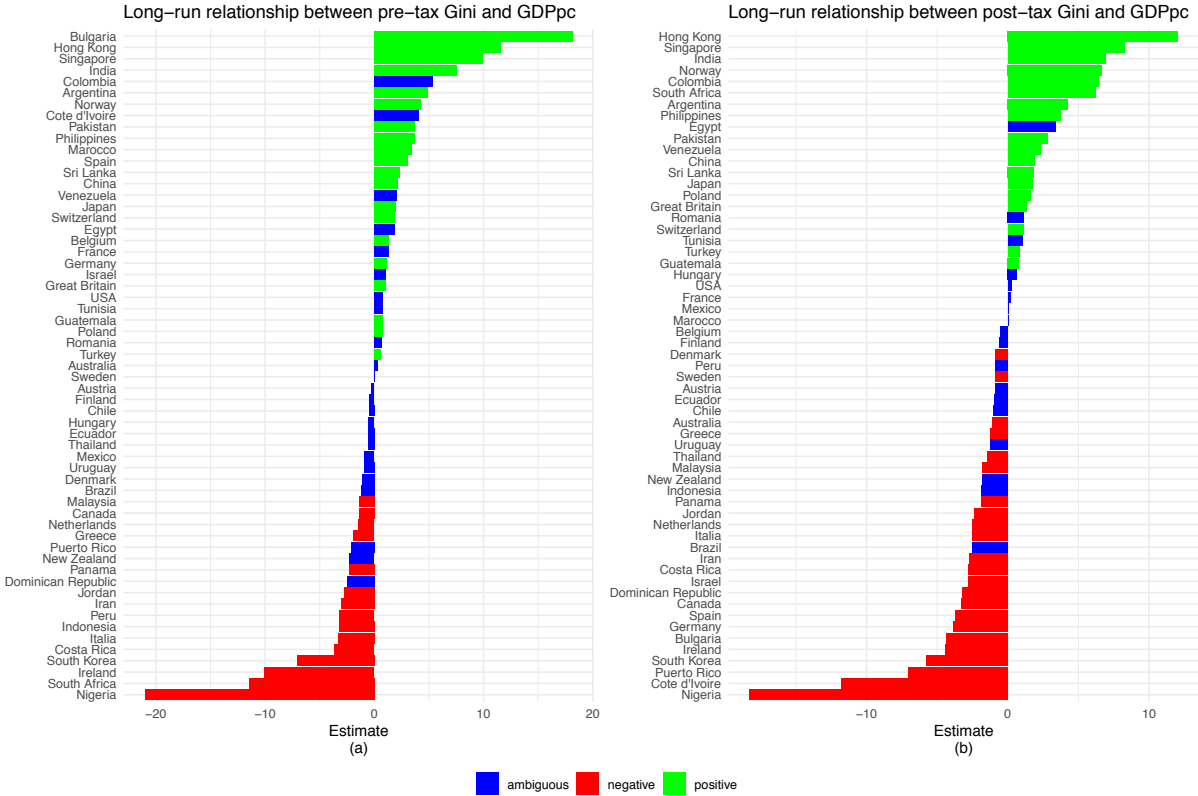
These results suggest that the relationship between inequality and income is context-dependent, a fact that is reflected by the ambiguous results of previous (meta) studies.

4 Conclusion

We studied the long-run relationship between inequality and income using co-integration techniques. While we confirm the overall negative relationship between pre-tax inequality on income found in Malinen (2012) and Herzer and Vollmer (2012), we do not find such relationship for the case of post-tax inequality. We also identified a systematic heterogeneity of estimates across countries, a finding consistent with a recent meta-study of Neves et al (2016).

Our results and the recognition of such contextual dependence of the relationship suggest several avenues for further research: on the inductive side one might use clustering techniques as in Gräbner et al (2019) to refine country classifications. More importantly, comparative investigations of the country groups summarized in table 4 might suggest theoretical rationalizations of the heterogeneity and lead to models proposing concrete mechanisms underlying the context-dependency of the income-inequality relationship.

Figure 1: Heterogeneity across estimates. Panel (a) refers to the estimation of equation (2) with the post-tax Gini, (b) to the estimation of the same equation with the pre-tax Gini. We speak of an ambiguous effect when the estimates are not significant at the 5% level.



References

- Feenstra RC, Inklaar R, Timmer MP (2015) The Next Generation of the Penn World Table. *American Economic Review* 105(10):3150–3182
- Gräbner C, Heimberger P, Kapeller J, Schuetz B (2019) Structural change in times of increasing openness: assessing path dependency in european economic integration. *Journal of Evolutionary Economics* forthcoming
- Herzer D, Vollmer S (2012) Inequality and growth: evidence from panel cointegration. *The Journal of Economic Inequality* 10(4):489–503
- Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. *Journal of Econometrics* 115(1):53–74
- Johansen S (2000) Modelling of cointegration in the vector autoregressive model. *Economic Modelling* 17(3):359–373
- Malinen T (2012) Estimating the long-run relationship between income inequality and economic development. *Empirical Economics* 42(1):209–233
- Neal T (2014) Panel cointegration analysis with xtpedroni. *The Stata Journal* 14(3):684–692
- Neves PC, Afonso Ó, Silva ST (2016) A meta-analytic reassessment of the effects of inequality on growth. *World Development* 78:386–400
- Pedroni P (2001) Purchasing power parity tests in cointegrated panels. *Review of Economics and Statistics* 83(4):727–731
- Pedroni P (2007) Social capital, barriers to production and capital shares: implications for the importance of parameter heterogeneity from a nonstationary panel approach. *Journal of Applied Econometrics* 22(2):429–451
- Solt F (2016) The Standardized World Income Inequality Database. *Social Science Quarterly* 97(5):1267–1281