Green Finance and Top Income Inequality

— Working Paper —

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Berkeley, 21. March 2023

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Motivation I

Does the (recent) rush to environmentally focused investing benefit in other ways than potential environmental improvements...

... or does environmental investing come at some cost for our societies?

Does green finance (GF) have effects on our societies?

If it does, who will benefit from it? Can GF improve living standards?

(How) does green finance affect income inequality?

Motivation II

- Climate change effects $\rightarrow$ GF
  $\rightarrow$ Inequality

- New: does GF by increasing climate change mitigation efforts (unintentionally) affect inequality?

$\rightarrow$ What type of finance could potentially have a direct impact?

$\rightarrow$ Investments into sustainability or ESG indices: impact is not so obvious.

$\rightarrow$ Example of investments we are interested in:
  - loans to make production process more environmentally friendly
  - investments into low-carbon infrastructure

$\rightarrow$ Global perspective to understand general relationship: generalization of results

$\rightarrow$ Direct effect might be implausible. What are mechanisms that channel the effect of green finance on inequality?
  - Major part of GF flows into renewable energy and low carbon sectors.
  - Necessary GHG reductions only achievable via innovation.
  - Innovation is known to affect inequality.

  $\rightarrow$ Innovation as a channel through which GF affects inequality.

Why Top Income Inequality?

- Top inequality is becoming the main source of income inequality (Aghion et al., 2018; Alvaredo et al., 2018; Lazonick and Mazzucato, 2013; van Zanden et al., 2014).

- Innovation drives top income inequality (Aghion et al., 2018).

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Summary of Results

- Green finance $\longrightarrow \uparrow$ Gini coefficient, top income shares
- The positive effect on the top income shares is driven by countries with
  - low and high levels of financial development, or
  - low levels of GDP, or
  - medium levels of inequality.
- Green finance affects inequality measures for more than 5 years.

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Climate Change Mitigation and Inequality

"We reviewed evidence showing how climate risks pose uneven effects on mortality, housing, consumer finance, social and labor markets, crime and conflict. These disparate effects were found to aggravate economic inequality by income and race and disadvantage the U.S. Southeast relative to other regions, thus further exacerbating already existing geographical and socioeconomic inequality. **These unequal effects are further exacerbated by the uneven adaptations to climate change**, *driven by differential abilities to migrate, adapt, or innovate to protect against climate risk."*

— Avtar et al. (2021)

Climate Change and Inequality

- Vicious cycle, whereby initial inequality is reinforced by adverse effects of climate change (Islam and Winkel, 2017).
- The poorer half of the world population contributes only approx. 10% to global emissions, yet the vast majority of that poorer half lives in countries most vulnerable to climate change (Oxfam Media Briefing, 2015).
- About 50% of the global emissions are caused by the richest 10% worldwide (Oxfam Media Briefing, 2015) and this population group has been unlikely to face adverse effects of climate change, while some even take profit (Callahan and Mankin, 2022).

→ *Does GF help the most vulnerable population groups?*

→ *Is GF directed towards regions most affected by climate change?*

Green Finance and Inequality

- Only (empirical) study from Bigger and Millington (2020):
  - Hurricane Sandy, which flooded New York City in October 2012.
  - Drought-induced water scarcity crisis in Cape Town, South Africa, between 2016 to 2018.
  - Both cities used green bonds for solving their investment needs to counteract the catastrophic event.
  - Rather than improving on their status quo, both cities still invested in projects that would deepen existing inequality.
  - In addition, the use of proceeds for climate adaption would intensify financial and environmental risks, which mainly affected the poor, people of color, and lower income households.

→ *What is the net effect of climate change mitigation efforts on inequality?*

→ *How does GF contribute to inequality?*

→ *What is the effect at the country level?*

→ *Can we see an inequality increasing effect in other situations?*

Finance and Sustainability

- Financial markets are key in the pursuit of sustainable development (Waygood, 2011; Scholtens, 2009; Weber, 2014; Youssef et al., 2020).
- Sustainable finance as a tool for climate change mitigation has been connected to the United Nations' Sustainable Development Goals (see e.g. Nedopil Wang et al., 2020; Ziolo et al., 2020), and the Paris Agreement on climate action (see e.g. Migliorelli, 2021; Kumar et al., 2022; Krueger et al., 2020), with both initiatives recognizing finance as the key enabling factor (Migliorelli and Dessertine, 2019).

$\rightarrow$ *We can see a large increase in green bond issuance volumes over the past decade.*

Financial Development and Inequality

- Agreement on a (causal) link but no consensus on functional form (Demirgüç-Kunt and Levine, 2009; Beck et al., 2007; Claessens and Perotti, 2007).
- Overall, an accumulating body of empirical results suggest that poorer households benefit rather than suffer from financial development (Demirgüç-Kunt and Levine, 2009).

→ *Is green finance part of financial development?*

→ *Does green finance behave similar to financial development?*

Innovation and a Low-Carbon Economy

- Innovation is key for the transformation to a green economy (Aghion et al., 2014; Hémous, 2021; Aghion et al., 2009) while maintaining or improving current living standards (Hémous, 2021).

→ *Are GF flows primarily directed towards the innovation of climate change mitigation technologies?*

→ *Does GF have different effects depending on a country's development status?*

→ *Can GF help to decouple emissions from growth in lesser developed countries?*

Innovation and Top Inequality

- The main cause for the increase in inequality is technological change (Acemoglu, 2002).
- New technologies, like the internet, created value which is extracted and distributed only to a small percentage of those people who initially contributed to the development and implementation of the new technologies (Lazonick and Mazzucato, 2013).
- Innovation is positively and significantly related with top income shares but not with general measures of inequality (Gini coefficient) (Aghion et al., 2018).
- It is the concentration of income at the top shares that is becoming central to the increase in income inequality (Lazonick and Mazzucato, 2013; Alvaredo et al., 2018; van Zanden et al., 2014; Aghion et al., 2018).

→ *Is innovation a potential channel through which GF affects inequality?*

→ *Does GF primarily help the top income earners?*

Green Finance and Innovation

- Two studies from China empirically link green finance to innovation.
- China set up pilot zones for green finance reforms and innovation.
- Zhang et al. (2022): positive effect on green technology innovation, as measured by the application and acquisition of green patents.
- Wang et al. (2022): enterprises significantly improve their green innovations by issuing green bonds.

→ *Can we link green finance to (green) innovation at the country level?*

Further Literature

→ *What other literature could contribute to this discussion?*

→ *Is there another angle from which our research question can be seen?*

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Research Design - The Panel in Short

The panel:

- i: individual country
- t: year (2004 to 2020)
- the individual observations are the combinations of i and t
- unbalanced: countries may drop out/in
- total of 36 countries covered in the analysis.

Research Design - The Panel in Short

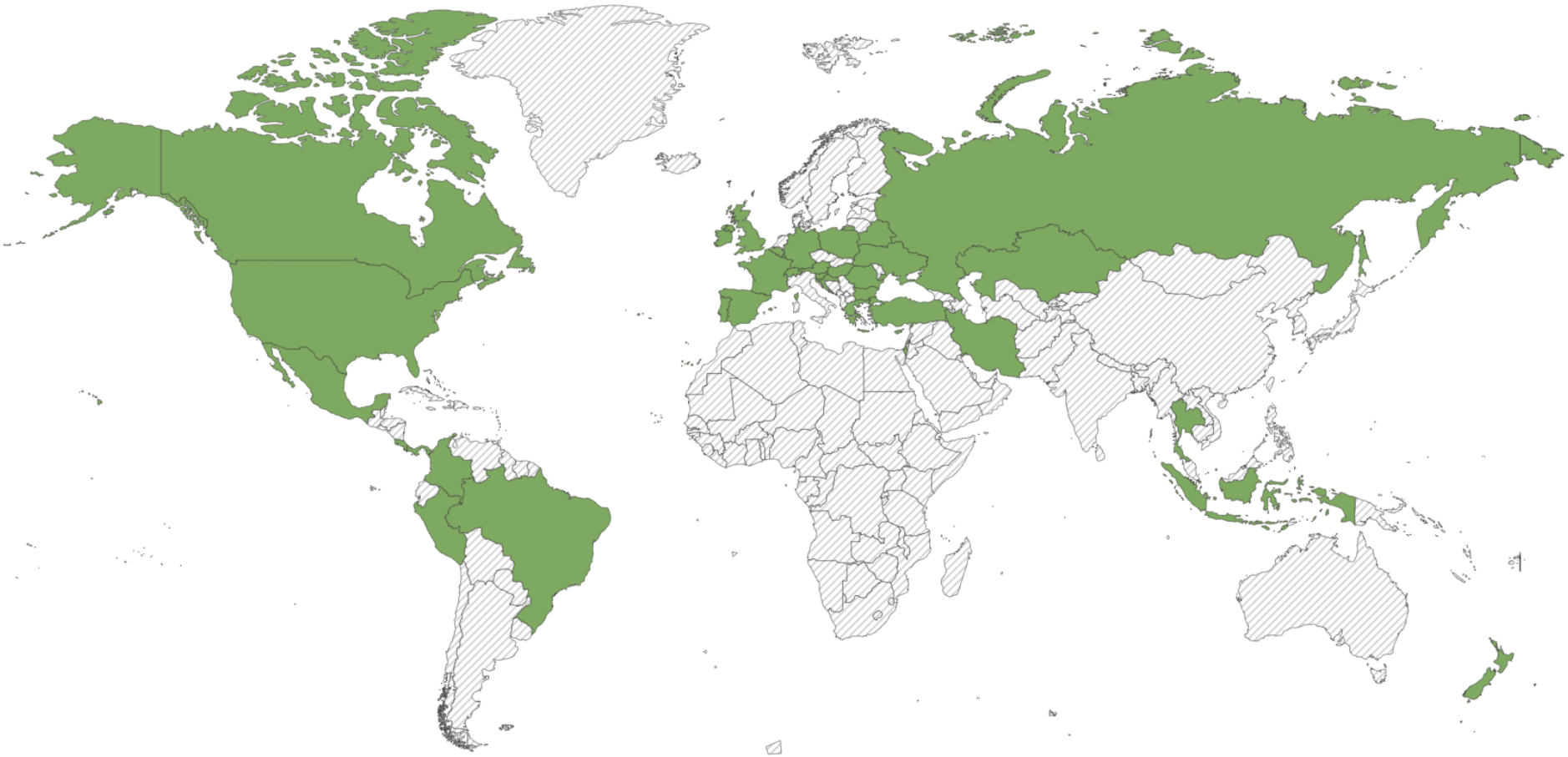
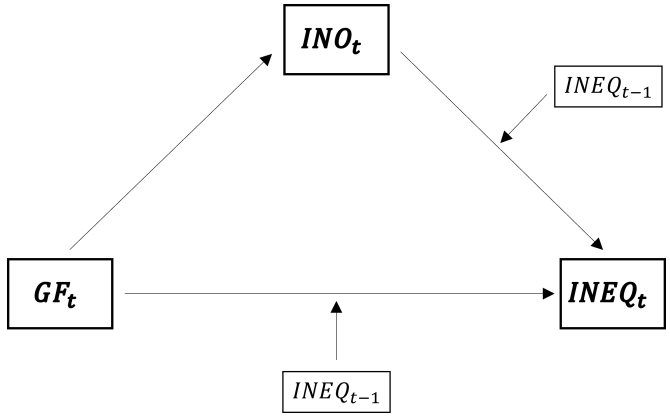


Figure: Countries covered in the analysis.

Research Design - Specifications



Part 1: Direct Effect

$$INEQ_{i,t} = \alpha GF_{i,t} + \beta_1 INEQ_{i,t-1} + \beta_2(GF_{i,t} \times INEQ_{i,t-1}) + \gamma' X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \quad (1)$$

Part 2: Moderated Mediation

$$INO_{i,t} = \alpha GF_{i,t} + \beta' X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \quad (2)$$

$$\begin{aligned} INEQ_{i,t} =& \alpha GF_{i,t} + \beta_1 INO_{i,t} + \beta_2 INEQ_{i,t-1} + \beta_3(GF_{i,t} \times INEQ_{i,t-1}) \\ &+ \beta_4(INO_{i,t} \times INEQ_{i,t-1}) + \beta_5 X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \end{aligned} \quad (3)$$

$INEQ$: Inequality
GF: Green finance
X: Control variables
δ_t, c_i, ϵ: time resp. individual-specific effects, error term

Research Design - Underlying Assumptions

GF_t is predetermined: affected by shocks to inequality ϵ_{t-s}, $s \geq 1$.

$\rightarrow$ *e.g.* $E[GF_t \epsilon_{t-1}] \neq 0$ and $E[GF_t \epsilon_t] = 0$

$INEQ_t$ is endogenous: affected by shocks to inequality ϵ_{t-s}, $s \geq 0$.

$\rightarrow$ *e.g.* $E[INEQ_t \epsilon_t] \neq 0$

System Generalized Method of Moments I

$$y_{it} = \alpha \quad y_{it-1} + \quad x'_{it}\beta + c_i + \quad \epsilon_{it} \tag{A}$$

$$\Delta y_{it} = \alpha \Delta y_{it-1} + \Delta x'_{it}\beta \quad + \Delta \epsilon_{it} \tag{B}$$

Why SGMM?

- remedy against reversed causality: inequality determines GF
- can handle weak exogeneity and endogeneity
- "small T - large N"
- removes unobservable individual-specific effect c_i
- difference GMM estimator suffers from two main problems:
  - dependence: $E\left[(\Delta\epsilon_{i,t})(\Delta\epsilon_{i,t-1})\right] \neq 0 \rightarrow$ common component: $\epsilon_{i,t-1}$
  - weak instruments: lagged x poorly predict future Δx

System Generalized Method of Moments II

Why does the method require instrumental variables? What are the underlying assumptions of the model?

$$\begin{aligned} y_{it} &= \alpha \quad y_{it-1} + \quad x_{it}'\beta + c_i + \quad \epsilon_{it} \\ \Delta y_{it} &= \alpha \Delta y_{it-1} + \Delta x_{it}'\beta \quad\quad + \Delta \epsilon_{it} \end{aligned}$$

- Predetermined variable x:
  1. *un*correlated with contemporaneous errors: $E[x_{i,t}\epsilon_{i,t}] = 0$
  2. future shocks do not affect today's x: $E[x_{i,t}\epsilon_{i,t+s}] = 0$, $s \geq 1$.

  $\Longrightarrow$ An unpredictable inequality shock in time t has impact in times $t+1, \ldots, T$ but not in $t, t-1, \ldots, 1$: $E[x_{i,t+s}\epsilon_{i,t}] \neq 0$, $s \geq 1$

  3. Problem in (B): $E\left[(\Delta x_{it})(\Delta \epsilon_{it})\right] = E\left[x_{it}\epsilon_{it-1}\right] \neq 0$
- Endogenous variable y:
  1. correlated with contemporaneous errors: $E[y_{i,t}\epsilon_{i,t}] \neq 0$
  2. future shocks do not affect today: $E[y_{i,t}\epsilon_{i,t+s}] = 0$, $s \geq 1$.
  3. Problem in (B): $E\left[(\Delta y_{it-1})(\Delta \epsilon_{it})\right] = E\left[y_{it-1}\epsilon_{it-1}\right] \neq 0$
- Problem in (A): $E[x_{it}(c_i + \epsilon_{it})] \neq 0$

System Generalized Method of Moments III

How does instrumenting work? What are the moment conditions?

$$\begin{aligned} y_{it} &= \alpha \quad y_{it-1} + \quad x_{it}'\beta + c_i + \quad \epsilon_{it} \\ \Delta y_{it} &= \alpha \Delta y_{it-1} + \Delta x_{it}'\beta \quad\quad + \Delta \epsilon_{it} \end{aligned}$$

- Predetermined variable x:
  1. Problem in (B): $E\left[(\Delta x_{it})(\Delta \epsilon_{it})\right] = E\left[x_{it}\epsilon_{it-1}\right] \neq 0$
  2. Solution: Instrument Δx_{it} with x_{it-s}, $s \geq 1$
  3. Moment conditions: $E\left[x_{it-s}(\epsilon_{it} - \epsilon_{it-1})\right] = 0$, $s \geq 1, \forall t$
- Endogenous variable y:
  1. Problem in (B): $E\left[(\Delta y_{it-1})(\Delta \epsilon_{it})\right] = E\left[y_{it-1}\epsilon_{it-1}\right] \neq 0$
  2. Solution: Instrument Δy_{it-1} with y_{it-s}, $s \geq 2$
  3. Moment conditions: $E\left[y_{it-s}(\epsilon_{it} - \epsilon_{it-1})\right] = 0$, $s \geq 2, \forall t$
- Problem in (A): $E[x_{it}(c_i + \epsilon_{it})] \neq 0$
  Solution: Instrument x_{it} with $\Delta x_{it} = x_{it} - x_{it-1}$
  Moment conditions: $E\left[(x_{it} - x_{it-1})(c_i + \epsilon_{it})\right] = 0$, $\forall t$
  Assumption: $E\left[x_{it}(c_i + \epsilon_{it})\right] = E\left[x_{is}(c_i + \epsilon_{it})\right]$, $\forall s, t$

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Green Finance

Bloomberg New Energy Finance: proprietary data on the transition to a low-carbon economy.

Green debt.

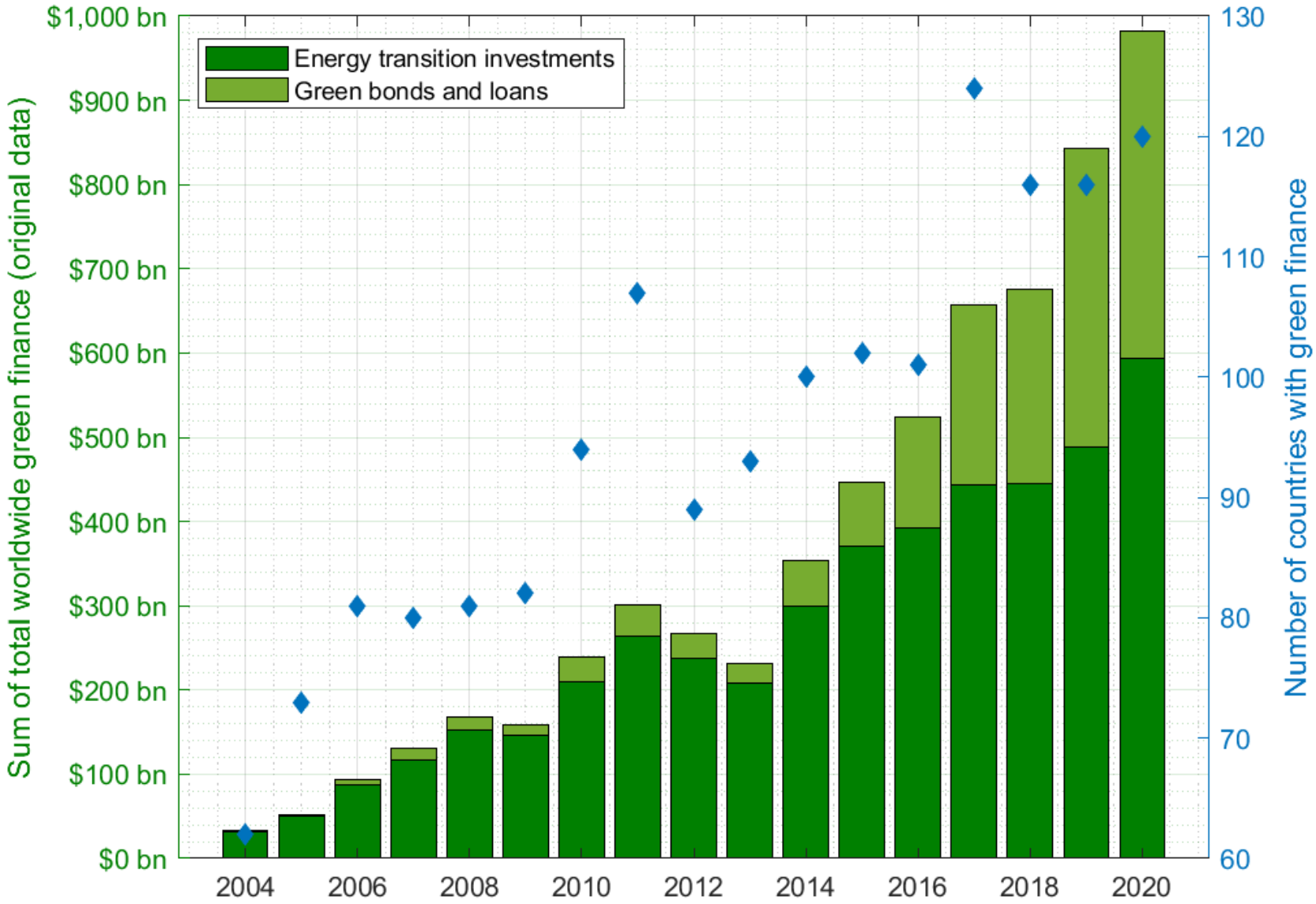
- Green debt and loans.
- Reported at the issuer level.
- Issuers can be corporate, municipal, and sovereign.
- Amount issued in $US.
- Allocation of green debt according to the country of risk.
- No supranational debt.

Energy Transition Investments.

- Investment flows into different energy transition sectors
  - renewable energy
  - electrified transport
  - electrified heat
  - carbon capture and storage
  - hydrogen
  - energy storage
  - sustainable materials
- Amount invested in $US.

$\rightarrow$ To obtain yearly values, we sum for each country and year the corresponding amounts issued.

Green Finance



Green Finance

Final variable is called GF.

It is the natural logarithm of the total amount issued per capita.

Green Finance

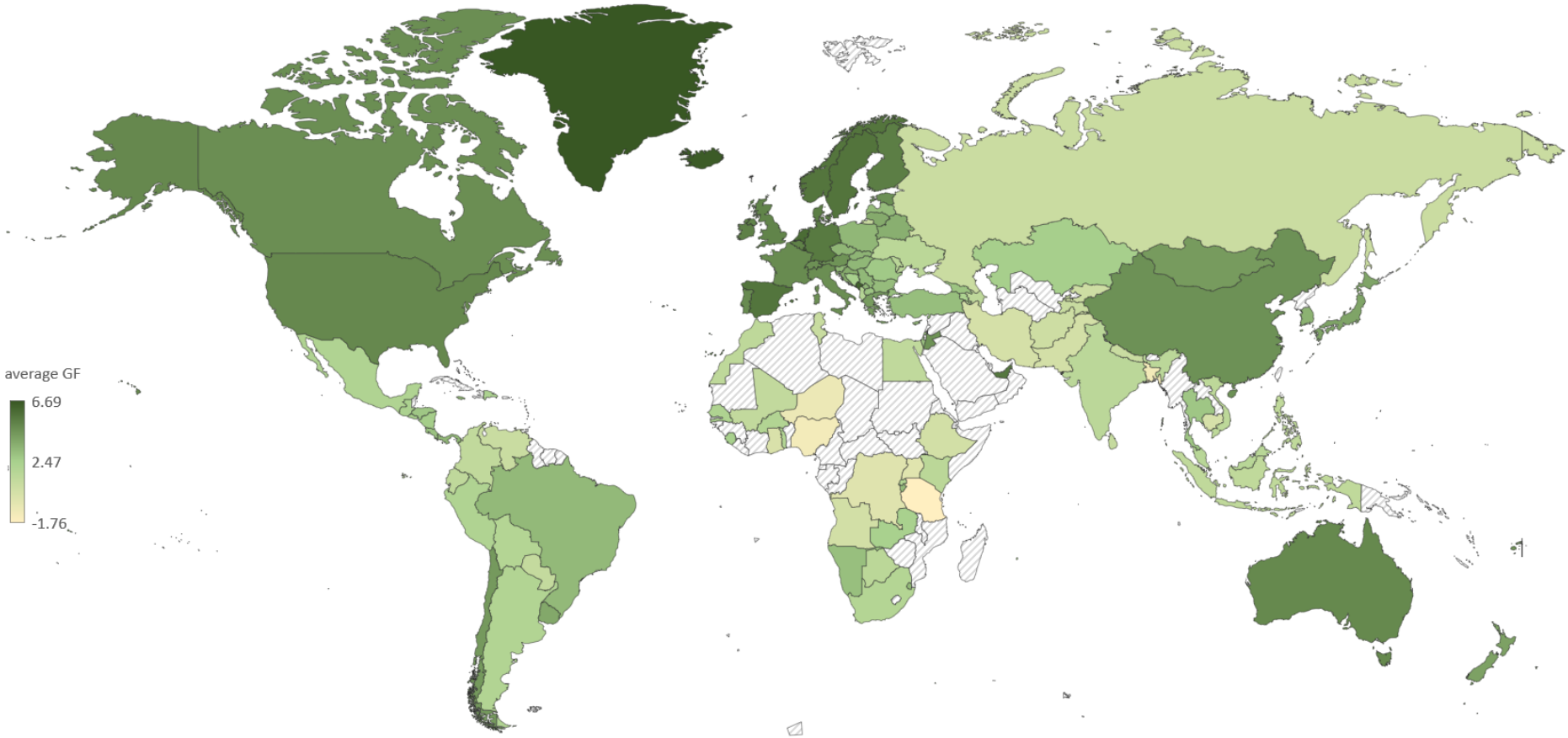
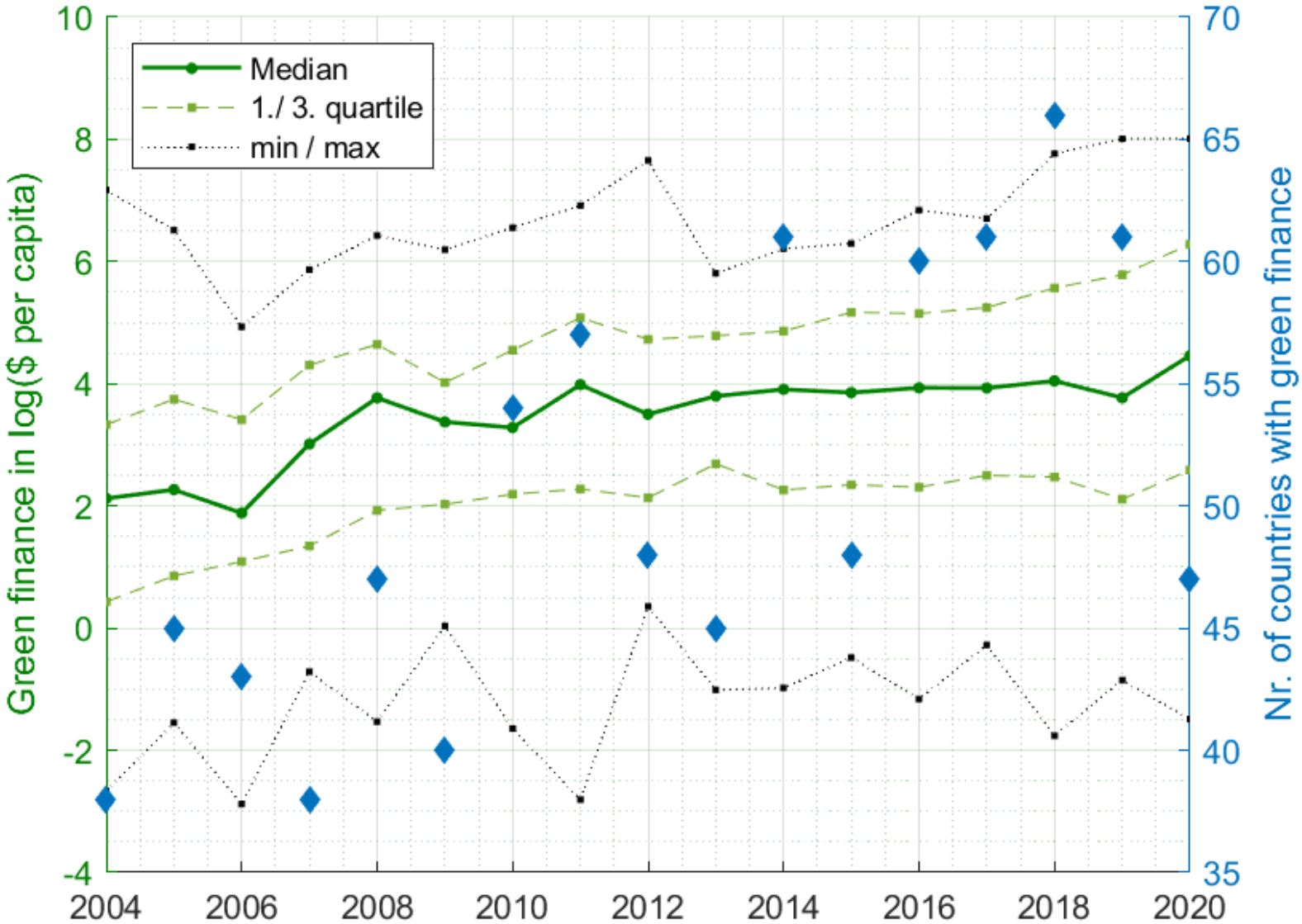


Figure: Average *GF* for each country from 2004 to 2020.

Green Finance



Inequality Data

- Source: UNU-WIDER
- Standardized data that allows to make comparisons between countries and over time.
- All indicators are scaled to lie between 0 and 100.
- Gini coefficient ($GINI$)
- Top income shares (TOPxx)
- Bottom income shares ($BTTM$xx)
- Restricted Gini (own computation based on Aghion et al. (2018)) ($GINI_{xx}$)

Control Variables

1. financial intermediary development: "domestic credit to private sector by banks (% of GDP)"
2. financial market development: "market capitalization of listed domestic companies (% of GDP)"
3. "school enrollment, secondary (% gross)"
4. "inflation, consumer prices (annual %)"
5. trade openness (trade is the sum of exports and imports of goods and services measured as a share of gross domestic product): "trade (% of GDP)"
6. "GDP per capita (current US$)"
7. "general government final consumption expenditure (% of GDP)"
8. "per capita CO2 emissions"
9. "Unemployment, total (% of total labor force)" (only in combination with innovation)
10. "Foreign direct investment, net inflows (% of GDP)" (only in combination with innovation)

Source: The World Bank

Economic Context

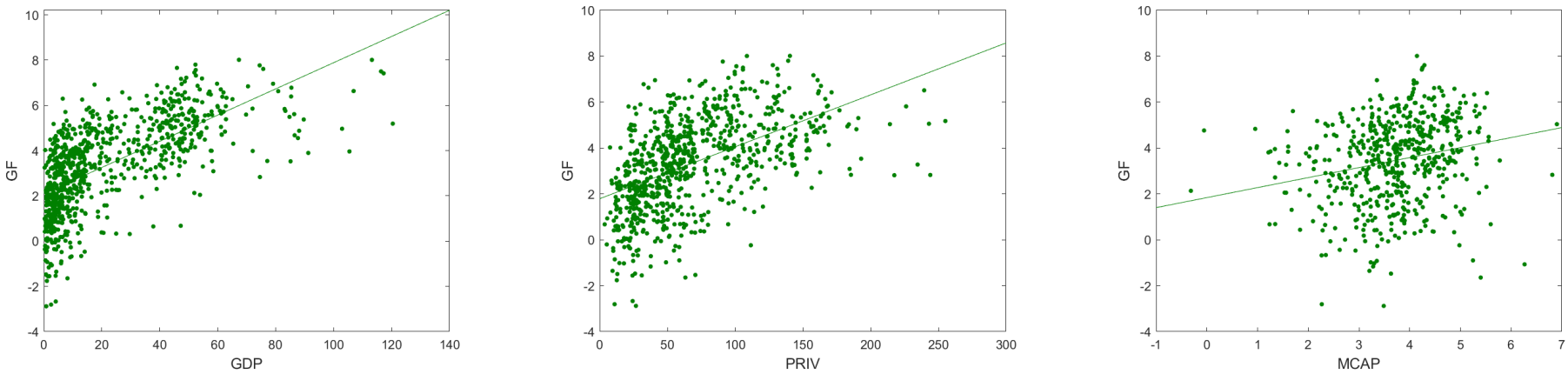


Figure: Scatterplots of *GF* against (left) GDP, (middle) financial development, and (right) market capitalization. The least squares line is indicated.

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Base specification - Regression Output

Table: Equation (1) including full covariate information.

	GINI	TOP50	TOP20	TOP10	TOP5	TOP1
GF	1.977**	3.5927**	2.5327**	2.1163**	1.2666**	0.5344*
	(0.7236)	(0.7371)	(0.5547)	(0.7043)	(0.7131)	(0.3729)
GF_GINIl	-0.058**					
	(0.0191)					
GF_TOP50l		-0.0481**				
		(0.0098)				
GF_TOP20l			-0.0681**			
			(0.015)			
GF_TOP10l				-0.0822**		
				(0.0238)		
GF_TOP5l					-0.0831**	
					(0.036)	
GF_TOP1l						-0.0718**
						(0.0348)
controls	yes	yes	yes	yes	yes	yes
time-fixed effects	yes	yes	yes	yes	yes	yes
J p-val	1	1	1	1	1	1
J statistic	0.1328	0.1328	0.1328	0.1328	0.1328	0.1328
R^2 adj	0.9928	0.9995	0.9983	0.9845	0.9462	0.8789
n mom	892	892	892	892	892	892
n diff	260	260	260	260	260	260
n level	267	267	267	267	267	267
n total	527	527	527	527	527	527
n unique	35	35	35	35	35	35

Base specifications - Economic Significance

Marginal effect of GF depends on the level of the lagged inequality variable. A p% increase in GF affects inequality as

$$\ln\left(\frac{100+p}{100}\right)(\alpha+\beta_2 INEQ_{i,t-1})$$

Example: Switzerland had an increase in *GF* of approx. 14% from 2018 to 2019, ending with 6.3918. How much would the top 20% income share change if *GF* were increased by the same percentage from 2019 to 2020?

$TOP20_{CHE,2019} = 35.0926$

$2.5327 * 0.131 - 0.0681 * 0.131 * 35.0926 = 0.0187$

The top 20% income share is expected to increase by 0.0187 percentage points.

Base Specification - Effect Visualization for *TOP*20

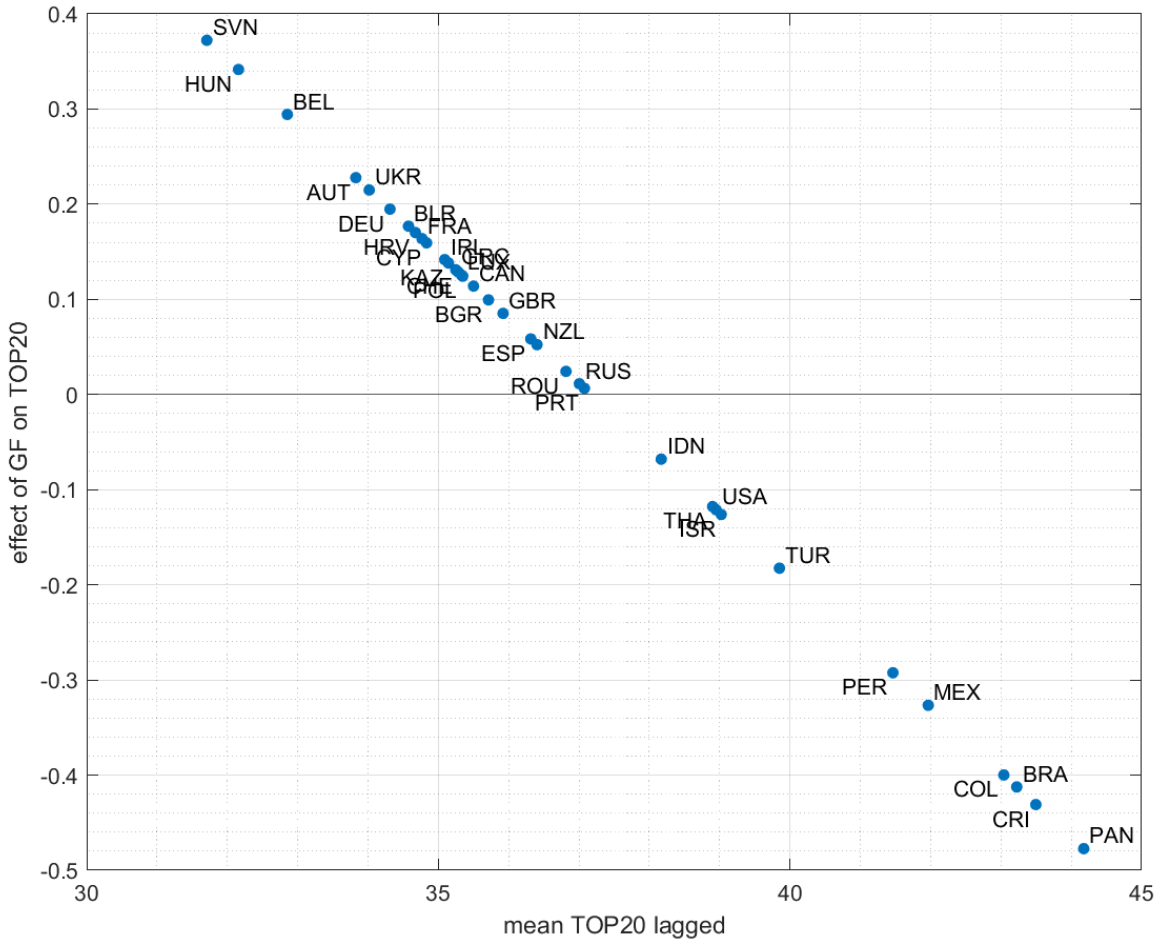

Figure: Effect of *GF* on *TOP*20 based on the average lagged inequality level of each country ($\alpha + \beta_2 \overline{INEQ}_i$). Effect turns negative from lagged *TOP*20 levels of 37.19 and higher.

Initial Value Regression - Setup

Are there country characteristics which can explain differences in the effects?

initial value: first value from 2004 onward for each country $\rightarrow$ tertiles

For
(1) financial development (FD)
(2) GDP
(3) Gini coefficient

Intermediate group is the reference group.

$$\begin{aligned} INEQ_{i,t} = \alpha GF_{i,t} + \beta_1 INEQ_{i,t-1} + \beta_2(GF_{i,t} \times INEQ_{i,t-1}) + \beta_3 Dh_i + \beta_4 Dl_i \\ + \beta_5(GF_{,i,t} \times Dh_i) + \beta_6(GF_{i,t} \times Dl_i) + \beta_7' X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \end{aligned} \tag{4}$$

Initial Value Regression - Results for *TOP*20

Table: Regression results for equation (4) for the top 20% income share.

initial	PRIV	GINI	GDP
		*TOP*20	
GF	2.7233**	5.0488**	3.1408**
	(0.4664)	(0.5305)	(0.7102)
Dh	-0.0238	0.9108*	1.2442*
	(0.8753)	(0.5789)	(0.7772)
Dl	0.1247	0.9472*	-0.5626
	(0.739)	(0.6876)	(0.6893)
GF_Dh	0.2016	0.3724**	-0.4055**
	(0.1993)	(0.1889)	(0.1725)
GF_Dl	0.3508**	-0.4916**	0.0632
	(0.1799)	(0.1535)	(0.1804)
controls	yes	yes	yes
time-fixed effects	yes	yes	yes
J p-val	1	1	1
J statistic	0.1346	0.1346	0.1346
R2adj	0.998	0.9976	0.9977
n mom	1167	1167	1167
mean init high	106.0201	41.6723	26.401
mean init medium	51.4827	36.6404	7.1939
mean init low	16.1934	33.9574	1.6617
n diff	260	260	260
n level	260	260	260
n total	520	520	520
n unique	35	35	35

Initial Value Regression - Effect Visualization FD

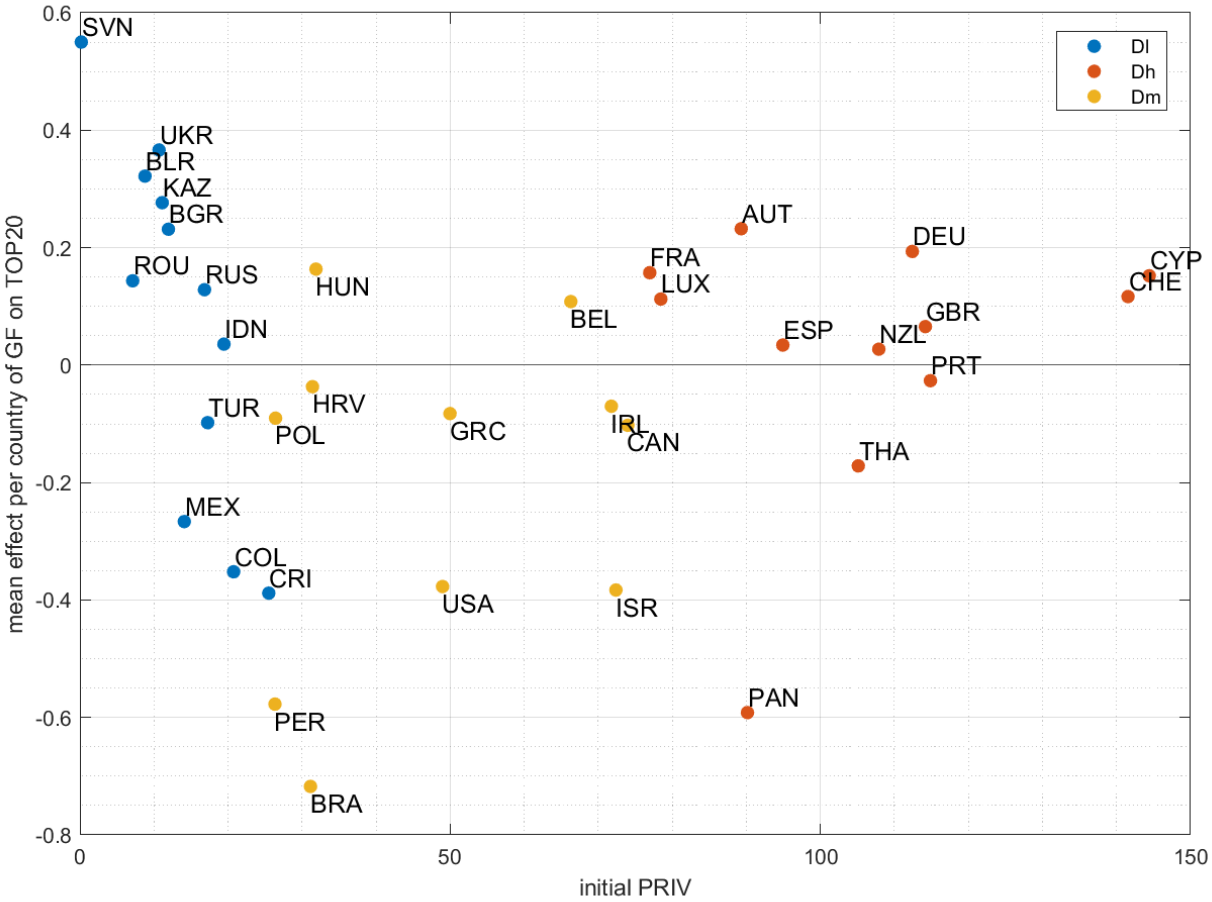

Figure: Effect of *GF* on *TOP*20 for each country as a function of its average lagged *TOP*20 level for initial *PRIV* categories.

Initial Value Regression - Effect Visualization *GDP*

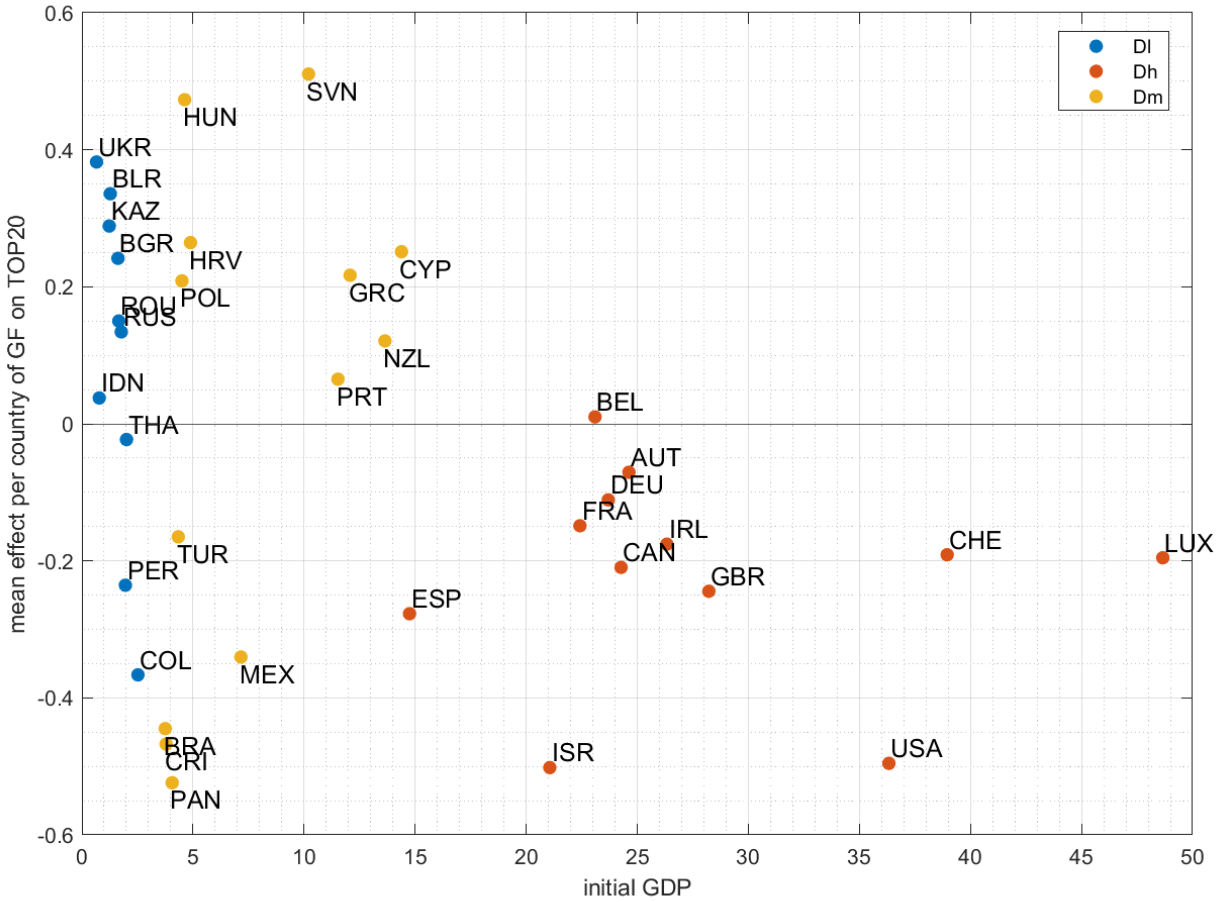

Figure: Effect of *GF* on *TOP*20 for each country as a function of its average lagged *TOP*20 level for initial *GDP* categories.

Initial Value Regression - Effect Visualization *GINI*

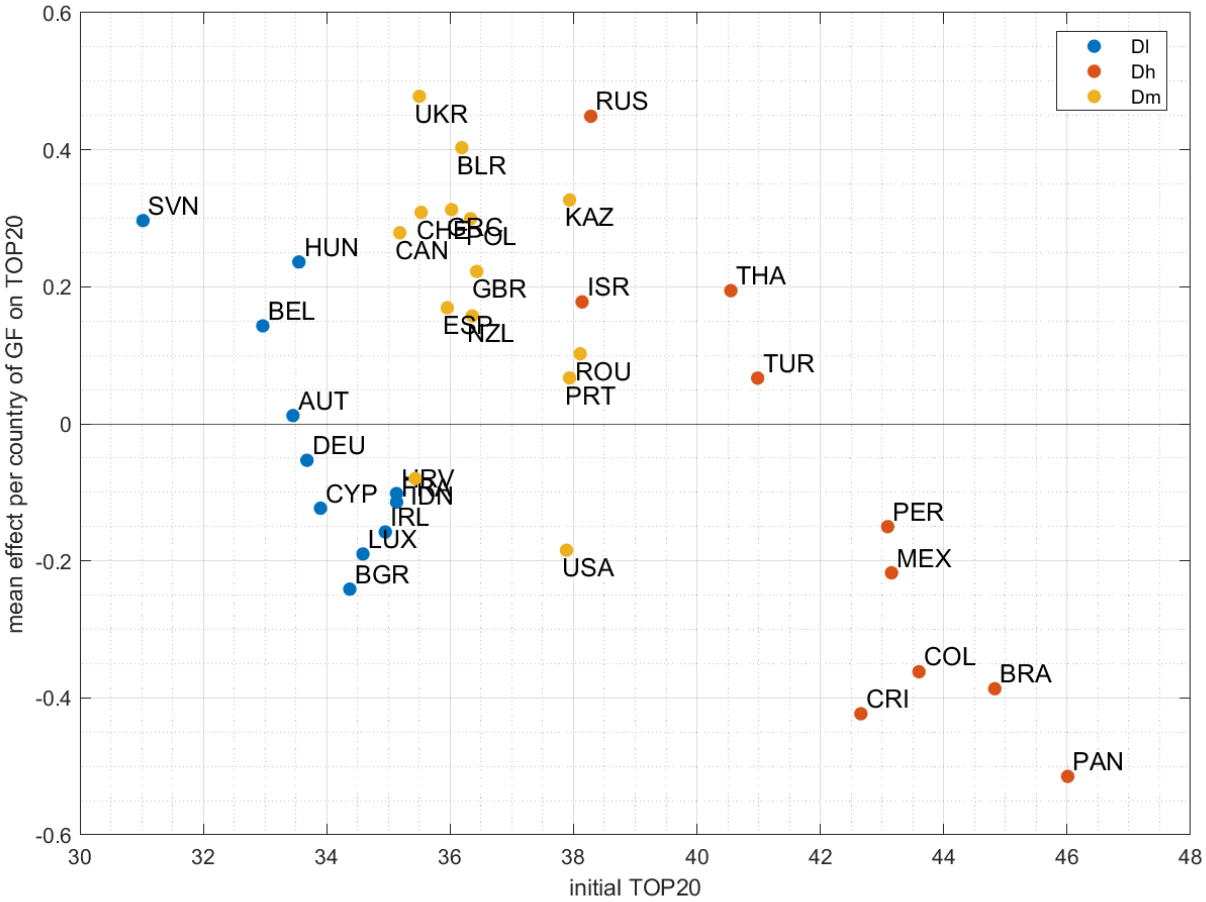

Figure: Effect of *GF* on *TOP*20 for each country as a function of its average lagged *TOP*20 level for initial *GINI* categories.

Initial Value Regression - Summary of Findings

- Increasing effects on the top 20% income share are associated with countries with
  - low and high levels of initial FD,
  - lower initial GDP levels, and
  - medium initial Gini coefficients.

- Decreasing effects on the top 20% income share are associated with countries with
  - medium levels of initial FD,
  - higher initial GDP levels, and
  - low and high initial Gini levels.

→ *Are our results in-line with findings from the financial development literature and with general development of inequality?*

→ *What other initial values could explain differences in the effects?*

Time Delayed Specification

What is the long-term effect of green finance on inequality?

$$z \geq 1: \quad INEQ_{i,t} = \alpha GF_{i,t-z} + \beta_1 INEQ_{i,t-1} + \beta_2 (GF_{i,t-z} \times INEQ_{i,t-z-1}) + \beta_3 INEQ_{i,t-z-1} + \beta_4 X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \tag{5}$$

- Adjustment of the interaction term: GF may vary with the lagged level of inequality
- GF_{t-z} is no longer predetermined $\forall z \geq 1$: $E[\Delta\epsilon_t \Delta GF_{t-z}] = 0$.
- $INEQ_{t-z-1}$ is exogenous $\forall z \geq 1$: $E[\Delta\epsilon_t \Delta INEQ_{t-z-1}] = 0$.

Time Delayed Specification - Results for *TOP*20

	lag 0	lag 1	lag 2	lag 3	lag 4	lag 5	lag 6	lag 7	lag 8	lag 9	lag10
GF_lag0	2.5327**										
	(0.5547)										
GF_lag1		0.6619*									
		(0.5028)									
GF_lag2			1.5448**								
			(0.7973)								
GF_lag3				2.1906**							
				(0.7701)							
GF_lag4					0.7453						
					(0.7446)						
GF_lag5						1.1724					
						(1.0154)					
GF_lag6							1.9402**				
							(0.8117)				
GF_lag7								-0.4715			
								(1.5853)			
GF_lag8									2.5194**		
									(1.3221)		
GF_lag9										-1.5325**	
										(0.8148)	
GF_lag10											-0.954
											(1.5974)
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
time-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
J p-val	1	1	1	1	1	1	1	1	1	1	1
J statistic	0.1328	0.1328	0.1391	0.1417	0.1398	0.1518	0.1742	0.1802	0.199	0.2331	0.2388
R^2 adj	0.9983	0.9969	0.996	0.9964	0.9976	0.9986	0.9917	0.9879	0.9954	0.9971	0.988
n mom	892	540	476	416	360	308	260	216	176	140	140
n diff	260	225	197	173	156	143	124	105	90	76	60
n level	267	257	220	194	173	160	140	117	101	87	74
n total	527	482	417	367	329	303	264	222	191	163	134
n unique	35	32	29	26	23	23	23	20	19	19	16

Time Delayed Specification - Results for *TOP*1

	lag 0	lag 1	lag 2	lag 3	lag 4	lag 5	lag 6	lag 7	lag 8	lag 9	lag10
GF_lag0	0.5344*										
	(0.3729)										
GF_lag1		0.2367									
		(0.3546)									
GF_lag2			1.0618**								
			(0.3899)								
GF_lag3				0.7553**							
				(0.2921)							
GF_lag4					1.1141**						
					(0.5261)						
GF_lag5						0.851**					
						(0.3341)					
GF_lag6							0.8353**				
							(0.322)				
GF_lag7								0.4155			
								(0.544)			
GF_lag8									0.0393		
									(0.6081)		
GF_lag9										0.2538	
										(0.4627)	
GF_lag10											0.175
											(0.3701)
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
time-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
J p-val	1	1	1	1	1	1	1	1	1	1	1
J statistic	0.1328	0.1328	0.1391	0.1417	0.1398	0.1518	0.1742	0.1802	0.199	0.2331	0.2388
R^2 adj	0.8789	0.824	0.8194	0.9351	0.8544	0.9636	0.8002	0.8428	0.9001	0.8663	0.819
n mom	892	540	476	416	360	308	260	216	176	140	140
n diff	260	225	197	173	156	143	124	105	90	76	60
n level	267	257	220	194	173	160	140	117	101	87	74
n total	527	482	417	367	329	303	264	222	191	163	134
n unique	35	32	29	26	23	23	23	20	19	19	16

Time Delayed Specification - Results for *GINI*

	lag 0	lag 1	lag 2	lag 3	lag 4	lag 5	lag 6	lag 7	lag 8	lag 9	lag10
GF_lag0	1.977**										
	(0.7236)										
GF_lag1		0.2128									
		(0.9686)									
GF_lag2			2.2873**								
			(1.1807)								
GF_lag3				2.2171**							
				(0.9697)							
GF_lag4					1.6446**						
					(0.9769)						
GF_lag5						1.9483**					
						(1.1136)					
GF_lag6							2.0779**				
							(0.8676)				
GF_lag7								0.1348			
								(1.3819)			
GF_lag8									1.4061*		
									(0.9442)		
GF_lag9										-0.0388	
										(1.1905)	
GF_lag10											0.3302
											(1.3459)
controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
time-fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
J p-val	1	1	1	1	1	1	1	1	1	1	1
J statistic	0.1328	0.1328	0.1391	0.1417	0.1398	0.1518	0.1742	0.1802	0.199	0.2331	0.2388
R^2 adj	0.9928	0.9653	0.958	0.985	0.9725	0.9908	0.946	0.9357	0.9796	0.9756	0.949
n mom	892	540	476	416	360	308	260	216	176	140	140
n diff	260	225	197	173	156	143	124	105	90	76	60
n level	267	257	220	194	173	160	140	117	101	87	74
n total	527	482	417	367	329	303	264	222	191	163	134
n unique	35	32	29	26	23	23	23	20	19	19	16

Time Delayed Specification - Summary

- A one-year lag does not yield significant effects.
- Lags 2 - 4 often yield the highest effects.
- GF_t is associated with inequality $INEQ_{t+s}$, with s up to 5 and more.

Robustness

1. Bottom income shares and restricted Gini coefficient
   - Bottom 5%, 20%, 50%.
   - Restricted Gini coefficient on the bottom 80%, 90%, and 95% of the distribution.

2. Other measures of green finance
   - Separate components of *GF*.
   - Green bond data from (i) Refinitiv, (ii) Climate Bonds Initiative.
   - Sustainable debt data from BNEF (green bonds incl. social and sustainability labeled debt).

3. Other environmental controls
   - Country Sustainability Ranking from RobecoSAM.
   - Environmental tax revenue per capita.

4. Institutional quality control
   - Chong and Gradstein (2007) show that there is strong reversed causality in both directions between institutional quality and inequality.
   - Khan et al. (2022) establish a positive link between institutional quality and financial development.
   - Rule of Law Index
   - Property Rights Index
   - Government Effectiveness Index
   - Control of Corruption Index

Robustness - Results for restricted Gini

Table: Equation (1) including full covariate information.

	GINI80	GINI90	GINI95
GF	-0.0983**	-0.0017	0.0037*
	(0.0227)	(0.0014)	(0.0028)
GF_GINI80l	-0.064**		
	(0.014)		
GF_GINI90l		-0.0204	
		(0.0291)	
GF_GINI95l			-0.0373**
			(0.0218)
J p-val	1	1	1
J statistic	0.1328	0.1328	0.1328
R^2 adj	0.9931	-0.2499	0.8194
n mom	892	892	892
n diff	260	260	260
n level	267	267	267
n total	527	527	527
n unique	35	35	35

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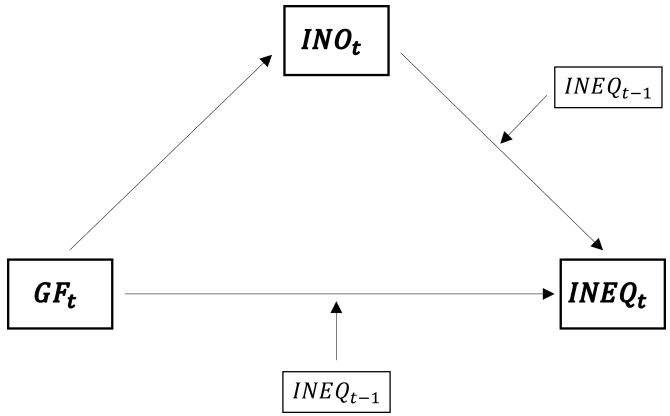
Part II - Moderated Mediation Design



$$INO_{i,t} = \alpha GF_{i,t} + \beta_1 X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \tag{2}$$

$$\begin{aligned} INEQ_{i,t} =& \alpha GF_{i,t} + \beta_1 INO_{i,t} + \beta_2 INEQ_{i,t-1} + \beta_3 (GF_{i,t} \times INEQ_{i,t-1}) \\ &+ \beta_4 (INO_{i,t} \times INEQ_{i,t-1}) + \beta_5 X_{i,t} + \delta_t + c_i + \epsilon_{i,t}. \end{aligned} \tag{3}$$

$\Longrightarrow$ Compared to (1), we want to see a reduction in the effect of GF in (3).

Part II - Innovation Data

- Total expenditure on R&D carried out by all resident companies, research institutes, universities and government laboratories, etc., in a country.
- "Research and development expenditure (% of GDP)"
- Source: The World Bank

Part II - First Explorative Results for *RD*

Table: Equation (1) including full covariate information.

	GINI	TOP50	TOP20	TOP10	TOP5	TOP1
GF	1.977**	3.5927**	2.5327**	2.1163**	1.2666**	0.5344*
	(0.7236)	(0.7371)	(0.5547)	(0.7043)	(0.7131)	(0.3729)
GF_INEQI	-0.058**	-0.0481**	-0.0681**	-0.0822**	-0.0831**	-0.0718**
	(0.0191)	(0.0098)	(0.015)	(0.0238)	(0.036)	(0.0348)

Table: Equation (3) results.

	GINI	TOP50	TOP20	TOP10	TOP5	TOP1
GF	1.3033**	1.5999*	1.5798**	1.2688**	0.581	0.1664
	(0.6567)	(1.2454)	(0.6361)	(0.4741)	(0.5233)	(0.2771)
GF_INEQI	-0.0339**	-0.0212*	-0.042**	-0.0427**	-0.0311	-0.0189
	(0.0166)	(0.0165)	(0.0177)	(0.0157)	(0.0272)	(0.0291)
RD	8.9822**	13.0856**	7.3865**	9.0997**	6.3009**	3.0363**
	(2.3498)	(3.5642)	(2.3115)	(3.0472)	(2.7725)	(1.4245)
n total	458	458	458	458	458	458
n unique	33	33	33	33	33	33

Part II - First Interpretation

- The coefficients of *GF* in (3) are reduced and turn insignificant with increasing top income shares.
- R&D spendings are associated with a significant increase in inequality in the presence of green finance.

→ *Are R&D spendings a suitable proxy for innovation?*

→ *How "strong" is the mediating effect?*

→ *Does the mediating effect have economic significance?*

→ *How does the mediating effect differ for different countries?*

→ *What other channel could explain a positive effect from green finance on inequality?*

Part II - Other Innovation Measures and Channels

Other innovation measures:

- Number of "patent applications (residents)" per capita and in natural logarithm.
- Patents in environmental related technologies as a share of total patents granted.
- Environmental R&D spendings.

Other potential channels:

- Environmental outcomes
- ...

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Conclusion

Some answers to previous questions:

- *Does GF help the most vulnerable population groups?* — *GF* does not significantly affect the income share of the bottom 5%, but it is associated with an increase in the income share of the bottom 20%.
- *How does GF contribute to inequality?* — On average, *GF* is associated with an increase in inequality. However, we see large effect differences between countries.
- *Does GF have different effects depending on a country's development status?* — Countries with low/high financial development, or low GDP, or medium Inequality can expect inequality to rise.
- *Does GF primarily help the top income earners?* — The top income earners benefit disproportionately more.

Thank you!

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