Ha Nguyen

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DOES INCOME INEQUALITY NEGATIVELY AFFECT GDP GROWTH? A PANEL STUDY

As wealth and income inequality rocket in many regions according to the World Inequality Report 2018[1], Pew Research, 2020[2], and UN World Social Report 2020[3], simultaneously rising is the occurrence of turbulences from both natural and socio-economic causes, which diretly lead to the losses of potential economic growth. Therefore, it is worth asking the question whether inequality, which can be felt at an individual level and also a phenomenon on a macro-economic level, would hamper the potentials for economic growth via many economic channels such as social instability as aforementioned. This area of research is also resurfacing due to discussions of inequality being in the spotlight on political platforms. Literature regarding this relationship between inequality and economic growth has not reached a consensus, yet more recent theories and research with currently available data continue to transform the relationship of inequality and growth, examining it under many complex lights, for example, the possibility of a non-linear correlation or the involvement of other factors previously not included. Considering these new developments, this decade-long question is worth revisiting. This paper is dedicated to studying the impacts of income inequality, expressed by the GINI index, on the growth of countries' economies, which would be measured through their GDP per capita annual growth rates, using the most recent data set from the World Bank.

In investigating the income distribution-economic growth dynamics, it is highly relevant to mention one of the forerunners in this discussion whose theory predicts the ultimate end of this relationship. Ricardo, during the 19th century, began arguing systematically about the effects of income distribution on growth, through his Distribution Theory. He contemplated that, as the world population increases, the total wages would increase, while production was plagued with

[1] Alvaredo et. al, World Inequality Report, 2018. https://wir2018.wid.world/
[2] Horowitz et. al., "Trends in Income and Wealth Inequality", Pew Research Center, 2020. https://www.pewresearch.org/social-trends/2020/01/09/trends-in-income-and-wealth-inequality/
[3] Department of Economic and Social Affairs, "World Social Report 2020: Inequality in a rapidly changing world", United Nations, 2020. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/02/World-Social-Report2020-FullReport.pdf

diminishing marginal returns. Thus, profits for capitalists would gradually fall until it was eliminated completely, at which point, there would be no capital investment forthcoming and the economy would reach a stagnant state[4] ("The Evolution of Economic Thought", Brue and Grant, p. 122). In short, the Distribution Theory implies that the mechanism which caused the unequal distribution of wealth among socio-economic classes would halt economic growth, since wealth would not be re-invested in production in the most efficient manners.

Ricardo's theory looks simple: wealth inequality would have a strong negative effect on growth. However, previous research papers in this discipline, which differ in terms of countries in the data sample, time periods, and model specifications, yielded significantly disparate results. Most cross-sectional studies found a negative correlation while research that used time-series and panel data with fixed effects revealed a positive relationship. To complicate the matter further, the conclusions of these research were not straight-forward, cautioning the possible heteroskedascity that were not accounted for in the cross sectional models (which will later be addressed in this paper), as well as the validity of the relationship outside of the data collected in time-series and panel models. It is truly as Michael Bleaney observed:

> "The majority of existing cross-sectional studies of the growth–inequality relationship report negative and significant coefficients for initial income inequality (see Alesina and Perotti, 1996, Chang and Ram, 2000, Deininger and Squire, 1998, Persson and Tabellini, 1994)… Forbes (2000) reports a significant positive coefficient in panel data using fixed effects estimation, which effectively removes the cross-sectional dimension (see also Banerjee and Duflo, 2000)"[5]

However, in Forbes' research which detected a significant positive correlation, the researcher cautioned that the result was only appropriate for short and medium term:

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[4] The Evolution of Economic Thought, by Stanley L. Brue and Randy R. Grant, Cengage Learning Asia Pte Ltd, 2019, p. 122.

[5] Michael Bleaney, Akira Nishiyama, Economics Letters, volume 84, issue 3, 2014, p.349-355 https://www.sciencedirect.com/science/article/pii/S0165176504001028

> "Results suggest that in the short and medium term, an increase in a country's level of income inequality has a significant positive relationship with subsequent economic growth."[6]

With this new development of adding a time dimension and the consideration for "level of income inequality" in its relationship with growth, there has been a number of growing theories that income inequality's impact on GDP may conform to an inverted U-shape, such as the tradeoffs of growth by Benhabib in 2003[7], the political distribution-saving theories by Kuznets[8], and an empirical research by Halter et. al in 2014[9] using an intertemporal model of both positive (savings) and negative channels (politics) via which inequality was theorized to affect growth. It is this most recent development—a more elaborately theorized dynamics of the relationship contemplated by Ricardo three centuries earlier, that prompted this paper to utilize the quadratic form of the income inequality measure variable, the GINI coefficient, for regression analysis.

In addition, despite various different results in both direction of GINI impact on GDP and the significance of the impact, it is realized through a number of preceding scholarly studies that the effect of the GINI index on an economy's growth may depend on where an economy is at, in other words, its GDP level. Bleaney and Nishiyama's paper also mentioned this phenomenon:

> "Partridge (1997) conjectures that the sign of the effect of income inequality on growth (GINI coefficient) varies with per capita income levels. In a cross-country sample, Barro (2000) reports evidence consistent with this conjecture, the division coming at a PPP-adjusted per capita GDP of $2070 (1985 US dollars)". (Bleaney and Nishiyama, Economics Letters volume 84, issue 3, 2004).[5]

Indeed, in 1999, the research about the impact of GINI on GDP per capita growth in the period of 1970-1990, using panel data, by Robert J. Barro from Harvard University revealed that:

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[6] Forbes, Kristin, J. 2000. "A Reassessment of the Relationship between Inequality and Growth." *American Economic Review*, 90 (4): 869-887.

[7] Jess Benhabib, 2003. "The Tradeoff Between Inequality and Growth," Annals of Economics and Finance, Society for AEF, vol. 4(2), pages 491-507, November.

[8] Kuznets, Simon. "Economic Growth and Income Inequality." *The American Economic Review*, vol. 45, no. 1, 1955, pp. 1–28. *JSTOR*, www.jstor.org/stable/1811581.

[9] Halter, Daniel, et al. "Inequality and Growth: the Neglected Time Dimension." *Journal of Economic Growth*, vol. 19, no. 1, 2014, pp. 81–104., www.jstor.org/stable/44113419.

"Evidence from a broad panel of countries shows that for growth, there is an indication that inequality retards growth in poor countries but encourages growth in richer places."[10]

Therefore, this paper's regression model will include an interaction term between the GINI coefficient for income inequality and a dummy variable which distinguishes between high income and low income countries. It is worth noting that the study by Bleaney and Nishiyama refuted Barro's hypothesis that there existed differentials of GINI effects on GDP between different GDP levels[5].

"**The estimated coefficients of initial income inequality are extremely similar for rich and poor countries…**we test whether the initial Gini coefficient varies with per capita GDP by adding an interaction term between these two variables to the regression**"**

However, Bleaney and Nishiyama's research interacted GINI coefficient and GDP per capita, while my research interacts GINI coefficient and the dummy variable "I", which separates the countries to 2 income groups—high and low, based on World Bank's classification of high and low income countries, which in turn, has been calculated based on Gross National Income (GNI) per capita and to determine lending credits internationally. Therefore, this paper is, to an extent, demonstrating a clearer separation between high income/high-performing and lower performing economies in relative term, in studying the impact of GINI on growth. With this disparity in specification of countries' income levels, this paper confirms Barro's conclusion that inequality's effect on growth is heterogenous as after performing robust tests, the interaction term is consistently positive and significant.

Using the quadratic model with the aforementioned interaction term in the regression, this paper's empirical result confirms the most recent literature findings that the relationship between income inequality and economic growth conforms to a non-linear, inverted U curve, and that an initial rise in inequality in higher income countries will contribute more positively to growth than in lower income countries. This result, especially the interaction term's significance and sign, is robust across models with different variables and specifications.

Interestingly, the Kuznet U-curve empirical observation of GDP growth's impact on GINI—or the reverse side of this paper's question, is not found in the data set and model regression.

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[10] Barro, Robert J., "Inequality and Growth in a Panel of Countries", Journal of Economic Growth, 5: 5–32 (March 2000) https://scholar.harvard.edu/barro/files/p_inequalitygrw.pdf

However, Kuznet's curve is criticized for its implicit heteroskedascity, thus inevitably, its fragility in data outside its originating period (1930-1950), as corroborated by Barro:

> "The full relationship between an indicator of inequality, such as a Gini coefficient, and the level of per capita product is described by an inverted-U, which is the curve named after Kuznets. Inequality first rises and later falls as the economy becomes more developed…Subsequent work suggested that the relation had weakened over time, see Anand and Kanbur (1992). Li, Squire, and Zou (1998) argue that the Kuznets curve works better for a cross section of countries at a point in time than for the evolution of inequality over time within countries." [10]

Since the data set used in this paper is panel, it is not abnormal that the evidence for Kuznets curve does not prevail.

The empirical model employed in this research is as follow:

$$GPC_{grwt} = \beta_0 + \beta_1 \text{exp\_grwt} + \beta_2 \text{cons\_grwt} + \beta_3 \text{povcount} + \beta_4 \text{cf\_grwth} + \beta_5 gini + \beta_6 gini\_sq + \beta_7 \text{I} + \beta_8 (\text{I*gini})$$

The paper will use the statistical technique of regressions, fitting the values of income inequality degrees (GINI) with the growth rates of GDP per capita, to detect and examine the relationship between them. Particularly, I am interested in estimating a regression model that expresses GDP growth as a function of the growth rates of consumption, export, capital investment, poverty rates and the GINI index. The data set to which this method is applied in this research is a panel data set, consisting of 146 countries over a twenty-seven-year period from 1992 to 2018. All data is collected from the World Bank database.

As detailed previously, the model of the regression equation is polynomial after considering previous literature and recent developments which suggest that, an initial elevation of income inequality can have a positive correlation to GDP, yet as it increases to a detrimentally high level, inequality begins to have a negative impact on GDP. This hypothesized relationship—an inverted U curve, is mathematically equivalent to the expectation that the GINI variable's estimated coefficient will first take on the positive sign, and then its squared form counterpart will become negative. Secondly, the dummy variable "I" is included (with "I" equals 1 if the observation is from a high income country, and 0 if otherwise), as well as the interaction term, to investigate whether the effect varies between different income levels of countries according to

literatures. This interaction term is expeted to be positive since the previously mentioned research by Barro found a positive relationship for high income countries. Finally, it is worth mentioning that the regression model includes other variables that have a large impact on GDP, such as consumption, export, capital formation, and poverty rates, so that the model will not suffer from omitted variables. Unemployment rate will be used in robustness tests.
The table below summarizes the variables used in this paper and their coefficient's expected sign.

Variable	Expected sign
Export, consumption, capital investment	(+)
Poverty	(-)
GINI	(+)
$GINI^2$	(-)
Interaction term (I = 1 means high-income level, 0 if otherwise)	(+)

A detailed list of variables and their definitions by the World Bank is included in Appendix 1.

The panel data employed in this paper is summarized by the following table.

Variable	Mean	Std.Dev.	Min	Max	Observations	
country overall	.	.	.	.	N	= 0
between	.	.	.	.	n	= 0
within	.	.	.	.	T	= .
year overall	2005	7.790	1992	2018	N	= 3942
between		0	2005	2005	n	= 146
within		7.790	1992	2018	T	= 27
gpc_grwt overall	2.261	4.826	-47.591	37.536	N	= 3796
between		1.838	-7.681	8.896	n	= 145
within		4.524	-49.189	35.850	T-bar	= 26.179
exp_grwt overall	6.534	14.048	-91.880	158.190	N	= 3198
between		4.574	-6.627	24.154	n	= 136
within		13.440	-87.540	151.482	T-bar	= 23.515
gini9218 overall	38.590	9.230	20.700	65.800	N	= 1477
between		8.316	24.886	61.714	n	= 145
within		2.881	28.490	55.415	T-bar	= 10.186
cons_g~t overall	3.754	5.634	-34.861	76.923	N	= 3078
between		1.945	-0.583	10.639	n	= 128
within		5.372	-34.505	74.643	T-bar	= 24.047
povcou~t overall	24.423	14.541	1.3	83.300	N	= 1014
between		15.581	6.6	71.600	n	= 134
within		6.976	1.493	83.493	T-bar	= 7.567

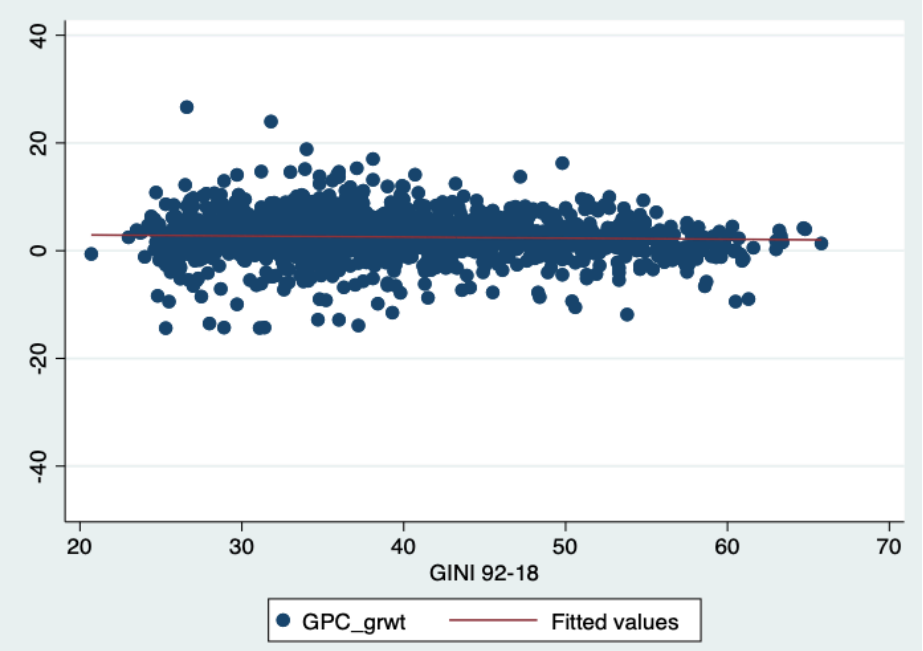
ue_grwt overall	7.988	6.171	0.317	49.700	N	= 3847
between		6.029	0.844	38.173	n	= 143
within		2.271	-3.480	23.072	T-bar	= 26.902
cf_grwt overall	5.985	33.314	-1068.562	887.580	N	= 3194
between		27.449	-308.657	38.064	n	= 138
within		30.424	-753.920	855.496	T-bar	= 23.145

It is worth cautioning that the unit of these variables are in percentage as these are growth rates, which directly alleviates the variance in the data, thereby limiting the issue of heteroskedascity which can cause unreliable hypothesis testing results. Moreover, using the data of growth rates is intended to substitute for the use of log form, which causes a loss of negative observations and further limits the size of the sample (which is already reduced due to the unavailability of the GINI coefficient across countries and years). With the use of robust standard error later detailed in this paper, it is expected that heteroskedascity—the problem that plagued previous cross-sectional literature, would not be as much of an issue and the results can thus be read as truly unbiased estimates. Secondly, from the table, it is realized that GINI and poverty rate have the least variation in time; their variation occurs mainly across countries. The opposite is true for economic aggregates: GDP per capita, capital formation, exports, consumption all vary within the same country. This indicates fixed effect regression could be the most appropriate for this sample data. Thirdly, the data set includes more low-income countries than high income ones; however, the difference is not large. The summary table of the dummy variable below reveals that fifty-nine percent of observations are from low-income countries and forty-one percent belongs to high-income counterparts, which shows a quite balanced data set.

I	Freq.	Percent	Cum.
0	2299	59.44	59.44
1	1569	40.56	100.00
Total	3868	100.00	

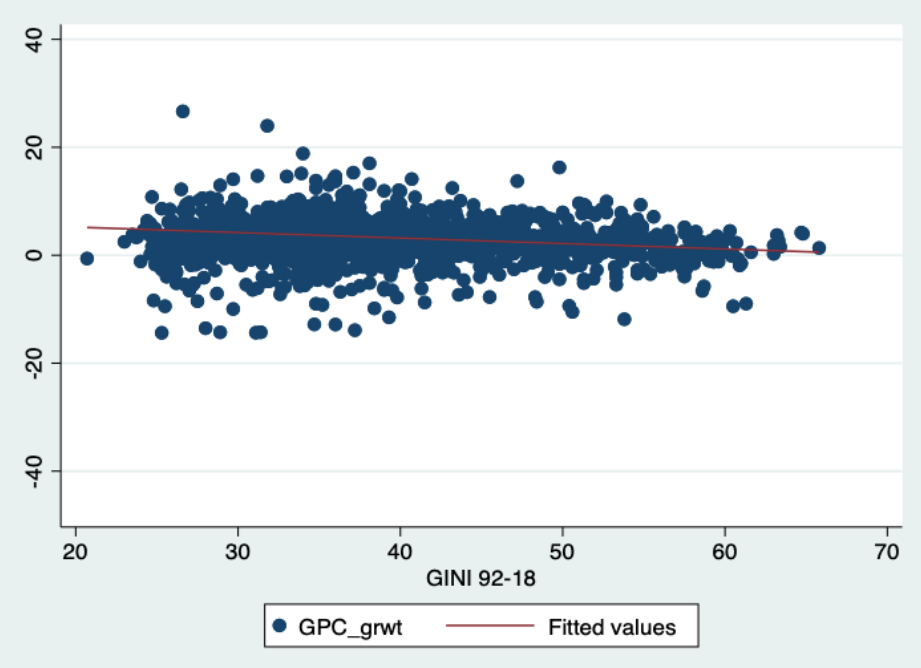
Initial examination of GINI and GDP relationship in the graph below (Graph 1) reveals that there are more observations of positive GDP per capita growth on the lower end of GINI (countries with low GINI) than on the higher end of GINI. On the high end of GINI, observations of GDP

per capita growth tends to center around 0. This gives an impression that the very negative GDP per capita growth rates get less negative, or increase, along the GINI axis, meaning GINI also increases with the growth rate. However, at the high end of GINI, there is virtually no growth. Individual countries' graphs (such as Argentina, Colombia, and Germany) in the Appendix 2 show a clearer inverted U or a hump-shaped pattern.

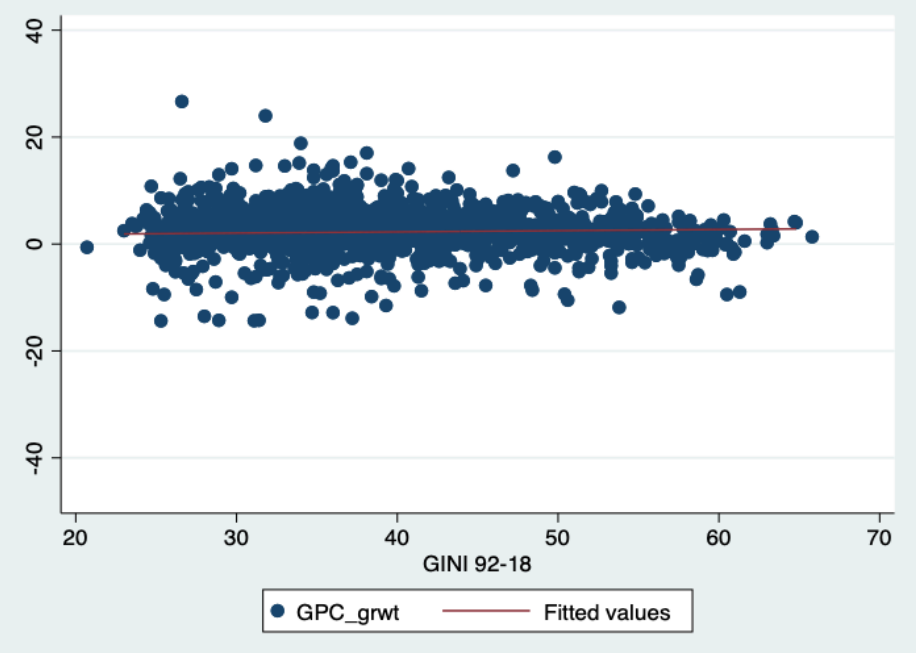


Graph 1

The graphs of low income countries' GINI with their growth (graph 2) versus high income countries counterpart (graph 3) show a clear distinction in the impact of GINI on growth between the two groups, with the lower income one suffering a more negative impact of income inequality. This evidence empirically substantiates that income inequality impact is heterogenous.



Graph 2



Graph 3

The covariance matrix result below verifies the reasoning of adding export and consumption into the model to avoid the problem of omitted variable bias, since they are both highly correlated to GDP at a 5% level. Interestingly, consumption growth rate has a significant correlation with

poverty rate and GINI. Therefore, the channels of income inequality's impact on GDP growth can be via poverty and consumption. A possible caution is that these significant correlations may cause multicollinearity. Therefore, the coefficient correlation matrix of the equation will be examined to detect if multicollinearity exists.

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) gpc_grwt	1.000						
(2) exp_grwt	0.393*	1.000					
(3) cons_grwt	0.567*	0.120*	1.000				
(4) povcount2	0.019	0.046	0.167*	1.000			
(5) gini9218	-0.047	0.011	0.098*	0.599*	1.000		
(6) ln_cap	0.290*	0.088*	0.146*	0.106*	0.030	1.000	
(7) ue_grwt	-0.019	-0.012	-0.087*	0.033	-0.008	-0.030	1.000

*** p<0.01, ** p<0.05, * p<0.1

The Hausman test table below confirms the previous expectation (from data summary) that the fixed effects model, which is capable of adjusting for cross-sectional difference, is the most appropriate model for this sample.

Hausman (1978) specification test

	Coef.
Chi-square test value	38.156
P-value	0

Therefore, the fixed effect model's empirical result is illustrated in the table below.

Regression results

gpc_grwt	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
cons_grwt	.518	.022	23.45	0	.475	.562	***
exp_grwt	.14	.01	13.92	0	.121	.16	***
povcount	-.007	.014	-0.46	.642	-.034	.021	
gini9218	.401	.195	2.06	.04	.019	.784	**
gini_sq	-.005	.002	-2.03	.042	-.009	0	**
i	-3.901	1.653	-2.36	.019	-7.147	-.655	**
o	0	.	.	.	.	.	
I : base 0	0	.	.	.	.	.	
1o	0	.	.	.	.	.	
i#co : base 0	0	.	.	.	.	.	
1	.066	.039	1.70	.09	-.01	.143	*
cf_grwt	.036	.004	9.49	0	.028	.043	***
Constant	-7.029	4.136	-1.70	.09	-15.15	1.091	*

Mean dependent var	2.658	SD dependent var	3.938
R-squared	0.665	Number of obs	848
F-test	182.065	Prob > F	0.000
Akaike crit. (AIC)	3615.662	Bayesian crit. (BIC)	3658.348

*** p<.01, ** p<.05, * p<.1

This empirical result is qualitatively in line with literature about the quadratic form of GINI: GINI first (+) then GINI squared (-). Interaction term also has a positive coefficient as expected. In terms of significance, GINI and GINI squared are significant at 5% while the interaction term is significant at 10%. Export, consumption, capital formation—variables that are evidently highly correlated with GDP growth in literature, are all significant at 1% as expected, suggesting that the model has a high probability of not containing specification error. However, poverty is insignificant although negative as expected.

The model is then tested against common issues such as multicollinearity, serial correlation and heteroskedascity, to ensure the results are reliable.

In terms of the possibility of multicollinearity indicated by the covariance matrix above, the table of coefficient correlation matrix in fact does not contain evidence of multicollinearity as none of the coefficient of correlation between the model's variables are higher than 0.5.

e(V)	cons_g~t	exp_grwt	povcount	gini9218	gini_sq	i	o. gini9218	1o. i	1.i# c.g~9218	cf_grwt	_cons
cons_grwt	1.0000										
exp_grwt	-0.2132	1.0000									
povcount	-0.0622	-0.1457	1.0000								
gini9218	-0.1356	0.0328	-0.0371	1.0000							
gini_sq	0.1383	-0.0502	-0.0543	-0.9726	1.0000						
i	0.0054	-0.0677	0.1608	0.3766	-0.3190	1.0000					
o.gini9218	.	.	.	.	.	.	.				
1o.i	.	.	.	.	.	.	.	.			
1.i# c.gini9218	-0.0133	0.0573	-0.0568	-0.3870	0.3310	-0.9645	.	.	1.0000		
cf_grwt	-0.2679	-0.1169	-0.0041	0.0488	-0.0355	0.0594	.	.	-0.0477	1.0000	
_cons	0.1183	-0.0091	-0.0020	-0.9787	0.9151	-0.4671	.	.	0.4501	-0.0595	1.0000

In terms of heteroskedascity, the Wald test result (Appendix 3) shows a p-value less than 0.01, which suggests the rejection of the null hypothesis of homoskedascity, meaning that the model does suffer from heteroskedascity. Therefore, the adjusted robust standard error is utilized for the model, which mitigates heteroskedascity and serial correlation altogether. The adjusted result is detailed in the table below.

Regression results

gpc_grwt	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
cons_grwt	.518	.074	7.00	0	.372	.665	***
exp_grwt	.14	.024	5.79	0	.092	.188	***
povcount	-.007	.026	-0.25	.8	-.058	.045	
gini9218	.401	.21	1.91	.059	-.015	.817	*
gini_sq	-.005	.002	-2.01	.046	-.009	0	**
i	-3.901	1.412	-2.76	.007	-6.701	-1.101	***
o	0	.	.	.	.	.	
I : base 0	0	.	.	.	.	.	
1o	0	.	.	.	.	.	
i#co : base 0	0	.	.	.	.	.	
1	.066	.032	2.10	.038	.004	.129	**
cf_grwt	.036	.025	1.45	.151	-.013	.085	
Constant	-7.029	4.764	-1.48	.143	-16.475	2.416	

Mean dependent var	2.658	SD dependent var	3.938
R-squared	0.665	Number of obs	848
F-test	36.919	Prob > F	0.000
Akaike crit. (AIC)	3613.662	Bayesian crit. (BIC)	3651.605

*** $p<.01$, ** $p<.05$, * $p<.1$

The GINI variables and the interaction term are still significant with the expected signs of coefficients. Thus, the estimated results of these variables are reliable, which further confirms the expectation of this paper that GINI has a non-linear, inverted U-shaped relationship with GDP growth and that the relationship depends on the economy's income level. Moreover, the previously shown significant correlation between GINI, consumption and poverty in the covariance matrix suggests that GINI's impact on GDP could also be permeating in various socio-economic channels such as those included (consumption and poverty), all of which are dynamically different across many economies and tackled differently by their governments. For higher income countries, such issues could be addressed and mitigated thanks to their well-developed capital market, economy and governance. Therefore, it is theoretically explicable that the level of income of an economy is a distinct and key factor in determining how much that economy's income inequality could affect its GDP growth. This conclusion agrees with the previous proposed theories and research by Barro, Benhabib, and Halter et. al.

For robustness testing, firstly, unemployment rate is added to the model, of which the comparison is illustrated below.

	(1)	(2)
	gpc_grwt	gpc_grwt
cons_grwt	.518***	.503***
	(.022)	(.023)
exp_grwt	.14***	.143***
	(.01)	(.01)
povcount	-.007	-.005
	(.014)	(.014)
gini9218	.401**	.44**
	(.195)	(.196)
gini_sq	-.005**	-.005**
	(.002)	(.002)
i	-3.901**	-4.439***
	(1.653)	(1.672)
gini9218		
0bn.i		
1.i		
0bn.i#c.gini9218		
1.i#c.gini9218	.066*	.078**
	(.039)	(.039)
gini9218		
cf_grwt	.036***	.036***
	(.004)	(.004)
ue_grwt		-.075**
		(.035)
_cons	-7.029*	-7.224*
	(4.136)	(4.14)
Observations	848	847
R-squared	.665	.667

Standard errors are in parentheses

**** p<.01, ** p<.05, * p<.1*

As seen from the table, the model is robust since adding unemployment rate does not alter the variables' signs of coefficients and significance from the original model and expectations. Secondly, it is concluded that the interaction term is significant across different model specifications—the linear or quadratic model and with or without poverty rates all show a significant effect of the interaction term. Therefore, the paper's conclusion on the heterogeneity of income inequality's impact on GDP growth is robust. The comparison is detailed in the table below.

	(1)	(2)	(3)
	gpc_grwt	gpc_grwt	gpc_grwt
cons_grwt	.514***	.524***	.518***
	(.016)	(.022)	(.022)
exp_grwt	.137***	.139***	.14***
	(.007)	(.01)	(.01)
gini9218	-.056**	.016	.401**
	(.024)	(.045)	(.195)
cf_grwt	.039***	.035***	.036***
	(.003)	(.004)	(.004)
0bn.i			
1.i	-3.064***	-4.974***	
	(1.133)	(1.57)	
i			-3.901**
			(1.653)
gini9218			
0bn.i#c.gini9218			
1.i#c.gini9218	.068***	.092**	.066*
	(.025)	(.037)	(.039)
gini9218			
gini9218			
povcount		-.008	-.007
		(.014)	(.014)
gini_sq			-.005**
			(.002)
_cons	2.207**	.666	-7.029*
	(1.016)	(1.671)	(4.136)
Observations	1352	848	848
R-squared	.663	.663	.665

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Finally, robustness test reveals that the polynomial model is significantly more robust that the linear model. As can be deducted from the comparison table below, in the linear form, the GINI estimated coefficient's t score and sign are prone to change as the model specification changes due to adding other variables, such as the addition of the interaction term and the employment of the log form of capital investment, all of which turned GINI estimated coefficient negative from the first baseline model. Therefore, this paper's result confirms that the relationship between income inequality and GDP growth is non-linear.

	(1)	(2)	(3)
	gpc_grwt	gpc_grwt	gpc_grwt
cons_grwt	.584***	.514***	.374***
	(.022)	(.016)	(.021)
exp_grwt	.146***	.137***	.123***
	(.011)	(.007)	(.008)
povcount	.012		
	(.014)		
gini9218	.037	-.056**	-.036
	(.046)	(.024)	(.026)
cf_grwt		.039***	
		(.003)	
0bn.i			
1.i		-3.064***	-3.838***
		(1.133)	(1.155)
gini9218			
0bn.i#c.gini9218			
1.i#c.gini9218		.068***	.082***
		(.025)	(.026)
gini9218			
ln_inv			.618***
			(.065)
_cons	-1.779	2.207**	1.805*
	(1.546)	(1.016)	(1.086)
Observations	852	1352	947
R-squared	.614	.663	.506

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

In conclusion, the estimated regression results of the model in this paper confirm recent hypotheses of the non-linear inverted U shape relationship between GINI and GDP growth, as well as the dependence of this relationship on income levels. This conclusion therefore contributes to the pool of literature supporting the aforementioned hypotheses.

The most fundamental weakness of the model is the measurement errors and imperfections of indices used to quantify our research targets (which are economic growth and unequal income distribution). The GINI index is most prone to measurement errors, and it is not an unbiased estimate. Moreover, there are a lot of missing observations for GINI, which decreases the sample size. In addition, using GDP per capita—a number that does not reflect the national incomes of many countries, primarily developing ones, where a lot of business activities are conducted in shadow markets, unregistered private businesses and within the informal sector, to measure economic activities growth, is another measurement shortcomings. Every economy in the world is different; not all comply to the formal structure as that of the Western countries—economies that are relatively more uniformed and used as "standard" by institutions in evaluating economies. On the other hand, it is observed that poverty headcount percent of the population is insignificant in the model, which implies the possibility of a specification error.

In light of the weaknesses, future research in this area should consider using wealth inequality (ratio of wealth disparity over mean wealth distribution), instead of income inequality measured by GINI, to increase variations and get more observations. Secondly, to best address the problem of inaccurate economic measurements, more research about the distinctions of economies between countries to discover other macroeconomic factors that are impacted by wealth and income inequality is necessary, in order to avoid omitted variable bias and improve the macroeconomic model for economies in their entirety. In addition, time series research on one specific country and case studies could offer a better alternative to scrutinize the mechanism of inequality and economic growth, than using panel data, as there could have been too many econoy-specific shocks that were not globally systematic, such as a civil war or regional catastrophe. Future research may look into adding other significant macro variables such as foreign investment (FDI), human development (HDI), or a dummy variable for countries where the period studied is associated with economic transition such as industrialization.

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APPENDIX 1: List of variables

GPC_grwt: annual percentage growth rate of GDP per capita in 1992-2018.

Exp_grw (hypothesized sign "+"): annual (2009-2010) growth rate of exports of goods and services based on constant local currency. Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.

Cons_grw (hypothesized sign "+"): average annual growth (2009-2010), in percentage, of final consumption expenditure based on constant local currency. Final consumption expenditure (formerly total consumption) is the sum of household final consumption expenditure (formerly private consumption) and general government final consumption expenditure (formerly general government consumption).

Povcount (hypothesized sign "−"): National poverty headcount ratio is the percentage of the population living below the national poverty lines in 2010.

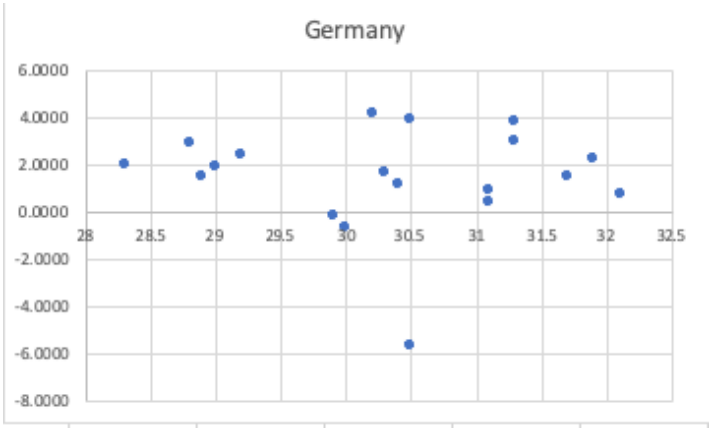
Gini (hypothesized sign "+"): Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.

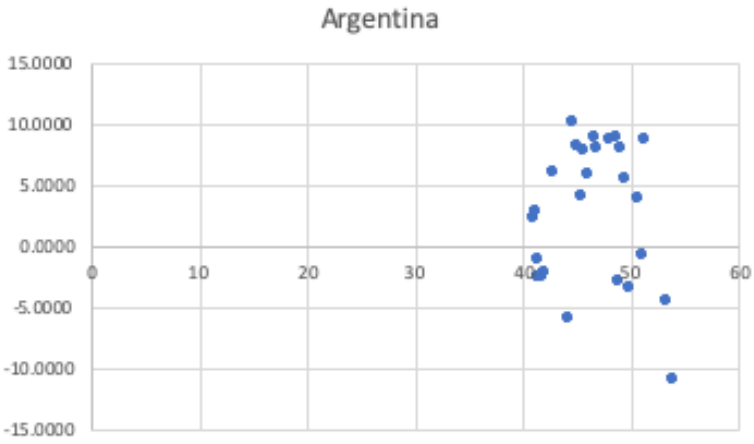
Gini_sq (hypothesized sign "−"): GINI squared.

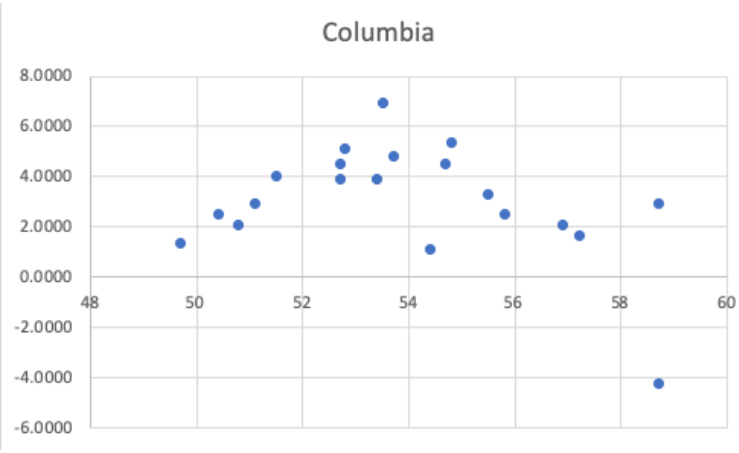
I (hypothesized sign "+"): dummy variable that separates high income and low income countries, based on the classification obtained from World Bank database. The classification of countries according to income is, in turn, based on the Gross National Income per capita intervals, which was changed dynamically every year by World Bank. I = 1 means upper-middle to high income classified by World Bank, I = 0 means lower-middle to low income.

I*gini (hypothesized sign "+"): interaction term between I and GINI. Research by Barro showed that GINI have a higher chance of positive correlation with GDP in high income countries than in lower income ones. Since I = 1 for high income economies, I expect this variable's estimated coefficient to be positive, in contrast with the omitted condition (0 = low income).

APPENDIX 2: Graphs of a sub-sample of individual countries







APPENDIX 3: Tests results

e(V)	cons_g~t	exp_grwt	povcount	gini9218	gini_sq	i	o. gini9218	1o. i	1.i# c.g~9218	cf_grwt	_cons
cons_grwt	1.0000										
exp_grwt	-0.2132	1.0000									
povcount	-0.0622	-0.1457	1.0000								
gini9218	-0.1356	0.0328	-0.0371	1.0000							
gini_sq	0.1383	-0.0502	-0.0543	-0.9726	1.0000						
i	0.0054	-0.0677	0.1608	0.3766	-0.3190	1.0000					
o.gini9218	.	.	.	.	.	.	.				
1o.i	.	.	.	.	.	.	.	.			
1.i# c.gini9218	-0.0133	0.0573	-0.0568	-0.3870	0.3310	-0.9645	.	.	1.0000		
cf_grwt	-0.2679	-0.1169	-0.0041	0.0488	-0.0355	0.0594	.	.	-0.0477	1.0000	
_cons	0.1183	-0.0091	-0.0020	-0.9787	0.9151	-0.4671	.	.	0.4501	-0.0595	1.0000

Coefficient correlation matrix

```
H0: sigma(i)^2 = sigma^2 for all i

chi2 (106)  =   1.9e+05
Prob>chi2 =      0.0000
```

Wald test