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GROWTH, DEBT, AND INEQUALITY

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Growth, Debt, and Inequality

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Abstract

After the 2009 global recession, many papers identified a non-linear inverted U-shaped relationship between economic growth and sovereign debt. However, their results are mixed regarding the exact turning point and, recently, the direction of its causality. According the traditional view, we assume debt-to-growth causality and show that the mixed results depend on the heterogeneity of the non-linear debt-growth relationship. In our sample of 27 countries over the period 1994-2010, countries with higher Gini index, our measure of income inequality, show lower threshold points upon which further increases in debt reduce growth but a higher sensitivity of growth to debt changes. Hence, the more distributionally fair countries are, the more fiscally virtuous they should be to growth. The policy implication is that more equal income distribution policies reduce (increase) economic growth in (not) highly indebted countries.

Key words: sovereign debt, economic growth, income inequality, heterogeneity

JEL Classification: H61, H62, H63.

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I. INTRODUCTION

In contemporary history, sovereign debt accumulation in developed countries has been generally slow and rapid build up has occurred only in times of war (Checherita and Rother, 2010). But, many developed economies have recently experienced an explosion of sovereign debt, in particular in Europe. In the United States and United Kingdom, for example, debt-to-GDP ratio rose respectively from 52.0% and 40,2% in 2001 to 93.8% and 103.2% recorded in 2012 (World Bank, 2014). In this paper, we hypothesise an inverted U-shaped relationship between sovereign debt and economic growth depending on income inequality. To motivate our heterogeneous non-linear hypothesis, we draw on the link between growth and debt and on the link between inequality and debt.

There is an opulent source of literature analysing the relationship between the accumulation of sovereign debt and its subsequent effect on economic growth. In a model with finite lived agents, Modigliani (1961) shows that sovereign debt promotes economic growth. But he also sheds light on potential negative effects to finance a larger debt for future generations. In Barro (1974), perfectly informed and infinitely lived agents reduce their actual consumption when government expenditure rises because they anticipate future tax increases. Therefore, the Ricardian equivalence implies an insignificant impact of sovereign debt on economic growth. If also the assumption of perfect information is relaxed, creditors do not expect to be fully reimbursed of extensive sovereign debts and the optimal solution becomes a “debt overhang” because an economically unsustainable debt would impact negatively on the probability to service the debt and, hence, economic growth (Krugman 1988).

Since Krugman (1988), the bulk of theoretical literature points towards a negative relationship between sovereign debt and economic growth (Saint-Paul 1992, Elmendorf and Mankiw 1999). The general intuition is that as governments should adopt expansionary fiscal policies in times of recession to recover the economy and contractionary fiscal policies in times of prosperity to control sovereign debt levels, sovereign debt and economic growth should be negatively correlated due to a time lag (Blanchard, 2006). However, the extent of this correlation remains questionable (Patillo et al. 2004, Aizenman et al. 2007, Cochrane 2011). More recently, Aschauer (2000) assumes that debt is used to finance public capital and infers a non-linear inverted U-shaped impact of sovereign debt on economic growth from the non-linear impact of public capital on economic growth. The accumulation of sovereign debt in the short term has a positive effect on economic growth but there comes a threshold point whereby any further indebtedness increases risk premium and could lead to a negative net impact on economic growth through a higher cost of borrowing.

The recent global recession renewed the interest on the debt-growth nexus moving the interest from an unclear theoretical prediction to an empirical issue. The debate has focused on the potential detrimental effects of debt on growth and its financial sustainability overtime. Applying simple correlation statistics to a dataset of 44 developed and developing countries, Reinhart and Rogoff (2010) find a weak underlying positive link between debt and growth at normal to medium levels of debt and a negative relationship between high levels of debt and economic growth. In particular, economic growth lowers 1% when debt exceeds 90% of GDP.[1] To check this threshold, Caner et al. (2010) split the same sample in countries with debt-to-GDP ratio higher and lower than 90% and employ a more sophisticated pooled least squares regressions. The impact of debt on growth is negative beyond 90% debt-to-GDP ratio but insignificantly positive below the threshold level corroborating only partially with Reinhart and Rogoff's (2010) results. Their analysis combines both times series data with cross sectional data but serial correlation may cause biased results still (Podesta, 2002). Using different measures of government debt and economic growth, Kumar and Woo (2010) find that a 10% points increase in initial debt-to-GDP ratio decreases annual GDP per capita of by 0.2% per year. Therefore, once again the findings corroborate with the relationship established by Reinhart and Rogoff (2010), but suggest a different impact. In brief, despite the majority of the empirical literature pointing towards a non-linear inverted U-shape relationship, mixed results cannot solely be justified due to the use of different datasets or methodologies.

Critiques to the non-linear debt-growth relationship move in three different directions. The first rejects the inverted U-shaped relationship. Cochrane (2011) assume uncertainty about future inflation and shows that extensive sovereign debt levels can reduce consumption levels. In this case, sovereign debt could reduce economic growth even in the short term (Diamond and He 2013). Schclarek (2004) estimates a statistical significant negative linear relationship between external government debt and GDP per capita. Herndon, Ash and Pollin (2013) replicate the Rainhart and Rogoff's (2010) results using the same methodology and dataset and find a 2.2% slowdown in economic growth for countries with debt-to-GDP ratio higher than 90% but no evidence of an inverted U-shaped relationship.

The second critique is about the causality of the growth-debt nexus. Although there is substantial empirical evidence suggesting a correlation between sovereign debt and economic growth, this does not imply causation. Reinhart, Reinhart and Rogoff (2012) suggest that low levels of economic growth could be the reason for high levels of sovereign debt. Additionally, Panizza and Presbitero (2012) point out that a negative correlation is automatically created due to measuring debt as ratio of GDP thus making the causality difficult to establish. Consequently, there are no papers making a definitive case with regards to a causal relationship between public debt and economic growth

The last direction of criticism extends the non-linearity notion suggesting that country-specific variables may affect the degree of debt-growth non-linearity and, hence, each country's debt-to-GDP threshold level (Panizza

[1] Similar exercises are applied to other financial indicators. For example, the threshold values for credit to private sector, liquid liabilities and domestic credit are 94%, 97% and 100%, respectively (Law and Singh 2014).

and Presbitero 2013). Eberhardt and Presbiterro (2013) address the cross-country heterogeneity issue by studying different crisis periods in different countries. They confirm the non-linear relationship between government debt and economic growth but find no evidence of similar threshold level across different countries suggesting that homogenous policy to control debt may not have the desired affects in every country. Khan and Senhadji (2000) and Khan, Senhadji and Smith (2001) use a large sample of countries and show that heterogeneity is related to financial depth and inflation. Moreover, finance impacts differently on growth for oil exporters and resource-based economies (Nili and Rastad 2007, Beck 2011). More recently, Arcand, Berkes, and Panizza (2011) find that the nonlinear impact of banking depth on growth weakens at very high level of banking depth. Krtellos et al. (2012) suggest that the relationship between economic growth and sovereign debt may also be influenced by a third variable such as trade openness.[2]

A natural extension of the Krtellos's et al. (2012) intuition is that income inequality could affect the debt-growth relationship. Kuznets (1955) and Williamson (1965) hypothesise that when development sets in, the equal income distribution pattern is broken by entrepreneurs at the forefront but once a country is fully developed, welfare state redistributes income more fairly. Banerjee and Duflo (2003) corroborates empirically this inverse U–shaped relationship between income inequality and economic development. Barro (2000) suggests that the Gini index impacts on economic growth indicating that a more unequal income distribution in a poor country leads to inertia in economic growth, whereas more equal income distribution leads to increasing growth levels in richer countries. Recently, he re-examined the relation employing a cross-country regression framework and concluded that "the overall effect of income inequality on economic growth was weak and, often, statistically insignificantly different from zero. […] These results could be interpreted from the perspective of some of the underlying theoretical models. In particular, the differing effects for poor and rich could reflect the greater impact of credit market restraints in poor countries" (Barro 2008, pag 2).[3] This finding suggests that even if income inequality is not a growth determinant and the Williamson-Kuznet's hypothesis is rejected, income inequality could affect the relationship between finance and development still.

In this paper, we test the hypothesis of a non-linear heterogeneous relationship between sovereign debt and economic growth suggesting that the reason for mixed results (different threshold points in the debt-growth relationship) is due to changes in country specific levels of income inequality. As income inequality data cover a too short period for a Granger analysis, we assume the traditional one-way causality from debt to growth. Our panel

[2] See Barajas et al. (2012) for other dimensions of potential heterogeneity.

[3] The main theories on the growth-inequality nexus are credit-market imperfections, political economy, social unrest, and saving rates. Their empirical predictions are ambiguous and empirical results very weak. However, Barro's (2008) results could be interpreted in favour of the credit-market imperfections theory.

regression analysis shows that the growth-debt relationship is more intense and the threshold level is lower in countries with more equal income distribution than in countries with more unequal income distribution. We further check the robustness of our results using different specifications, sub-periods and sub-samples. All the exercises corroborate with the results obtained from our main framework.

The paper proceeds in the following manner. Section 2 describes the empirical framework. Section 3 presents descriptive statistics. Our main findings are presented in Section 4. The next section is devoted to robustness analysis. Finally, the last section includes our concluding remarks along with suggestions for future research.

II. EMPIRICAL FRAMEWORK

We derived our basic specification model from the multivariate linear equation used by Checherita and Rother (2010):

$$y_{it} = \alpha + \beta DEBT_{it} + \theta CTRL_{it} + \varepsilon_i \qquad (1),$$

whereby y_{it} is the GDP per capita growth rate computed over 3 years i being the country and t denoting the year. *DEBT* is the gross government debt as a percentage share of GDP. *CTRL* stands for the vector of influential variables identified by the economic literature, which are understood to have an effect on levels of economic growth. The control variables included are inflation, exports, population, age dependency.[4] Finally, we use real GDP per capita as used in Barro's (1996) growth model. ε_i is an idiosyncratic error term which accounts for disturbances within the panel data.

To account for country specific features, we apply country fixed effects (FE) and random effects (RE) to our benchmark specification. We employ the Hausman test (1973),[5] the Breush Pagan Lagrange Multiplier test (1979, BPLM henceforth)[6] and the likelihood test to determine the most appropriated estimator. For all our estimates, we use robust standard errors to control for heteroskedasticity in the residuals. According to a Keynesian view, we assume that an increase in the debt to GDP promotes short-run economic growth (H1: $\beta > 0$). On the

[4]Age dependency ratio is the ratio between the population and those that are dependent on others (i.e. the elderly and the working age) (Bongaarts et al, 1998)

[5] The null hypothesis of the Hausman's test is that that fixed and random effects are not statistically different (Gujarati, 2004). The BPLM Test has the null hypothesis that there is zero variance amongst country effects. (Woodbridge, 2009)

[6] The BPLM Test has the null hypothesis that there is zero variance amongst country effects. (Woodbridge, 2009)

contrary, an insignificant or zero coefficient is a necessary (but not sufficient) condition for the Ricardian equivalence.

We adopt a benchmark specification similar to that used in the majority of empirical literature (e.g. Kumar and Woo, 2010; Reinhart and Rogoff, 2010). To check for the non-linear relationship, we modify this specification as follows:

$$y_{it} = \alpha + \beta DEBT_{it} + \gamma DEBT_{it}^2 + \theta CTRL_{it} + \varepsilon_i \qquad (2).$$

The quadratic term $DEBT^2$ allows us to test the non-linearity relationship between government debt and economic growth. Empirically, the relationship of government debt is seen to come to a tipping point where increases in government debt subsequently have a negative effect on growth (Ghosh, et al, 2011). In theory, we expect a positive $DEBT_{it}$ coefficient (H2.a: $\beta > 0$) and a negative $DEBT_{it}^2$ coefficient (H2.b: $\gamma < 0$), in order to observe an inverted U-shape relationship similar to Checherita and Rother (2010). We maintain the same vector of controls and the error term as in the benchmark and also apply both FE and RE models to our specification using robust standard errors as in the benchmark specification.

Many papers focus intently on the non-linearity between government debt and economic growth by attempting to identify the threshold debt level that leads to a consequential decline in economic growth. We hypothesise that income distribution within a country creates an heterogeneous relationship between government debt and economic growth across countries. We use the Gini index (Gini 1921) as a measure of income inequality amongst a population because it is quite able to recover the relationship between inequality and growth and performs better than alternative easily available inequality measures such as the decile ratio (Gobbin et al. 2007). Moreover, as it includes residents and non-residents, it is consistent with the use of GDP (i.e. gross domestic product). To test the heterogeneous effect of government debt on economic growth, we interact the Gini index (Gini, 1921) with the debt-to-GDP ratio and we obtain the following equation:

$$y_{it} = \alpha + \beta DEBT_{it} + \delta DEBT * GINI_{it} + \theta CTRL_{it} + \varepsilon_i \qquad (3),$$

where $DEBT * GINI$ is our interactive term. If our hypothesis is true, we should observe a significant positive coefficient on $DEBT$ (H3.a: $\beta > 0$) and a significant negative coefficient on $DEBT * GINI$ (H2.3: $\delta < 0$), thus, providing evidence of a positive linear relationship which is lower for more unequal countries.

Furthering to this, we combine equations (2) and (3) to test whether there is a non-linear heterogeneous relationship. As suggested by the literature, we assume there to be a parabolic (inverted U-shape) relationship. However, we expand on this by suggesting there is different parabolic relationships in different countries due to their individual level of income inequality. Our last hypothesis assumes that governments of countries with unequal income distributions benefit elites and lobbies taking from general economic growth. According to Barro (1999), it implies a flatter parabolic relationship between government debt and economic growth for more unequal countries

Our final specification including squared terms is as follows:

$$y_{it} = \alpha + \beta DEBT_{it} + \gamma DEBT_{it}^{2} + \delta DEBT \cdot GINI_{it} + \zeta DEBT^{2} \cdot GINI_{it} + \theta CTRL_{it} + \varepsilon_{i} \qquad (4).$$

in which we introduce $DEBT^2$ and $DEBT^2 * GINI$ to test the hypothesis of a non-linear heterogeneous relationship. We expect an inverted U-shaped curve on the terms $DEBT$ and $DEBT^2$ (HYP4.a: $\beta > 0$ and HYP4.: $\gamma < 0$) and opposite signs for the linear and quadratic interactive terms between $DEBT * GINI$ and $DEBT^2 * GINI$ (HYP4.c: $\delta < 0$ and HYP.d: $\zeta > 0$). Given this, we expect there to be different parabolic relationships present within our data, indicating non-linear heterogeneity.

III. DATA AND DESCRIPTIVE STATISTICS

Our data set includes 27 countries; see Table 1. We collect data from different sources. The majority of our data are from the World Development Indicators (WDI) database by the World Bank (2013). It comprises many developmental indicators updated quarterly. Anyway, for consistency with data from other sources, we can rely only on annual data. Due to the presence of missing values, we also integrate some of our data with information from other datasets.

[Insert here Table 1]

[Insert here Table 2]

Table 2 reports the full list of variables. Our control variables include *Inflation, Exports*, *Population* and *GDP per capita* and the *Age Dependency ratio*[7]. Finally our data for the *Gini Index*[8] comes from the World Income Inequality Database (2013) under the United Nations University. This variable is our proxy for income inequality.

We collect data across a time period of 17 years from 1994-2010 the logic being to exclude global macroeconomic issues such as the reaction to the collapse of the Soviet Union in 1991 and the adjustment following the withdrawal of the United Kingdom and Italy from the European Exchange Rate Mechanism (ERM) in 1992. Both these situations created not only huge direct economic shocks within the countries involved, but also further large indirect shocks in the global economy. Therefore, by excluding these years, we prevent any starting biases occurring within our estimates.

The descriptive statistics of the dataset are shown in Table 3. We calculate the mean, standard deviation and reference distribution points for all the variables. We include the full dataset and further split it into two sub-samples of countries that are apart of the Organisation for Economic Co-operation and Development (OECD) and non-OECD countries. We also run two univariate statistical hypothesis tests, the Wilcoxon signed rank test (Wilcoxon, 1945) and the mean comparison test, in order to gain a further insight into the variable distribution through the two sub-samples.

[Insert Table 3 here]

Firstly, we take a look into the central tendency of the variables used within our full sample and compare them with the sub sample. For instance, the mean value for our interest variable *DEBT*, is 54%; this debt level is categorised as a medium debt level (Reinhart and Rogoff, 2010). Further comparison between the mean levels in the sub samples show considerable differences. OECD countries have an average *DEBT* value equal to 61% whereas the mean is 37% for non-OECD countries. The statistical difference is evident through the mean comparison test showing a significant rejection ($p<0.05$) of the null hypothesis (H_0: equal means). The implication being that there is a significant statistical difference amongst the mean values between the two sub samples. Our data stays in accordance with the economic theory suggesting that OECD countries on average have higher debt-to-GDP levels in comparison to non-OECD countries.

Further analysis of the means of our other interest variables within the dataset shows similar tendencies. Take GDP per capita growth rate (dependent variable) as an example. Within the full sample, it has a mean of 4%.

[7] Inflation is measured as annual percentage change, Exports as a percentage share of GDP. Population is in millions and GDP per capita in real terms.
[8] The Gini Index has a scale between 1-100 where, the closer to 1 a country is the more equal there distribution of income and the closer to 100 the more unequal there level of income distribution is (Yitzhaki, 1983)

Moving to the sub sample the average rate of growth for OECD countries is around 3% in comparison to non-OECD countries having around 6%. There is the substantial difference amongst developed and developing economies with the former being more likely to grow slower. The substantial difference is explained by non-OECD countries being economically developing and hence experiencing large increase in their economic growth rate. The significant difference is further evident through the mean comparison test.

In order to further stress the large differences in our sub samples we also look at the median values of all the variables and run the Wilcoxon signed-rank test. As observed before, large differences are also seen across all variables when analysing their median values. For example consider our third interest variable, the Gini index. The median value of the full sample is 35.4 where as for the sub samples it is 30.9 for OECD countries and 50.4 for non-OECD countries. A difference of 20.5 between sub samples together with the significant rejection (at 5% confidence level) of the null hypothesis of equal medians from the Wilcoxon signed-rank test proves a large statistical difference of income inequality between the sub samples. We can infer that non-OECD countries experience more income inequality (50.4) than OECD countries (30.9). Furthermore, the majority of countries in our full sample show low-income inequality (35.4).

Analysing the descriptive statistics for certain control variables may indicate patterns emerging between our dataset and our estimated results. Let us take *POPULATION* as an example. It shows a fairly low mean value (76.7), which could signify that our dataset as a whole includes countries with fairly low population levels. This may be reflected in the results of our regressions estimates, as low population in theory would have a positive effect on economic growth. In contrast, *Age dependency ratio* displays a medium-high mean value (54.6%), which may imply that the countries within our dataset suffer from an ageing population (see table 1 for the list of countries included). Theoretically this could be detrimental to economic growth as there are fewer people of working age supporting the potential increases in government expenditure on pensions through tax revenues.

It is clear from the descriptive statistics that there is a considerable difference between non-OECD countries and OECD countries. This difference could potentially be observed within our estimated results. We will specifically address this issue in our robustness analysis.

IV. RESULTS

Table 4 presents the main results. The dependent variable is real GDP per capita growth along with the variable of interest being government debt as a ratio of GDP (Debt-to-GDP). Throughout all the estimations, we control for *INFLATION, EXPORTS, POPULATION,GDP PER CAPITA* and *AGE DEPENDENCY.* The first column presents the benchmark specification using an OLS estimator. The impact of debt-to-GDP on GDP per capita growth is significant at 5% confidence interval showing a negative linear relationship (-0.96). On average a 1% increase in debt-to-GDP will decrease GDP per capita growth by -0.96%. This contradicts present literature because it rejects both our HYP1 (positive relationship) and the alternative hypothesis of a Ricardian Equivalence (insignificant relationship). However, it can be accountable due to the majority of countries within our dataset being OECD countries. Therefore, they already have high debt-to-GDP levels, which could cause this negative impact on GDP per capita growth.

The results with respect to the control variables used in the benchmark equation, for the most part, are consistent with the economic theory. The *INFLATION* coefficient shows a negative relationship with GDP per capita growth as expected. *INFLATION* is a proxy for economic risk and so an increase in inflation leads to a decrease in growth. However, the coefficient itself is not significant. Individual coefficients of *EXPORTS* and *POPULATION* show highly significant, positive relationships with the dependent variable. For instance, as the level of population within a country increases, the overall level of production (and sometimes also productivity) in theory should increase, creating a positive change in GDP per capita growth. A similar understanding can explain the significant positive coefficient in *EXPORTS* i.e. an increase in a countries level of exports allows increases of GDP per capita growth. As for GDP per capita (in actual terms), our dataset yields a negative relationship with GDP per capita growth. This could come as a result of the majority of countries within our dataset being developed. According to Barro (1999), developed countries find it more difficult to grow as they have to pave their own path of growth, rather than developing countries that simply follow the path of developed countries. Therefore, this may account for the negative coefficient observed on GDP per capita.

In order to account for biases such as country specific features, we employ the Likelihood test to check if the use of fixed effects (FE) is appropriate. The likelihood statistic does not reject the null hypothesis proving the suitability of FE. Additionally, we use the Hausman test to check between fixed effects and random effects. The Hausman test statistic (46.6) rejects the null hypothesis at 5% significance level, thus proving that FE is the most suitable approach for estimation.

[Insert Table 4 here]

We present the results for both FE and RE in columns 2 and 3 of Table 4. The coefficient for debt-to-GDP becomes positive under FE but is no longer significant. It is consistent with the Ricardian Equivalence. As for the control variables in both models, exports, per capita GDP level and the age dependency ratio remain significant and stable through both FE and RE estimates.

The majority of literature surrounding this topic finds a non-linear relationship between debt-to-GDP and GDP per capita growth. We test this hypothesis in columns 4 and 5 that show the results for equation 2 (Non-

Linearity). The Hausman test fails to match the assumptions and generates an unreliable negative statistic (-30.8). Therefore we move to a Breusch-Pagan Lagrange Multiplier test (BPLM) as the next best alternative. The BPLM test doesn't directly distinguish between FE and RE, but allows us to test whether an RE estimation is most appropriate over a standard OLS. As the null hypothesis is zero variance of country effects, our BPLM statistic of 81.22 rejects the null hypothesis favouring RE.

The adjusted R^2 remains consistent with that of the benchmark model under RE. The most relevant observation noted by adopting this method is the sign on the coefficient for debt-to-GDP. It remains positive and, combining this with the negative sign on the non-linear term, draws an inverted-U-shape parabolic relationship between debt-to-GDP and GDP per capita growth. However, the coefficients on both interest variables are not significant individually and only marginally significant jointly, as the corresponding p-value of the F-test (0.98) accepts the null hypothesis (H_0: $\beta = \gamma = 0$). This indicates that the traditional quadratic specification does not work with our dataset and so does not corroborate with our second hypothesis (HYP2) and the basis of most literature.

Due to the lack of consistency with our results to the established quadratic model indicated by previous literature, we move to the heterogeneity specification where we introduce the Gini index as an interactive term. Columns 5 and 6 present the results for both FE and RE. We once again run the Hausman test upon which the test statistic (32.72) rejects the null hypothesis indicating FE as the most appropriate method of estimation. Despite moving to a new specification, the R^2 shows little deviation from the one recorded in our benchmark specification for both FE and RE. The control variables also are fairly stable.

The coefficient on *DEBT* remains positive (4.93) and is marginally significant at a 15% confidence interval. When we interact *DEBT* with the Gini index, the related coefficient is negative (-0.06) but not significant. However the significance of the joint F-test indicates that these variables have a joint influence on the level of GDP per capita growth and so heterogeneity is present. This indicates that the subsequent relationship between GDP per capita growth and debt-to-GDP is positive but the slope changes according to country specific levels of income inequality. The estimated results under this specification corroborate weakly with our third hypothesis (HYP3).

The results from the previous two specifications produce mixed results: the quadratic (non-linear) relationship is not significant, but there is a weak heterogeneous relationship present. Therefore, within our final specification, we combine the two models together to test whether the heterogeneous relationship is actually non-linear rather than linear. We run the Hausman test which once again rejects the null hypothesis signifying FE as the appropriate method. The results of our equation (4) are presented in columns 7 and 8. Adjusted R^2 for both FE and RE remain consistent with not only the benchmark model but also the other advanced specifications used. Analysing our interest variables we can see that the coefficient on *DEBT* becomes very significant and positive (22.9) and the coefficient on $DEBT^2$ becoming significantly negative (-17.4) suggesting a significant non-linear relationship. Testing the joint influence of our interest variable yields the F-statistic to be significant at a 1% confidence interval. It means that there is a quadratic relationship between GDP per capita growth and debt-to-GDP and a country's specific level of inequality creates differences in the shape of the slope of this relationship and so we would observe the formation of different parabolas.

In order to understand this result, we plot the relationship between GDP per capita and debt-to-GDP of two representative countries. We compare Finland as representative of countries with a fairly low level of Gini with Chile as our representative of a country with a fairly high level of Gini. The relationship is shown in Figure 1. Let us consider the shape of the relationships first. Given Chile's average Gini level to be approximately 42.2, the corresponding relationship shows a flatter inverted U-shape parabola. Finland in comparison has a lower average Gini level of approximately 25.8 and so a much steeper inverted U-shape parabola is observed. Finland and Chile display two different parabolic relationships revealing that the non-linear relationship between GDP per capita and debt-to-GDP ratio is heterogeneous. Consequently, as our hypothesis HYP4 suggests, each country, depending on its level of income inequality, will have a different threshold level of debt. This becomes apparent within this graph. Finland's threshold debt level is approximately 77% whereas Chile has a much higher threshold debt level of 129%.

[Insert Figure 1 here]

Under the assumption that income inequality is more persistent than economic growth, a causal relationship can be formed from looking at this graph. Countries that suffer from high levels of income inequality (higher Gini levels) are more likely to benefit from higher growth levels as they become increasingly indebted because their debt threshold point is very high. This is made clear from Chile's debt to growth relationship forming a faint inverted U-shaped parabola. Contrastingly, countries like Finland that have low levels of income inequality will display a far steeper inverted U-shape relationship with a much lower debt threshold point. This indicates that low Gini bearing countries also benefit from higher growth levels as they become more indebted but the point where any further indebtedness will lead to a negative impact on economic growth is much lower.

In sum, due to the presence of two different inverted U-shaped parabolas a 1% increase in debt-to-GDP would produce different effects on different countries depending on their level of inequality. This corroborates with our hypothesis HYP4.

V. ROBUSTNESS

We carry out four different types of robustness exercises to check the plausibility of our main findings. For all robustness exercises we report the non-linearity heterogeneity specification as the benchmark specification under FE. Tables 5 reports the first two robustness checks. We begin by modifying our benchmark specification. Columns 1-6 report the separate removal of some control variables in order to test the sensitivity of our results to different specifications. The results are conclusive and indicate that the separate removal of each control variable creates little movement on the significance and the signs of the coefficients on our interest variable. Hence, this exercise confirms our main findings.

In columns 7-8 we control for potential omitted variables by adding extra regressors to our specification. In accordance to growth theory (see Pagano, 1993) proxies used for financial development such as domestic credit to the private sector could potentially have a positive effect on economic growth. In column 7 we introduce *CREDIT* (% share of GDP). The t-statistic and its corresponding p-value suggest that it is marginally significant at a 10% confidence interval. However, the negative sign on the coefficient conflicts with economic theory as Pagano (1993) suggests increases in financial development leads to a positive effect on economic growth. Therefore, this indicates that CREDIT as a variable lacks relevant influencing power. All previous results on our interest variables are fully corroborated.

[Insert Table 5 here]

The popularity of recent empirical studies introduces INTERNET (Internet users per 100 people) as a proxy for technological progression. Therefore, we include this as an extra control variable in column 8. However, the t-statistic and corresponding p-value indicate that the variable is not significant and so has no affect on the coefficients of our interest variables as they remain consistent with our benchmark specification (column 6). The only exception is $DEBT^2*GINI$ that is marginally insignificant at 10% level individually but significant at 1% in the joint test F^{INT}.

Modifications to the benchmark specification indicate that the coefficients show little deviation from our main results. The joint hypothesis test of our interest variables always rejects the null hypothesis throughout all robustness exercises in Table 5. Therefore, indicating that our interest variables always hold influencing power regardless of the inclusion of more or less control variables. This further proves the structural robustness of our results.

Table 6 presents the results of two further robustness checks. The first column presents the benchmark specification for the whole period. Columns 2 and 3 report the results over a shorter time periods. Firstly, we look at the time period spanning from 1994-2008. This period excludes the onset of the Eurozone debt crisis when many peripheral European countries experiencing very high debt-to-GDP levels such as Greece, Spain, Ireland, Italy and Portugal (Young and Semmler, 2011). In this way, we check if our non-linear heterogeneous relationship is driven by this debt crisis. For consistency with previous estimates, we run a FE method. As expected, the number of observations falls slightly when moving to the pre-debt crisis period (column 2). However, our interest variables remain fairly unchanged and they are all still very significant with $DEBT^2$ even experiencing an increase in significance from a 5% to a 1% confidence interval. It provides evidence that our results are robust to the exclusion of Eurozone debt crisis period.

[Insert Table 6 here]

We further adapt on the previous exercise by contrasting the results of our benchmark specification with a further decrease in the sample period. We re-estimate our results between the time periods of 1994-2006 in order to exclude the sub-prime mortgage crisis that began in the early months of 2007 within the US. One of the many consequences of the subprime mortgage crisis was the increase in government debts levels in many developed countries. These increases occurred as a result of governments being forced to rescue failing banks through such financial packages such as capital injections and liquidity provisions. This left many governments not being able to finance their own debts and so debt accumulation occurred (Ureche-Rangau and Burietz, 2013). Our results are not affected by the subprime mortgage crisis. Table 6 shows a further decrease in the number of observations from 328 in the benchmark (column 1) to 279 within the 1994-2006 sub-period (column 3). However, the coefficient estimates on our interest variable show marginal changes. Most of our interest variables again remain very significant with $DEBT^2$, *DEBT*GINI* and $DEBT^2$**GINI* all experiencing increases in significance from a 5% to a 1% confidence interval. Additionally, our control variables also remain fairly unchanged. In brief, the subprime-mortgage crisis is not the main determinant of our non-linear heterogeneous relationship.

As final robustness checks, we split our data into two separate sub-samples, one displaying the estimates for OECD countries (column 4) and the other for non-OECD countries (column 5). Let us look at the OECD sub sample. The number of observation falls to 214 indicating that the majority of our dataset is made up of OECD countries. The signs of the estimated coefficients on our interest variables stay in line with our benchmark results. Additionally, the significance level improves slightly within the OECD sub-sample as all interest variables now become significant at a 1% confidence interval. It indicates that our results become more robust when we consider more homogeneous countries, an assumption that works against our main hypothesis (HYP4). Upon moving to the non-OECD sub-sample, the lack of significance may be linked to the low number of observations. However, the signs on the coefficients for the most part remain unchanged.

In sum, our main findings of a non-linear heterogeneous relationship are robust through various econometric exercises. They include the individual removal of control variables in order to test the structural validity of our specification, the addition of extra control variables to test for omitted variable bias, sub-periods and sub-samples regression to check the robustness to particular exceptional events or specific more unstable countries.

VI. CONCLUDING REMARKS

The lasting effect of the recent crisis has put great strain on many global economies. As a consequence, governments have opted to exercise budget deficits in order to employ fiscal stimulus packages, in an attempt to stabilise their individual economies after the recent crisis, many governments financed huge budget deficits and in turn accumulated government debt. The majority of literature points towards a non-linear inverted U-shaped relationship between government debt and economic growth. However, upon analysing the empirical literature there are mixed results, in what is considered the precise threshold level of debt. Analogously to the debt-growth nexus, also the well-known Williamson-Kuznet's hypothesis of an inverted-U shaped relationship between income inequality and economic growth has an ambiguous theoretical background and it shows weak empirical evidence.

In this paper, we combine the two puzzles and hypothesise a non-linear heterogeneous relationship between government debt and economic growth as the reason for mixed results on the finance-growth nexus, suggesting that that there is an inverted U-shaped relationship but it varies in accordance to a country's specific level of income inequality as measured by the Gini index. The presence of a non-linear homogeneous relationship also implies that a county's threshold point is different depending on its income inequality level.

In order to test our hypothesis, we systematically examined different kind of relationships between government debt and economic growth according to the literature. Results from the linear model indicate an insignificant relationship. We also tested the non-linear relationship and despite our results showing a positive coefficient on *DEBT* and a negative coefficient $DEBT^2$, the interest variables were individually not significant and jointly significant but only marginally, thus indicating a weak non-linear relationship. When we interact *DEBT* with Gini index, a very significant joint F-test indicates the presence of a heterogeneous linear relationship. Due to the mixed results of the previous two specifications, we moved to test a non-linear heterogeneous relationship that fully support our new hypothesis of an heterogeneous inverted U-shaped relationship between sovereign debt and economic growth according to the level of income inequality. We find that countries with a lower Gini index show a more intense debt-growth relationship but a lower threshold point.

The main policy implication of our results is that a "golden" threshold level of debt applicable to every country doesn't exist because individual country specific circumstances (such as income inequality) play a pivotal role in the way government debt interacts with economic growth. As a consequence, governments exercising homogenous fiscal policies, as part of international austerity policy programs such as in the European Union, may have undesired outcomes depending on a country income inequality level. In general, countries with fairer income distribution grow more when they are ruled by more fiscally virtuous governments whereas countries with less equal income distribution can bear higher level of sovereign debt.

Our findings could be improved further. Firstly, we were presented with a number of limitations with respect to the availability of data. The lack of available data concerning the Gini index has reduced the number of countries within our dataset. In the same vein, our econometric analysis is dependent on a fairly small time period of 17 years. Future research may benefit from looking at a longer time period. Additionally, future research may use more advanced econometric analysis to identify the presence of a non-linear heterogeneous relationship rather than relying on the simple use of interactive terms. This may therefore, lead to a more precise measure of the relationship. Another extension could be the application of different proxy for income inequality to check the impact of the taxation system on our results.

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APPENDIX

Table 1. List of countries used in the dataset

Developed Countries (OECD)		Developing Countries (No OECD)
Australia	Greece	Uruguay
Austria	Hungary	Brazil
Belgium	Italy	China
Canada	Luxembourg	Colombia
Denmark	Mexico	Costa Rica
Finland	Norway	Dominican Republic
France	Sweden	Honduras
Germany	United Kingdom	Panama
		Paraguay
		Peru

Table 2. List of Variable Descriptions

Variable	Description	Source
GDPPCG	GDP per capita growth (Annual percentage change)	World Bank
DEBT	Government Debt (percentage share of GDP)	World Bank
GINI	The Gini Index (measure of income inequality)	World Institute for Development Economic Research
GDPPC	GDP per capita GDP divided by midyear population (actual terms)	World Bank
INFLATION	Inflation (annual percentage change)	World Bank
EXPORTS	Exports (percentage share of GDP)	World Bank
POPULATION	Population (actual terms)	World Bank
AGE DEPEND	Age Dependency Ratio (ratio between Dependents and the working population)	World Bank
CREDIT	Domestic Credit to Private Sector (percentage of GDP)	World Bank
INTERNET	Internet Users (per 100 people)	World Bank

Table 3. Descriptive Statistics

Variables	Mean	(a)	SD	Min	p25	Median	(b)	p75	Max	Nr. Obs.
					All countries					
GDPPCG	0.0449		0.0562	-0.128	0.016	0.042		0.072	0.273	459
DEBT	0.5455		0.289	0.061	0.341	0.522		0.682	1.483	416
GINI	40.179		11.798	23.000	29.300	35.450		51.920	61.330	367
GDPPC	22.946		19.621	0.709	4.152	27.483		35.277	87.717	459
INFLATION	9.8635		96.907	-1.408	1.699	2.667		6.470	2075.890	459
EXPORTS	5.8740		8.867	-26.637	1.580	6.191		10.833	36.738	459
POPULATION	76.789		241.029	0.405	5.398	10.446		56.909	1340.910	453
DEPEND	54.613		9.111	36.041	48.466	52.006		59.048	92.825	459
CREDIT	75.655		47.287	10.590	31.528	74.044		104.813	223.873	447
INTERNET	29.669		28.859	0.0012	4.138	20.211		51.533	93.390	452
					OECD countries					
GDPPCG	0.0338		0.0453	-0.128	0.0134	0.039		0.063	0.153	306
DEBT	0.616		0.292	0.061	0.428	0.594		0.765	1.483	292
GINI	32.808		7.444	23.000	27.633	30.900		34.825	53.950	227
GDPPC	32.889		16.723	4.587	27.483	33.159		38.238	87.717	306
INFLATION	3.768		5.687	-0.494	1.621	2.205		3.500	44.736	306
EXPORTS	5.863		7.887	-26.637	2.220	6.168		10.523	36.499	306
POP	27.498		29.892	0.405	5.375	10.708		56.994	114.292	306
DEPEND	51.122		4.544	43.835	47.827	49.912		53.375	68.944	306
CREDIT	91.457		46.636	15.213	58.117	91.145		115.628	223.873	294
INTERNET	39.080		30.133	0.0433	9.534	35.880		68.820	93.390	303
					No OECD countries					
GDPPCG	0.067	***	0.0681	-0.076	0.023	0.064	***	0.106	0.273	153
DEBT	0.380	***	0.199	0.061	0.206	0.347	***	0.549	0.875	124
GINI	52.131	***	6.619	28.433	49.025	54.055	***	56.722	61.330	140
GDPPC	3.062	***	1.373	0.709	1.576	3.173	***	4.152	6.296	153
INFLATION	22.054	*	167.353	-1.408	3.490	6.925	***	11.048	2075.890	153
EXPORTS	5.897		10.587	-20.633	-0.434	6.314		11.304	36.738	153
POP	179.396	***	402.861	2.583	5.457	9.033		44.450	1340.910	147
DEPEND	61.596	***	11.623	36.041	54.051	60.678	***	67.073	92.825	153
CREDIT	45.291	***	30.946	10.590	24.278	32.270	***	52.638	129.503	153
INTERNET	10.530	***	11.617	0.001	0.786	6.555	***	17.660	40.650	149

Notes: Period: 1994-2010. OECD countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Mexico, Netherlands, Norway, Sweden, United Kingdom, Uruguay; No OECD countries include Brazil, China, Colombia, Costa Rica, Dominican Republic, Honduras, Panama, Paraguay, Peru. (a) Mean-comparison test (2 tails); (b) Wilcoxon rank-sum test.

*** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Table 4. Impact of debt-to-GDP ratio on 3-years economic growth. Estimates over the period 1994-2010.

Dependent Variable		Standard		Non Linear		Heterogeneity		Non Linear Heterogeneity	
Per-Capita GDP Growth	OLS	FE	RE	FE	RE	FE	RE	FE	RE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
INTEREST VARIABLES	-0.9646**	2.0690	0.0289	5.7804	0.4138	4.9390#	0.4010	22.9012***	6.6830
$DEBT^2$				-3.0983	-0.3035			-17.4315**	-8.9069*
*DEBT*GINI*						-0.0632	-0.0094	-0.3926**	-0.1982*
*$DEBT^2$*GINI*								0.3555**	0.2574#
CONTROLS	-0.0435***	-0.2275***	-0.0630***	-0.2350***	-0.0630***	-0.2226***	-0.0652***	-0.2361***	-0.0721***
INFLATION	-0.0188	0.0485	0.0174	0.0513*	0.0179	0.0495	0.0181	0.0551#	0.0150
EXPORTS	0.0474***	0.0286**	0.0389***	0.0281**	0.0389***	0.0284**	0.0385***	0.0254*	0.0358**
POPULATION	0.0028***	0.0025	0.0025**	-0.0014	0.0025**	0.0033	0.0025**	-0.0019	0.0023*
AGE DEPEND	-0.0732***	-0.1935**	-0.1091**	-0.2011***	-0.1093**	-0.1869**	-0.1085**	-0.2073***	-0.1029**
CONSTANT	7.7149***	16.5802***	9.4897***	16.6108***	9.4000**	15.7905***	9.4931***	16.3142***	9.6748***
Observations	328	328	328	328	328	328	328	328	328
R^2	0.299	0.202	0.269	0.207	0.268	0.204	0.266	0.224	0.283
F^{ALL}	39.23	26.02	96.09	21.99	93.91	20.80	112.3	20.69	137.4
Prob(F^{ALL})>F	0	0	0	0	0	0	0	0	0
F^{INT}	4.330	1.070	0	0.860	0.0200	2.740	0.0500	4.450	3.100
Pr(F^{INT})>F	0.0380	0.311	0.980	0.436	0.988	0.0830	0.974	0.00700	0.542
Likelihood Ratio		7.58							
Prob(LR)<chi2		0							
BPLM			82.49		81.22		76.84		58.74
Pr(BPLM)>chi2			0		0		0		0
H			46.60		-30.88		32.72		45.11
Pr(H)>chi2			0		1		0		0
Number of countries		27	27	27	27	27	27	27	27

Notes: Sample: 27 countries. Period: 1994-2010. See Table 2 for variable definitions. OLS = ordinary least squares; FE = (country) fixed effects; RE = (country) random effects; F^{ALL} = F-test on the full specification; F^{INT} = F-test on interest varaibles; LR = likelihood ratio test; BPLM = Breusch-Pagan Lagrange Multiplier test. H = FE vs RE Hausman test. Negative Hausman statistics suggest that the test assumptions are not matched.

Robust standard errors. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Table 5. Impact of debt-to-GDP ratio on 3-years economic growth. Robustness: different specifications of the non linear heterogeneity model.

Dependent Variable			Less Regressors			*Benchmark*	More Regressors	
GDPPC Growth	FE	FE	FE	FE	FE	*FE*	FE	FE
	(1)	(2)	(3)	(4)	(5)	*(6)*	(7)	(8)
INTEREST VARIABLES	21.4541**	21.7028***	24.0167***	22.7943***	19.4939***	22.9012***	22.6596***	21.6814***
DEBT^2	-12.2649*	-16.6918**	-18.4534***	-17.3615**	-12.5493**	-17.4315**	-18.0464**	-15.4679**
*DEBT*GINI*	-0.3618*	-0.3760**	-0.4148**	-0.3922**	-0.3391**	-0.3926**	-0.4038**	-0.3299*
DEBT^2*GINI*	0.2602	0.3484**	0.3791**	0.3551**	0.2439#	0.3555**	0.3837**	0.2938#
CONTROLS		-0.2320***	-0.2439***	-0.2361***	-0.2172***	-0.2361***	-0.1312**	-0.3327***
INFLATION	0.0461		0.0616*	0.0555*	0.0335	0.0551#	0.0596*	0.0497
EXPORTS	0.0360**	0.0295**		0.0257*	0.0293*	0.0254*	0.0192	0.0250#
POPULATION	-0.0016	-0.0059	-0.0061		0.0295***	-0.0019	0.0037	-0.0096
AGE DEPEND	-0.1712**	-0.1883***	-0.2128***	-0.2042***		-0.2073***	-0.2046***	-0.2192**
CREDIT							-0.0217#	
INTERNET								0.0173
CONSTANT	8.5922*	15.8597***	17.1459***	16.0172***	2.6094*	16.3142***	15.1015***	18.8028***
Observations	328	328	328	328	328	328	322	323
R^2	0.110	0.212	0.215	0.224	0.172	0.224	0.244	0.243
F^{ALL}	17.86	13.89	21	18.27	16.23	20.69	28.56	21.98
$Pr(F^{ALL})>F$	0	0	0	0	0	0	0	0
F^{INT}	4.670	3.920	4.500	4.660	4.340	4.450	4.280	4.270
$Pr(F^{INT})>F$	0.00600	0.0130	0.00700	0.00600	0.00800	0.00700	0.00900	0.00900
H	11.66	66.98	86	87.74	29.20	45.11	-2802	214.8
Pr(H)>chi2	0.167	0	0	0	0.000300	0	1	0
Number of countries	27	27	27	27	27	27	27	27

Notes: Sample: 27 countries. Period: 1994-2010. See Table 2 for variable definitions. OLS = ordinary least squares; FE = (country) fixed effects; RE = (country) random effects; F^{ALL} = F-test on the full specification; F^{INT} = F-test on interest varaibles; LR = likelihood ratio test; BPLM = Breusch-Pagan Lagrange Multiplier test. H = FE vs RE Hausman test. Negative Hausman statistics suggest that the test assumptions are not matched.

Robust standard errors. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

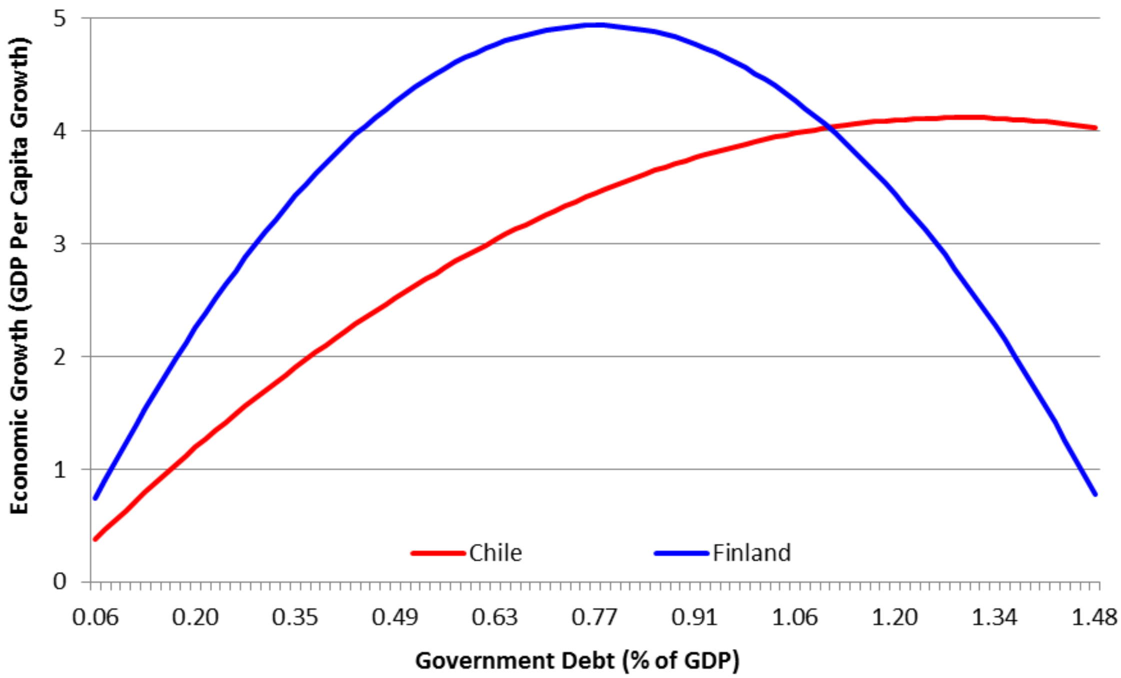
Table 6. Impact of debt-to-GDP ratio on 3-years economic growth. Robustness: different samples.

Model	***Benchmark***	Subperiod		Subsample	
Sample	***Whole***	Pre-Debt	Pre-Subprime	OECD	NoOECD
Estimator	***FE***	FE	FE	FE	FE
Period	***1994-2010***	1994-2008	1994-2006	1994-2010	1994-2010
	(1)	(2)	(3)	(4)	(5)
INTEREST VARIABLES	***22.9012****	22.3326***	23.3823***	15.4696***	70.7462#
DEBT^2	***-17.4315***	-17.9866***	-17.1480***	-13.3872***	-46.8082
*DEBT*GINI*	***-0.3926***	-0.3450**	-0.4971***	-0.4646***	-1.1223
DEBT^2**GINI*	***0.3555***	0.3739**	0.4497***	0.4150***	0.8388
CONTROLS	***-0.2361****	-0.2105***	-0.1081**	-0.2162***	0.4469
INFLATION	***0.0551#***	0.0486#	0.0576*	-0.0219	0.0614*
EXPORTS	***0.0254****	0.0526***	0.0384**	0.0330	0.0032
POPULATION	***-0.0019***	0.0016	-0.0099	-0.1669	-0.0269
DEPEND	***-0.2073****	-0.1795**	-0.3924***	-0.0616	-0.2347***
CONSTANT	***16.3142****	13.0417**	24.4898***	17.0457	16.7822**
Observations	***328***	306	279	214	114
R^2	***0.224***	0.262	0.320	0.336	0.265
F^{ALL}	***20.69***	20.03	33.55	24.84	96.98
$Pr(F^{ALL})>F$	***0***	0	0	0	0
F^{INT}	***4.450***	7.670	10.08	9.060	5.530
$Pr(F^{INT})>F$	***0.00700***	0	0	0	0.0200
H	***45.11***	49.29	-32803	143.0	-1.280
Pr(H)>chi2	***0***	0	1	0	1
Number of countries	***27***	27	27	18	9

Notes: See Table 2 for variable definitions. FE = (country) fixed effects; F^{ALL} = F-test on the full specification; F^{INT} = F-test on interest varaibles; H = FE vs RE Hausman test. Negative Hausman statistics suggest that the test assumptions are not matched. Breusch-Pagan Lagrance Multipier test (nor reported) rejects the null hypothesis for the NoOECD subsample, but not for the 1994-2006 sub-period.

Robust standard errors. *** p<0.01, ** p<0.05, * p<0.10, # p<0.15

Figure 1 – Non-Linear Heterogeneous Relationship



Notes: Average Gini is 25.8 for Finland and 42.5 for Chile

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