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WIDER Working Paper 2015/009

Threshold and interaction effects in the trade, growth, and inequality relationship

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January 2015

United Nations University World Institute for Development Economics Research

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Abstract: This paper examines the relationship between trade (exports), growth, and inequality, using a panel of 100 countries over 30 years (1980 to 2010). As there is no clear theoretical relationship between trade (exports) and inequality, and as inequality can be considered a proxy for 'governance quality', the paper also tests for a threshold in inequality for the effect of trade (exports) on growth. The findings are that in general trade openness advances growth while inequality reduces growth. However, when we identify an inequality threshold, we find that inequality is positively associated with growth if below the threshold (low inequality) but negative above the threshold, whereas trade has a positive impact once the threshold is allowed for. Thus, trade generally promotes growth and relatively high inequality retards growth.

Keywords: trade, growth, inequality, threshold effects
JEL classification: F10, I31, O40

Acknowledgements: Useful and constructive comments were provided by Oliver Morrissey.

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This paper has been presented at the UNU-WIDER Conference on 'Inequality - Measurement, Trends, Impacts, and Policies', held 5-6 September 2014 in Helsinki, Finland.

ISSN 1798-7237 ISBN 978-92-9230-894-0 https://doi.org/10.35188/UNU-WIDER/2015/894-0

Typescript prepared by Minna Tokkari at UNU-WIDER.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme from the governments of Denmark, Finland, Sweden, and the United Kingdom.

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1 Introduction

Income inequality is defining challenge of our time.

President Barack Obama speaks in Washington D.D. on 4 December 2013 about the need to address income disparity.

Not just in the advanced economies in the North and West, which were thought to have reached levels of prosperity where inequality would level off in line with the prediction of Kuznets' (1955) hypothesis, rising income inequality is also experienced across and within most of emerging and developing countries in Eastern Europe, Asia, Latin America, and Africa. Despite differences across countries, much of the increase in inequality has happened at the upper end of the income distribution. Atkinson et al.'s (2011) data show a big increase in the top 1 per cent income share in countries like the United States (USA), United Kingdom (UK), and Canada, hence the *'we are the 99 per cent'* slogans of the Occupy Wall Street movement. In the USA for example, over the past four decades, the Gini coefficient has risen from around 30 per cent to around 40 per cent, and the income share of the top 10 per cent increased from around 33 per cent to 50 per cent in the same period. The same is the case when looking at the developing world. China has experienced a sharp rise in income inequality, where from 1981 to 2010 the Gini coefficient has increased from 24 to 40 per cent and the income share of the top 10 per cent has increased from 17 to 28 per cent between 1986 and 2003. However, it is also important to note that income inequality has remained stable in other countries, and still fallen appreciably in others. Atkinson et al. (2011) and the Luxembourg Income Study's (LIS) data (2014) show that income inequality has been stable or even declining slightly since the mid-twentieth century in countries such as Australia, France, Norway, and Switzerland; while according to the World Bank's (2014) *PovCal* database it has changed little and even declined in some emerging and developing countries.

Rising income inequality across and within countries over the past two decades poses one of the greatest challenges to economic policy makers in both developed and developing countries. Concerns about rising income inequality are at the forefront of many policy debates today and is on top of the policy agenda in every corner of the world. The International Monetary Fund (IMF) is today embracing redistribution policies as pro-growth, arguing that rising income inequality is damaging to economic growth (Ostry et al. 2014). The World Bank has recently made a major public commitment to the goal of promoting 'shared prosperity', defined as growth in average incomes of those in the bottom 40 per cent of the income distribution in each country in the developing world (Dollar et al. 2014). Even the Head of the Catholic Church is concerned about the growing economic inequality, denouncing 'trickle-down' economic theories in sharp criticism of rising income inequality. Beyond policy elites, recent public opinion surveys suggest that majorities of respondents in advanced, emerging, and developing economies feel that the gap between the rich and the poor has worsened in recent years. The recent Pew survey (Pew Research Center 2013) reveals that over 80 per cent of respondents in advanced economies say things have gone worse, compared with 70 per cent in the developing economies and 59 per cent in the emerging markets.

In spite of the positive effects inequality can have on economic growth, much of the debate is on the adverse effects of high and rising income inequality on lowering economic growth rate, on limiting the pace of absolute poverty reduction, on engendering social unrest and political instabilities. The main concern of *'we are the 99 per cent'* slogan is on the worsening income inequality between the working (and poor) class and the rich. The wave of protests and unrests

that swept across the Middle East and North Africa since 2011 are due to the gross socio-economic and political inequality perpetuated by long-entrenched 'elites' in power. Wilkinson and Pickett (2010) provide an abundance of evidence to show that income inequality dramatically has an impact on people's everyday lives: greater inequality seems to lead to general social dysfunction*;* homicide rates are lower and children experience less violence in more equal societies; people trust each other less in unequal societies; and less equal societies tend to do worse regarding health, education, and general well-being. Many leading economists regard growing income inequality as one of the main causes of financial crashes. For example, the IMF has published evidence that inequality led to huge debts behind the 2008 bank crisis. Thus, addressing income inequality is not only about achieving a more egalitarian distribution of income for the social cohesion and well-being of society, it is also necessary for a stable economy.

Rising income inequality is happening at a time that, following trade liberalization which most countries have embraced since the mid-1980s; most developing countries have increasingly integrated into the global trading system, with expectation of advancing their economic growth, raising their real per capita income, and reducing poverty. The entry of China and countries from the former Soviet bloc into the global economy has led to an unprecedented level of integration of the world's economy. While, as the result of trade openness most developing countries have achieved impressive economic growth, substantial poverty reduction has only occurred in a few regions—like East Asia. Poverty rates for most countries have fallen only modestly or even worsened, while income inequalities have seen worsening in most countries. Thus, the benefits of rising incomes and aggregate GDP growth rates associated with trade openness have not been shared equally across all segments of the population. This therefore is against one of the most accepted tenets of trade theory—the Stolper-Samuelson theorem (Stolper and Samuelson 1941), that changes in exposure to international trade alter the demand for and returns to factors and the distribution of incomes within a country. Trade (as one component of globalization) is expected to affect the poor through two major channels: its contribution to growth and its impact on income distribution (inequality). In principle, any change in income (growth) can be decomposed into two components: the change in average income (capturing poverty) and the change in income distribution (capturing inequality). That is, poverty cannot change unless income changes on average (growth) or the distribution changes (inequality).

While trade openness is expected to affect economic growth positively, there is no particular reason to posit a clear relationship between trade (in particular export) and income inequality. Consequently, the main aim of this study is to establish if there is any evidence of a link between growth, trade (exports), and income inequality. First we test for the direct effects of trade (exports) and income inequality on growth, then condition on income inequality the effect of trade (exports) on growth. As income inequality can be considered a proxy for 'governance quality' we also test for a threshold in income inequality for the effect of trade (exports) on growth.[1]

To assess and explore heterogeneity in these relationships, this study uses a recent large panel of more than 100 countries, and applies dynamic panel regression methods and Hansen's (2000) endogenous threshold regression technique to locate the thresholds. The paper is structured as follows. Section 2 summarizes both the theory and empirics on trade, growth, and inequality. Section 3 specifies the contingent and threshold models formally, outlines the methods used in

[1] This helps to answer the question if more openness to trade reduces or exacerbates inequality and effects of that in growth. Is there a threshold in the trade-inequality relationship where trade is good both for inequality and growth, and above all will it worsen both inequality and growth?

their estimation and data sources. Section 4 provides descriptive statistics, focusing on the current patterns of income inequality, trade, and growth. Section 5 presents and discusses the empirical results on the existence of threshold and interaction effects in the trade-growth relationship given income inequality. Section 6 concludes and gives the implication of the study.

2 Trade, growth, and income inequality: theory and empirics

Acknowledging the large theoretical literature, we focus here on a brief review of empirical evidence on the relationship between: (i) trade and growth; (ii) trade and inequality; and (iii) growth and inequality.

2.1 Trade and growth

Many economists today assert that trade is good for economic growth; hence countries with fewer restrictions on trade experience faster economic growth than countries that heavily restrict trade. Besides the insights offered by neo-classical trade theory that, countries that differ in comparative advantage can benefit from trade by specializing in their areas of comparative advantage, in the form of resource endowments (as in the Hecksher-Ohlin model) or differences in technology (the Ricardian model)[2]; both endogenous growth theory (Romer 1986; Lucas 1988) and new trade theory (Krugman 1980; Grossman and Helpman 1994) have provided a firm theoretical basis for linking openness to trade with long-run growth. Endogenous growth models show how deliberate investment decisions made by profit maximizing firms advance innovation, and as a result economic growth is accelerated by endogenous technological improvements. From these models, the main channels through which trade is expected to affect the overall growth rate are endogenous and dynamic in nature. These include: economies of scale (i.e. a greater exploitation of increasing return); importing ideas and diffusion of information, knowledge and benefit from better inputs and technology capacities from abroad; innovation, increased competition and thus efficiency; increased availability of capital; increased product variety; technological progress; institutional change, policies, and political process. Even though, theory does not predict a simple relationship between exposure to trade and growth. Skeptics of trade liberalization like Krugman (1994) and Rodrik (1995) argue that the effect of openness on growth is, at best, tenuous and at worst doubtful.

Huge empirical studies exist today that have looked at the effects of trade openness on economic growth, employing either *ex ante* modelling (such as CGE analysis) or *ex post* econometric analysis. The *ex post* econometric analysis (which is the focus of this study) distinguishes between individual country studies and cross-country studies. The former are the detailed multi-country studies of protectionist practices and liberalization episodes that have been useful in providing details on the way in which trade policies have affected economic performance. The latter are the cross-country regression studies which at identifying empirical regularities in the relationship between trade openness and growth, distinguishing those looking at trade performance (using outcome measures such as trade shares of GDP or indices of trade openness) from those looking at trade policy measures, such as average tariffs.

Overall, the literature identifies, on average, a positive cross-country correlation between trade and growth, although the relationship is not necessarily causal (Harrison 2006). There is no robust evidence that trade liberalization impedes growth, instead, the overwhelming evidence

[2] However, the standard neo-classical theory of trade predicts effects only on levels (increases in the level of income), not on the long-run growth rate (Lucas 1988; Romer 1990; Lee 1993; Krugman 1994; Baldwin 2003).

supports the fact that trade openness promotes growth. Even though, cross-country regressions have come under severe criticism (Rodrik and Rodríguez 2001). Results are more mixed when trade policy measures are used instead of outcome measures, as some find a significant negative relationship between tariff rates and growth for richer countries but a positive relationship for poorer countries (DeJong and Ripoll 2006; Ackah and Morrissey 2007). Others find that the relationship between average tariffs or non-tariff barriers and economic growth varies according to the period covered. Recently, the emerging consensus is that the potential for trade to affect growth is contingent on various economic, social, political, institutional, and structural factors. Some studies specify the conditional relationship, whilst others test for the thresholds in these factors in determining the effect of trade on growth (Bhagwati and Srinivasan 2002; Rodrik and Rodríguez 2001; Foster 2008; Dufrenot et al. 2009). One such factor debated recently is the contingent effect of income inequality in the trade-growth relationship (the focus of this study).

2.2 Trade and income inequality

The traditional position in international trade on this issue is encapsulated in the Heckscher-Ohlin and Stolper-Samuelson theorems. In its simplest form this says that countries export goods intensive in their abundant factor, suggesting that the abundant factor should see an increase in its real income when a country opens up to trade. Krueger (1983) and Bhagwati and Srinivasan (2002) argue that, since developing countries are likely to have a comparative advantage in goods made with unskilled labour, trade should be pro-poor as it raises the incomes (wages) of unskilled labour in poor (unskilled-labour abundant) countries. For an advanced economy where high-skill factors are relatively abundant, the reverse would hold, with an increase in openness leading to higher inequality. However, most evidence suggests that the poor (or the unskilled) in developing countries are generally not better off following more than two decades of trade liberalization; in fact, most benefits, such as those captured by changes in relative wages or incomes, have accrued to labour with higher skills or education levels (Harrison 2006; Sala-i-Martin 2007; Goldberg and Pavcnik 2007).

Researchers have sought to explain this apparent paradox with various suggestions for why we do not observe Stolper-Samuelson effects or more generally that increased trade is not associated with reduced income (wage) inequality. One extension is the increase in the skill premium and according to this the main contributing factor for widening wage gap between skilled and unskilled labour is an increase in the demand for skilled and well-educated workers. Feenstra and Hanson (1996, 2003) suggest that intermediate goods and outsourcing explain part of the observed increase in demand for skilled workers in both developed and developing countries. Hence, the Heckscher-Ohlin model is inconsistent with recent inequality experience around the world, not just related to the fact that inequality increased in developing countries, but also along multiple other dimensions: for example, factor reallocation seems to occur primarily within rather than across sectors (Berman et al. 1994); small change in the prices of unskilled goods relative to skilled goods accompany large changes in the skill premium (Lawrence and Slaughter 1993). Recent theoretical and empirical studies try to rethink the effects of trade on inequality in the context of heterogeneous firms and provide quite different insights from those observed in the Heckscher-Ohlin model. The contributions here include Egger and Kreickemeier (2009), Verhoogen (2008), and Yeaple (2005).

As the theories are often in terms of endogenous technological change, skill-biased technological change is another explanation for increased demand for skilled labour and increases in skill premium due to the increase in capital flows and complementarity of capital with skilled labour. One explanation of how the spread of technology may affect inequality is that technology may increase capital intensity in production, thereby increasing the returns to capital and the relative income of capital owners (Krusell et al. 2000). Any empirical estimation of the overall effects of

globalization therefore needs to explicitly account for changes in technology in countries, in addition to standard trade-related variables. Openness to trade is also expected to affect labour income through transitional unemployment; industry wage; uncertainty and labour market standards. It should be noted therefore that the link between trade openness skill-biased technological change and income inequality operate through labour income.

Much of the empirical evidence linked between trade openness and income distributions has been either on cross-country regressions or country case studies. While cross-country regressions are based on aggregate data, some case studies are based on aggregate while others on micro data. Harrison (2006) and Sala-i-Martin (2007) summarize the cross-country empirical evidence, while Goldberg and Pavcnick (2004, 2007) review country case studies. For most of the channels reviewed they found empirical evidence that suggests that trade openness has been associated with increasing inequality in developing countries. Easterly (2007) and Milanovic and Squire (2004) on their study found that increasing trade openness is associated with falling inequality within developed countries and greater inequality within developing countries. A couple of studies, more recently, have looked at the complex relationship among globalization (trade openness, financial liberalization, and technology), growth, income distribution, and poverty. Some of the findings are: whereas trade globalization is associated with a reduction in inequality, financial (foreign direct investment in particular) and technology globalization is associated with an increase in inequality, and that there is a conditional relationship between trade openness and inequality (Jaumotte et al. 2013; Lee 2014).

2.3 Growth and income inequality

Kuznets (1955) was the first to articulate the mechanism by which growth affects income inequality; inequality tends to rise in the early stages of economic development and then fall, hence the inverted U-shape hypothesis. Kuznet composed data from three developed countries—USA, Germany, and the UK and according to his hypothesis, income inequality increases in the initial phase of development and then decreases in the course of development. Though early cross-country studies gave strong support to this hypothesis, recent studies have called these findings into question. As a result there are different channels through which income inequality affects growth rates.

Kaldor (1956) suggests that marginal propensity to save is higher for the rich than that of the poor, implying that a higher degree of inequality will yield higher aggregate savings, higher capital accumulation, and growth. Saint-Paul and Verdier (1993) argue that in more unequal societies, the median voter will elect a higher rate of taxation to finance public education, which will increase aggregate human capital and economic growth. In contrast, Persson and Tabellini (1994) and Alenia and Rodrik (1994) emphasize the four main channels through which income inequality lowers growth rates. First, the impact of inequality on encouraging rent-seeking activities that reduce the security of property rights; second, unequal societies face more difficulties in collective action—possibly reflected in political instability, a propensity for populist redistributive policies, or greater volatility in policies—all of which can lower growth; third, the median voter in a more unequal society is relatively poorer and favours a higher (and thus more inefficient) tax burden; fourth, to the extent that inequality in income or assets co-exists with imperfect credit markets, poorer people may be unable to invest in their human and physical capital, with adverse consequences for long-run growth. Because of these different channels, empirical studies on the effect of income inequality on economic growth have yielded different results, resulting in three main positions.

In the first group, Deininger and Squire (1996) using the data for 108 countries over the period 1960-74, found no systematic relationship between growth and changes in aggregate inequality.

The simple relationship between current as well as lagged income growth and the change in the Gini coefficient is insignificant for the whole sample, as well as for subsamples defined in terms of country characteristics like rich or poor, equal or unequal, fast-growing or slow-growing economies, suggesting no strong relationship between growth and changes in aggregate inequality. Similar results seen also by Lee and Roemer (1998), Castelló and Domenech (2002), and Panizza (2002) who find no correlation or inconclusive evidence of any correlation between inequality and economic growth.

The second group found positive relationship between inequality and growth—Kaldor (1956), Partridge (1997), Forbes (2000), Garbis (2005), and Nahum (2005) found that inequality does lead to growth. While finding a positive effect, Banerjee and Duflo (2003), Pagano (2004), Voitchovsky (2005), Barro (2008), and Castelló-Climent (2010) propose a sign changing non-linear relationship.

The third group of studies, which is also a dominant view today, found a negative relationship between growth and inequality. The argument in this group is that inequality is not a final outcome of growth but plays a central role in determining the rate and pattern of growth (Bourguignon 2004). According to the results of Galor and Zeira (1993), Perotti (1996), Persson and Tabellini (1994), Alesina and Rodrik (1994), Clarke (1995), Birdsall et al. (1995), Alesina and Perotti (1996), Castelló-Climent (2010), Knowles (2005), Davis (2007), and Pede et al. (2009), initial inequality seems to be empirically associated with lower growth rates.

More recently, findings that inequality is damaging to economic growth are also supported by the IMF, who argued that countries with high levels of inequality suffered lower growth than nations that distributed incomes more evenly. IMF findings warned that inequality can also make growth more volatile and create the unstable conditions for a sudden slowdown in GDP growth. Further, analysis of various efforts to redistribute incomes showed they had a neutral effect on GDP growth (Ostry et al. 2014). Ncube et al. (2013) also investigated the effect of income inequality on economic growth and poverty in the Middle East and North Africa (MENA) and their empirical results showed that income inequality reduces economic growth and increases poverty in the region.

3 Empirical and threshold-interaction effect model

3.1 Model specification

To explore the empirical pattern in the data, in addition to descriptive statistics that analyse the recent patterns and trends, this section provides the empirical specification to investigate and assess any evidence of a link between growth, exports, and inequality. As there is no particular reason to posit a clear relationship between trade (exports), and inequality, and as inequality can be considered a proxy for 'governance quality', we also test for a threshold in inequality for the effect of trade (exports) on growth. To estimate the effects of trade on growth given inequality, we need first to consider the direct effects of inequality on growth and then that of trade on growth. Following the work by Levine and Renelt (1992) and endogenous growth theory of Romer (1986, 1990) and Lucas (1988), there is an agreement that growth models should control for: initial per capita GDP, physical capital, human capital, and population growth. This is because the ultimate drivers of per capita growth are technological progress and per capita growth of human and physical capital. Thus, in a standard growth specification, economic growth is regressed on this set of control variables. Hence, our reduced form model follows the specification of Barro (1991) and Mankiw et al. (1992) with a general representation:

$$y_{it} = \alpha + x'_{it}\beta + s'_{it}\gamma + \mu_{it} \quad (1)$$

where y_{it} is the growth rate of real GDP per capita. x_{it} is a vector of explanatory variables mentioned above: $lnGDPO_{it}$—initial income measured as log of real GDP per capita; often used to capture conditional convergence, as per capita growth rate is expected to be inversely related to the starting level of income per capita (but this may also capture country-specific effects). SEC_{it}—secondary school enrolment (per cent gross), either initial or the average, is used to proxy human capital. INV_{it}—gross capital formation (per cent of GDP), measures physical capital, which enlarges the economy's capacity to produce. By controlling for human and physical capital both of which are considered a positive factor in stimulating economic growth, this specification is implicitly assuming that trade and inequality affects growth only through total factor productivity (TFP) and not through factor accumulation. $POPNGR_{it}$—population growth (annual per cent), as growth theories are formulated in per capita (or labour) terms, population is a core variable and is expected to be negative.

As noted previously, our empirical model for growth is that trade (and income inequality) exert direct as well as conditional effects on growth. Hence the variables of specific interest in our analysis, denoted by s_{it}, are trade and income inequality, which can have direct impacts on growth (y_{it}). Two measures of trade openness are considered: exports over GDP ($XGDP_{it}$), and trade over GDP ($TRADE_{it}$), (i.e. exports plus imports over GDP). We expect trade and especially exports to have a positive sign, implying that trade openness is good for growth. Income inequality is measured by Gini index ($GINI_{it}$—a measure of inequality between 0 (everyone has the same income) and 100 (richest person has all the income)). From the theoretical and empirical literature, effects of income inequality on growth are inconclusive, some studies have found negative results, others positive, and there are those which have found no significant correlation.

Though trade is expected to advance economic growth, the effect of trade on inequality, just as of inequality on growth, is indeterminate. Theory and empirical evidence have shown that trade can raise per capita income and reduce inequality, especially in the developing world (Stolper-Samuelson theorem). Alternatively, by increasing the skill premium, trade can increase income inequality, especially in advanced economies. Trade can also increase inequality both in developed and developing economies due to technology bias. Thus, one can hypothesize in this subtle interrelationship that if trade advances economic growth and at the same time reduces income inequality while income inequality increases growth, then the overall effects of trade on growth would be positive. In another case, even if trade advances economic growth but at the same time increases income inequality, and inequality reduces economic growth, then the overall effect of trade on growth is indeterminate. To allow for such heterogeneity in the trade-inequality-growth relationship we allow for interaction effects (i.e. the effect of trade on growth given inequality). The contingent model (linear interaction effects) specification becomes:

$$y_{it} = \alpha + x'_{it}\beta + s'_{it}\gamma + GINI_{it} * TRADE_{it}\delta + \lambda_t + \eta_i + \varepsilon_{it} \quad (2)$$

$GINI_{it} * TRADE_{it}$ is the interaction terms between inequality and trade or and export ($GINI_{it} * XGDP_{it}$).

Furthermore, trade might affect growth differently depending on the different levels of income inequality. For example, while many East Asian economies had relatively low levels of inequality and grew at unprecedented rates, many Latin American countries had significantly higher levels of inequality and grew at a fraction of the average of East Asian rate. This contingent relationship may be non-linear in nature, as trade affects growth differently given different levels (thresholds) of prior factors (inequality). Traditionally the strategy to allow for this is to model the simple product terms in a polynomial regression by calculating the square of the mediating variables, i.e. inequality. This is the quadratic interaction effect model. Another approach is arbitrarily exogenous sample splitting done in a number of studies. Unlike previous studies, we adopt a more formal approach to the modelling of heterogeneity in the trade-inequality-growth relationship.

Given our *prior* assumption that the effects of trade openness on growth differ across countries based on the countries' level of income inequality, the relationship is discrete in nature. We do not know, however, how the coefficients on the openness variables vary with different income inequality levels. In light of this, we formally apply the endogenous threshold regression technique of Hansen (2000) to estimate the thresholds or cut-off values and the level of confidence we can attach to the position of the threshold to make valid statistical inferences. To allow for non-linearity due to thresholds, Equation (2) is extended to the Hansen's (2000) endogenous threshold regression sample splitting specifications that are non-linear in two regime threshold regression as:

$$y_{it} = \theta_1' x_{it} + \varepsilon_{it}, q_{it} < \sigma$$

$$y_{it} = \theta_2' x_{it} + \varepsilon_{it}, q_{it} \geq \sigma \qquad (3)$$

as before y_{it} is growth rate and $x_i = (1, s_i', w_i')$ is a vector of explanatory variables, including both thresholds. The corresponding coefficient vector $\theta_j = (\beta, \gamma, \varphi)$ where j=1, 2 and q_i is the indicator function used to sort the data into different regimes or groups. The threshold parameter is $\sigma \in \Gamma$, where Γ strict subset of the support of is q_i. This model, which also contains an unobservable country-specific effect η_i and time effect λ_t, permits the regression parameters (θ_1 and θ_2) to switch between regimes depending on whether q_i is smaller or larger than the (unknown) threshold value (σ). And the threshold regression model can be described as captured by either of the single threshold variables, where in Equation (4) inequality is the threshold identifying variable:

$$y_{it} = \gamma X_{it} + \beta_1 TRADE_{it} I(GINI_{it} \leq \alpha) + \beta_2 TRADE_{it} I(INI > \alpha) + \mu_{it} \qquad (4)$$

I (.) is the indicator function used to sort the data; α is the threshold value; this specification also contains an unobservable country–specific effect η_i and time effect λ_t. x_{it} as before is a vector of explanatory variables, including the threshold.

3.2 Estimation methods

To explore heterogeneity in the trade–inequality–growth relationship we estimate variants of the equations derived above: baseline model, linear interaction (contingent) model and non-linear interaction (thresholds) models. There are a number of econometric difficulties to consider here,

as estimating Equations (1) to (2) could be biased for a number of reasons. First, difficulties in measuring trade and inequality; even simple measures like exports suffer from the fact that both are determined simultaneously with other variables (especially GDP) so there is a potential simultaneity bias. Measuring inequality is not without challenges, should it be based on consumption or income measures, or other measures of inequality other than income inequality (Deaton 2003; Ravallion 2004).[3] Omitted variables bias such as unobserved country-specific effects is another problem, and the potential endogeneity of trade and trade policy besides the persistence in series must also be allowed for.

To allow for most of these econometrics difficulties, that is measurement errors in variables, omitted variable biases, simultaneity biases, and any endogeneity due to any factor, we adopt the standard estimators. First we run the regression using simple pooled ordinary least squares (OLS), but this does not allow for individual country heterogeneity and time effects. To allow for both of these, we explore Fixed Effects (FE) and Random Effects (RE). With panel data, the FE or RE estimator has the ability to control for both unobserved country-specific and time effects, which could be correlated with observed regressors, thus ensuring consistent and unbiased estimation for our parameters of interest. In this study we adopt RE estimators based not on the Hausman test but on the fact that some of the variables in our specification, such as initial level of development or region dummies, are fixed in nature and using FE omits them automatically (Baltagi 2001; Hsiao 1986).

More critically, variables such as trade openness and investment are more likely to be endogenous due to simultaneity bias and persistence in series, calling for the use of instrument variables (IV); but getting credible IV is difficult, giving rise to the problems involved with weak instruments. Further, evidence shows that dynamic adjustments are quantitatively very important in studies related to growth. To address these concerns studies typically estimate a dynamic panel specification with growth and all variables averaged over five-year sub-periods to reduce large variations in the data and the effects of business cycles, hence our panel model is dynamic in nature and thus becomes:

$$y_{it} = \alpha y_{it-1} + x'_{it}\beta + s'_{it}\gamma + \eta_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where y_{it-1} is lagged dependent variable, the dynamic component (captured by the variable $ln\ GDPO_{it}$). Once we introduce the dynamic element in the relationship as is the case with Equation (5), the standard unbiasedness and consistency results underlying OLS and FE/RE models no longer apply. A different technique is required to overcome all these difficulties. As noted, one way to address problems of endogeneity is to use instrumental variables (IV). To combine the instruments in an efficient way, Arellano and Bond (1991) propose the use of Hansen's (1982) Generalized Method of Moments (GMM), which is computed in two steps. Thus, among the alternative set of instruments, a GMM estimator is an IV estimator that uses lagged information optimally to account for the serial correlation among the disturbances caused by the dynamic (Holtz-Eakin et al. 1988; Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998). The gain in efficiency from GMM is considerable, and it is for this reason system GMM is our preferred estimator, as it addresses problems of measurement errors, omitted variables bias, persistence in series, and endogeneity (Blundell and Bond 1998). For

[3] Issues include: the coverage of income sources and taxes tend to vary both across countries and, for a specific country, across years; the increase in the non-response rates of the richer households' biases estimates; the household surveys used are often redesigned such that the data are not comparable across years or across countries.

comparison purposes we estimate the base model and linear interaction (contingent relationship) model using pooled OLS, FE/RE, and system GMM estimators.

The non-linear interaction model, as specified in Equations (3) and (4), is estimated by applying the Hansen's (2000) endogenous threshold regression technique that locates the thresholds, tests for their significance and constructs their confidence intervals. In doing so, three procedures are followed. In the first step, we follow Hansen (2000) to eliminate the individual effects in our model. Then the threshold value and the slope parameters are jointly determined after the transformations. This is done by applying the algorithm provided by Hansen (2000) that searches over values for α sequentially until sample splitting value $\hat{\alpha}$ is found (i.e. least squares estimations through the procedure of minimizing the concentrated sum of square errors, as recommended by Chan (1993) and Hansen (2000). Once found estimates of γ, β_1 and β_2 are easily provided.

The second step is to test the statistical significance of the threshold effects. More specifically, to test the null hypothesis of no threshold effect: $H_0 : \beta_1 = \beta_2$ against the alternative hypothesis of having at least one threshold: $H_1 : \beta_1 \neq \beta_2$. A problem arises in testing the null hypothesis of no threshold effects (that is, a linear formulation) against the alternative of threshold effects, as under the null hypothesis the threshold variable is not identified. Hence, classical tests such as the Lagrange Multiplier (LM) test do not have standard distributions and so critical values cannot be read off standard χ^2 distribution tables. To address this problem, Hansen (2000) recommends a bootstrap procedure to obtain approximate critical values of the test statistics which allows one to perform the hypothesis test. Thus we follow Hansen (2000) and bootstrap the p-value based on the likehood ratio (LR) test. The null hypothesis of no threshold effect is rejected if the bootstrap estimate of the asymptotic p-value for this likelihood ratio test is smaller than the desired critical value.

Once we find a threshold (i.e. $\beta_1 \neq \beta_2$), the last step is to construct confidence intervals for the threshold value and slope coefficient. We test the null hypothesis: $H_0 : \alpha = \alpha_0$, against the alternative hypothesis: $H_0 : \alpha \neq \alpha_0$. This enables us to attach a degree of certainty as to the threshold for a country with a given level of income inequality. Under normality, the likelihood ratio test statistic $LR_{n(\alpha)} = n\frac{S_n(\alpha) - S_n(\hat{\alpha})}{S_n(\hat{\alpha})}$ is commonly used to test for particular parametric values. Hansen (2000) proves that when the endogenous sample-splitting procedure is employed, $LR_{n(\alpha)}$ does not have a standard χ^2 distribution, so derives the correct distribution function and provides a table of the appropriate asymptotic critical values.[4] The null hypothesis is rejected if the likelihood ratio test statistic exceeds the desired critical value (we want them to be reasonably small). After the confidence interval for the threshold value is obtained, the corresponding confidence interval for the slope coefficient can also be easily determined because the slope coefficient and the threshold value are jointly determined. Equations (3) and (4) assume that there exist only single thresholds; similar procedures can be conducted to deal with the case of multiple thresholds. This possibility of existence of more than one threshold represents another advantage of this method over the traditional approaches, which allow for only a single threshold. We allow for the possibility of multiple thresholds in our estimation.

[4] See Table 1 in Hansen (2000: 582)

3.3 Data sources and descriptions

The sources for most of the data and definitions used in this study are provided in Appendix Table A.2. Most data come from World Bank World Development Indicators, with the income inequality and poverty for developing and emerging economies from World Bank *PovCal* database, and for advanced economies from the LIS database. Both of these inequality databases allow more within and across country comparisons than available elsewhere. Appendix Tables A.3 and A.4 give both summary statistics and correlation matrix. Descriptive statistics that include data plotting and data analysis are in Section 4.

4 Trends and patterns in income inequality, trade, growth, and poverty

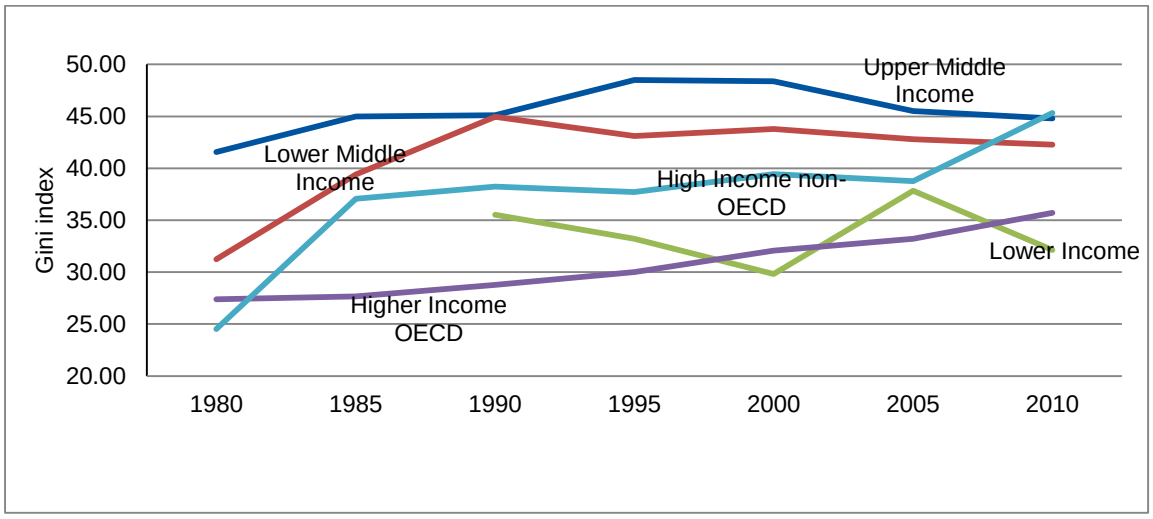
Appendix Table A.5 summarizes the trends in the main variables (inequality, trade, growth, and poverty) for each region, between 1980 and 2010. East Asia that have achieved the highest GDP growth rate, on average 7 per cent per annum compared to other regions, have also experienced a huge poverty reduction over the past 30 years; from 77.7 per cent at the end of the 1970s to 12.8 per cent at the end of the 2000s. South Asia, which grew on average at the same rate as East Asia (6 per cent per annum), has only seen a modest fall in poverty, from 59.4 per cent to 50.8 per cent in the same period. Those regions which experienced low GDP growth rate such as MENA, Latin America, sub-Saharan Africa (SSA), and OECD countries, have seen no significant fall (and sometimes worsening) in levels of poverty rate. For example, Latin America, as it is for SSA, which on average has been growing at 3 per cent has experienced persistent levels of poverty of around 10 per cent, fell from 12.8 per cent at the end of the 1970s to 7 per cent at the end of the 2000s. SSA, the most poorly performing region, despite the recent good economic growth rate, has experienced a persistent high level of poverty rate of around 55.5 per cent, with poverty falling from 53.4 per cent at the end of the 1970s to 47.5 per cent at the end of the 2000s. MENA, which had the lowest poverty rate from the beginning and experienced low growth rate, on average around 3 per cent per annum, has seen reasonable poverty reduction from 7.9 per cent at the end of the 1970s to 3.6 per cent at the end of the 2000s (things might have reversed recently following the Arab spring). OECD countries in contrast, experienced low growth rate and poverty has slightly worsened, from 16 per cent at the end of the 1970s to 20 per cent at the end of the 2000s (the recent economic and financial turmoil are partly to blame). Exports and trade as share of GDP have increased significantly during this period for all of the six regions.

Though most regions have experienced high economic growth rates, a significant rise in the share of trade (exports) to GDP, few regions have experienced a significant reduction in poverty, income inequality has worsened for most country groups. As shown, both in Figures 1.A-D and Appendix Table A.5, income inequality has risen in most income groups from the 1980s to 2000s. However, it has risen much more in the high-income countries, both in OECD (from 27 to 37 per cent) and non-OECD (from 24 to 45 per cent), so are the upper and lower middle-income countries (see Figure 1.A). There is a slight fall in income inequality for low-income countries. Nearly, the same pattern is observed in Figure 1.B when we group countries by regions, with some regions like East Asia expiring falling and rising inequality, South Asia and SSA experiencing a slight rise in income inequality, MENA have seen a fall, and Latin America have retained high levels of income inequality.

When we decompose the entire sample into individual countries, a mixed picture emerged. Much as there are many countries that have experienced a significant rise in income inequality, especially in the advanced economies, there are those which have not and others which have experienced falls in income in inequality. Some countries in advanced economies that include the

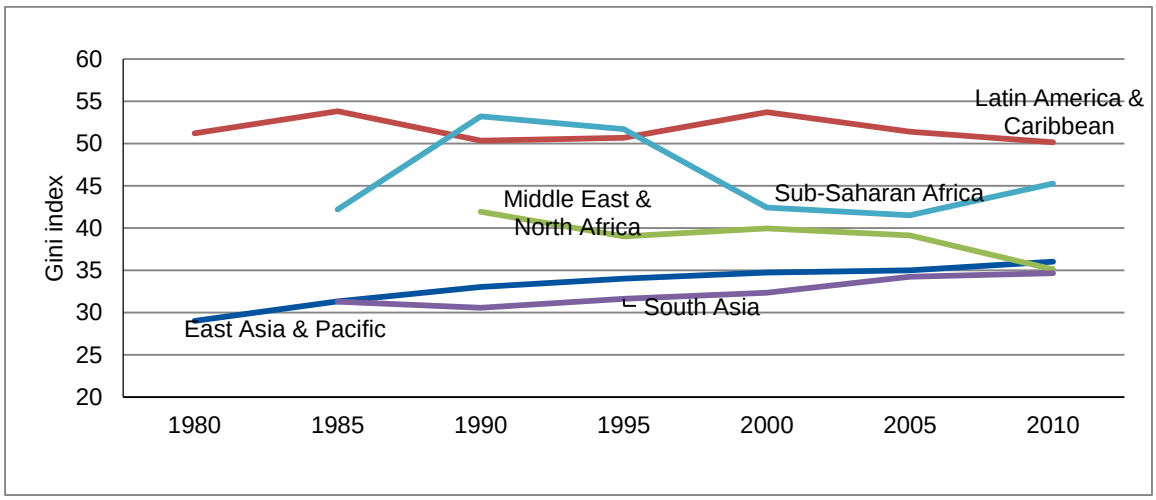
UK, USA, Sweden, Poland, Netherlands, Luxembourg, Italy, Israel, Germany, Finland, Canada, Belgium, and Austria have experienced a substantial rise in income inequality. Others such as Australia, Denmark, Norway, and Spain have only experienced very marginal or no change, while countries like France, Switzerland, and Ireland have seen income inequality falling. The same stories can be extended when looking at individual countries in the emerging and developing economies. While for instance China and Indonesia have been experiencing rising income inequality, Brazil and Russia are experiencing falling in income inequality, but income inequality in Brazil, South Africa, and Mexico have remained very high.

Figure 1.A: Country income inequality by income groups



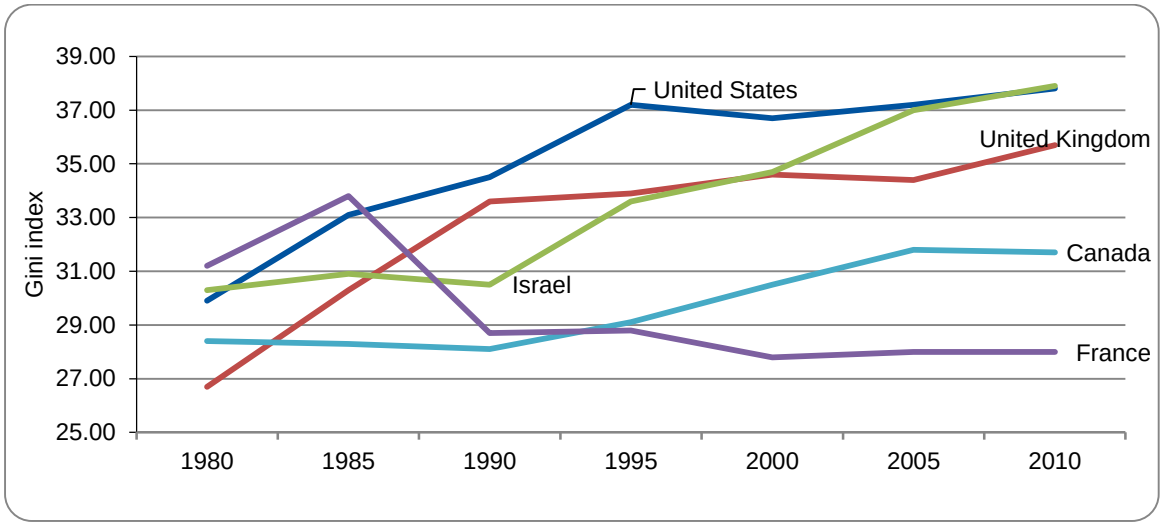
Source: Author's compilation based on the PovCal (World Bank) and LIS databases.

Figure 1.B: Country income inequality by regions groups



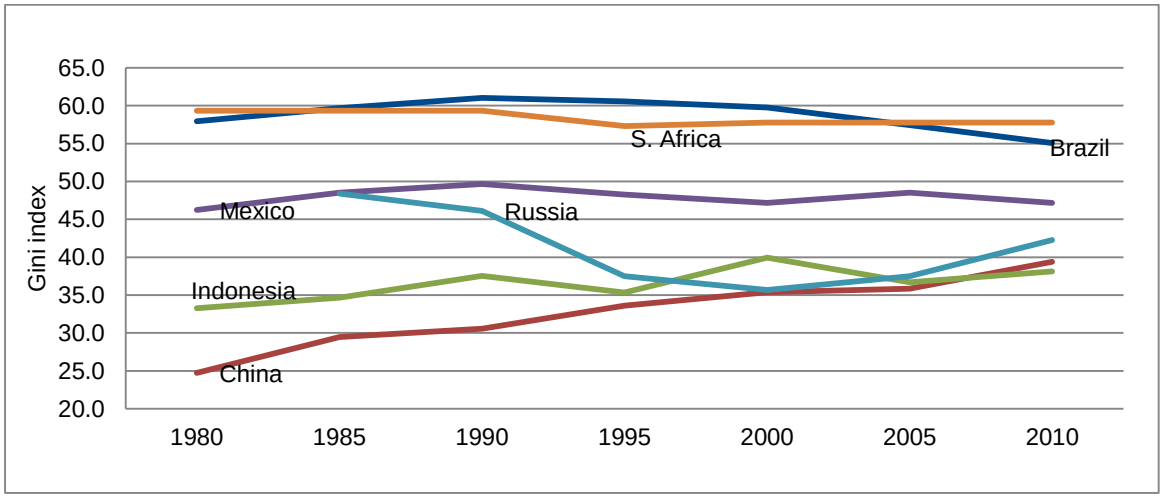
Source: Author's compilation based on the PovCal (World Bank) and LIS databases.

Figure 1.C: Income inequality by selected advance economies



Source: Author's compilation based on the PovCal (World Bank) and LIS databases.

Figure 1.D: Income inequality by emerging and developing countries



Source: Author's compilation based on the PovCal (World Bank) and LIS databases.

To get the feel of our sample data, we plot, summarize, and explore correlations among the key variables as shown in Appendix Tables A.3 and A.4, for the whole period (from 1975 to 2010) and for the entire sample. The correlation matrix and plots show that income inequality reduces growth, while exports and trade promote growth. At the same time while exports reduce inequality, trade as whole increases inequality. Most of other variables have the expected signs.

5 Results and discussion

5.1 Base model

The (parsimonious) base regression results are in Table 1 in Columns 1-3, and includes initial income, annual population growth rate, secondary education, and gross capital formation (investment) as determinants of growth. In all three estimators, that is the Pooled OLS (POLS), RE, and System GMM (SYSGMM) models, all variables, have the expected signs and most are significant. RE are selected over the FE model for two reasons. One, the relationship between

trade, inequality, and growth potentially suffers from omitted variables that are due to differences across countries but constant over time (i.e. fixed effects) and those which are fixed across countries but vary over time (i.e. between effects). Second, variables like lnGDPO are effectively fixed, so when the FE model is used these are dropped. Hence, RE is used as a weighted average of fixed and between effects. Any effect that appears to be country-specific is captured by RE. The SYSGMM estimator is our preferred technique because, besides controlling for measurement errors, heterogeneity, and endogeneity biases that are inherent in our covariates, it also addresses the persistence in our panel series.

Table 1: Determinants of cross-country growth: baseline specification

	POLS (1)	RE (2)	SYSGMM (3)	POLS (4)	RE (5)	SYSGMM (6)
lnGDPO	-0.545*** (-4.385)	-0.353** (-2.291)	-0.700*** (-4.136)	-0.294** (-2.310)	-0.345** (-2.293)	-0.970*** (-5.359)
lnPOPLN	-0.730*** (-5.685)	-0.677*** (-3.969)	-0.834*** (-5.917)	-0.347** (-1.997)	-0.335** (-2.204)	-0.512*** (-5.053)
SEC	0.012** (1.995)	0.001* (1.710)	0.022*** (4.450)	0.009 (1.216)	0.005 (1.655)	0.040*** (4.590)
INV	0.167*** (9.402)	0.168*** (9.780)	0.156*** (6.331)	0.158*** (8.334)	0.165*** (9.258)	0.155*** (8.251)
GINI				-0.023** (-2.316)	-0.024** (-2.056)	-0.034** (-2.074)
CONS	1.832* (1.813)	0.863 (0.776)	3.049** (2.463)	1.917 (1.502)	1.283 (0.991)	6.471*** (4.208)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
BreuschPagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.115			0.196
R^2(overall)	0.31	0.30		0.29	0.31	
N	534	534	534	528	528	528

Notes: Figures in parentheses are t-ratios: *** denotes significant at 1%, ** significant at 5%, and * significant at 10%. The F-test supports the hypothesis that all coefficients are jointly significant (i.e. rejects the null that all are zero). The Breusch Pagan (BP) heteroscedasticity test reveals no evidence of heteroscedasticity, as we reject the null hypothesis and conclude that RE is appropriate. To evaluate whether our models are correctly specified and whether our instruments are valid, we use two criteria: the test for first/second order serial correlation of the residual in differenced equation ((AR (1)/m1 and AR (2)/m2). The former is the Sargan/Hansen test for over-identifying restrictions, which, under the null of instrument validity, is asymptotically distributed as a chi-square with degrees of freedom equal to the number of instruments less the number of parameters. If the model is correctly specified, the variables in the instrument set should be uncorrelated with the idiosyncratic component of the error term ε_{it}. The AR (2)/m2 test is asymptotically distributed as a standard normal under the null of no second-order serial correlation, and provides a further check on the specification of the model and on the legitimacy of variables dated t-2 as instruments. In order for the instruments to be acceptable, the p-values for the Sargan test and the AR (2)/m2 test should both be greater than 0.05.The AR (1)/m1 test is asymptotically distributed as a standard normal under the null of no first-order serial correlation. According to Arrelano and Bond (1991), the GMM estimator requires that there is first-order serial correlation (AR (1)/m1) but no second-order serial correlation (AR (2)/m2) in the residuals; hence the p-values for the AR (1)/m1 test should be less than 0.05. All support the fact that these models are correctly specified.

Source: Author's estimation based on the PovCal (World Bank), LIS (Luxembourg Income Study), and WDI (World Bank) databases.

The coefficient on initial income, which captures both country-specific effects and conditional convergence, is negative and significant, implying that poor countries are catching up with rich ones. Secondary education and investment are good for economic growth as expected, as their coefficients are positive and statistically significant for all three estimators. As expected, the coefficient on population growth is negative and statistically significant, implying that population growth is bad for economic growth. Our baseline empirical model therefore behaves as what found in many other empirical studies.

Given rising income inequality, even in the emerging and developing economies, most of which have been experiencing high economic growth over the past two decades, we introduce income inequality in the baseline regression model, Column 4–6 (Table 1). Though some studies have found positive significant effects and others no effects, like a good number of other studies, this study finds negative significant effects of inequality on economic growth, suggesting that rising income inequality is bad for economic growth, both in advanced and developing economies. The findings that inequality is damaging to economic growth are also supported by the IMF, who argued that countries with high levels of inequality suffered lower growth than nations that distributed incomes more evenly. Further, one of the IMF publication (Ostry et al. 2014) warned that inequality can also make growth more volatile and create the unstable conditions for a sudden slowdown in GDP growth. According to Ostry et al. (2014), analysis of various efforts to redistribute incomes showed a neutral effect on GDP growth. Ncube et al. (2013) also investigated the effect of income inequality on economic growth and poverty in the MENA region and their empirical results showed that income inequality reduces economic growth and increases poverty in the region.

As the focus of this study is also on the effects of exports and trade on economic growth conditional on levels of income inequality, we first test for the direct effects of trade openness on economic growth. As shown in Appendix Table B.1 and Table 2, as in many other empirical studies, openness to trade does advance economic growth. There are however, no particular reasons to posit a clear relationship between exports (trade) and income inequality. More recently, a couple of studies have looked at the complex nexus among globalization (trade openness, financial liberalization, and technology), growth, income distribution, and poverty. Some of the findings are: whereas trade globalization in term of trade openness is associated with a reduction in inequality, financial, and technological globalization are associated with an increase in inequality, and that there is a conditional relationship between trade openness and inequality (Jaumotte et al. 2013; Lee 2014). The correlation matrix in this study shows that exports reduce inequality while trade increases it.

Table 2: Determinants of cross-country growth, with trade openness and inequality

	POLS (1)	RE (2)	SYSGMM (3)	POLS (4)	RE (5)	SYSGMM (6)
lnGDPO	-0.529*** (-4.291)	-0.394** (-2.574)	-1.141*** (-12.399)	-0.521*** (-4.257)	-0.384** (-2.519)	-1.075*** (-12.751)
lnPOPLN	-0.616*** (-4.600)	-0.561*** (-3.211)	-0.654*** (-13.687)	-0.620*** (-4.632)	-0.563*** (-3.218)	-0.785*** (-6.833)
SEC	0.011* (1.722)	0.001 (0.188)	0.044*** (9.580)	0.011* (1.772)	0.002 (0.226)	0.041*** (8.239)
INV	0.153*** (8.285)	0.156*** (8.839)	0.089*** (6.284)	0.154*** (8.278)	0.155*** (8.743)	0.107*** (9.428)
GINI	-0.018* (-1.838)	-0.022* (-1.765)	-0.031*** (-3.784)	-0.018* (-1.852)	-0.021* (-1.737)	-0.035*** (-3.603)
XGDP / TRADE	0.010* (1.853)	0.011* (1.734)	0.011** (2.244)	0.001 (0.282)	0.002 (0.654)	0.009*** (2.961)
CONS	2.694** (2.394)	2.303* (1.868)	8.036*** (7.896)	2.664** (2.355)	2.264* (1.835)	6.316*** (8.211)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
Breusch Pagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.157			0.203
R^2 (overall)						
r2	0.29			0.29		
N	526	526	526.	226	5526.	526

Notes: See Table 1.

Source: See Table 1.

5.2 Linear interaction effects

Assuming that the effect of trade (exports) on economic growth varies depending on the level of inequality, we hypothesize that the relationship between trade (exports) and growth is moderated by the level of income distribution. The most common approach is to use the simple product term (traditional product term). Thus, our reduced form specification uses product terms to allow for interaction effects, where inequality is embedded as a variable that mediates the relationships between trade and economic growth. To estimate the simple interaction effect of model 2 and ensure a meaningful interpretation, we transformed our mediating variable inequality. This is done by mean centring inequality to create a new scale for our mediating variable. Then we re-estimate the traditional product term of model 2 with its transformed mediating variables such that our coefficient of interest γ is the predicted effects of trade on growth when income inequality equals its sample mean. This is the marginal impact of trade on growth, which can be derived from Equation (2) as:

$$\partial y_{it} / \partial s_{it} = \gamma TRADE + GINI_{it} * TRADE_{it}\delta \qquad (6)$$

Table 3 presents the linear interaction effects between exports and inequality in Columns 1-3, and trade and inequality in Columns 4-6, allowing for the effects of exports (trade) on growth conditional on inequality. The interaction effects are treated in a similar way for GMM and RE as for the OLS estimator. The fact that the coefficient on exports and trade are negative and statistically significant, while that of interaction effects is positive and statistically significant, implies that trade openness measures lower economic growth at higher values of income inequality. This suggests that, the beneficial impacts of increased trade openness on economy are lower when the values of income inequality are higher, and the opposite holds. In other words, more openness results in a lower growth rate when inequality is higher. These results are,

however, sensitive to the size of the sample used, when allowing for outliers in the sample, as shown in Appendix Table B.2. The positive and to a less extent significant effect of trade openness' measures on growth given inequality, while their interaction effects are positive and statistically significant seem to suggest that rising income inequality tends to lower economic growth. But at the same time, as found in some latest empirical studies, trade openness also lowers income inequality (Jaumotte et al. 2013; Lee 2014) such that its effects on growth given inequality will be positive; since on one hand it will be enhancing economic growth while at the another hand it will be reducing income inequality.

Table 3: Determinants of cross-country growth, with interaction terms

	POLS	RE	SYSGMM	POLS	RE	SYSGMM
	(1)	(2)	(3)	(4)	(5)	(6)
lnGDPO	-0.525***	-0.335**	-1.137***	-0.522***	-0.331**	-0.966***
	(-4.264)	(-2.097)	(-15.353)	(-4.281)	(-2.084)	(-17.378)
lnPOPLN	-0.673***	-0.604***	-0.904***	-0.657***	-0.596***	-0.965***
	(-4.896)	(-3.422)	(-18.823)	(-4.830)	(-3.368)	(-11.131)
SEC	0.011*	-0.001	0.033***	0.012**	-0.000	0.028***
	(1.783)	(-0.069)	(10.044)	(1.960)	(-0.011)	(10.502)
INV	0.158***	0.160***	0.083***	0.159***	0.159***	0.084***
	(8.860)	(9.191)	(14.126)	(8.848)	(9.010)	(13.736)
GINI	-0.059***	-0.068***	-0.111***	-0.058***	-0.070***	-0.104***
	(-3.220)	(-2.939)	(-7.734)	(-3.003)	(-2.769)	(-5.937)
XGDP /TRADE	-0.046**	-0.048*	-0.062***	-0.024**	-0.024*	-0.036***
	(-2.363)	(-1.915)	(-4.271)	(-2.354)	(-1.950)	(-4.398)
GINI*XGDP/*GINI*TRADE*	0.001**	0.001**	0.002***	0.001**	0.001**	0.001***
	(2.563)	(2.248)	(5.938)	(2.409)	(2.089)	(5.641)
CONS	1.833*	0.814	7.538***	1.840*	0.817	6.394***
	(1.805)	(0.720)	(14.634)	(1.808)	(0.722)	(15.802)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
Breusch Pagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.167			0.263
R^2 *(overall)*	0.33			0.32		
N	526	526.	526.	526.	526.	526

Notes: See Table 1.

Source: See Table 1.

5.3 Allowing for non-linear interaction effects

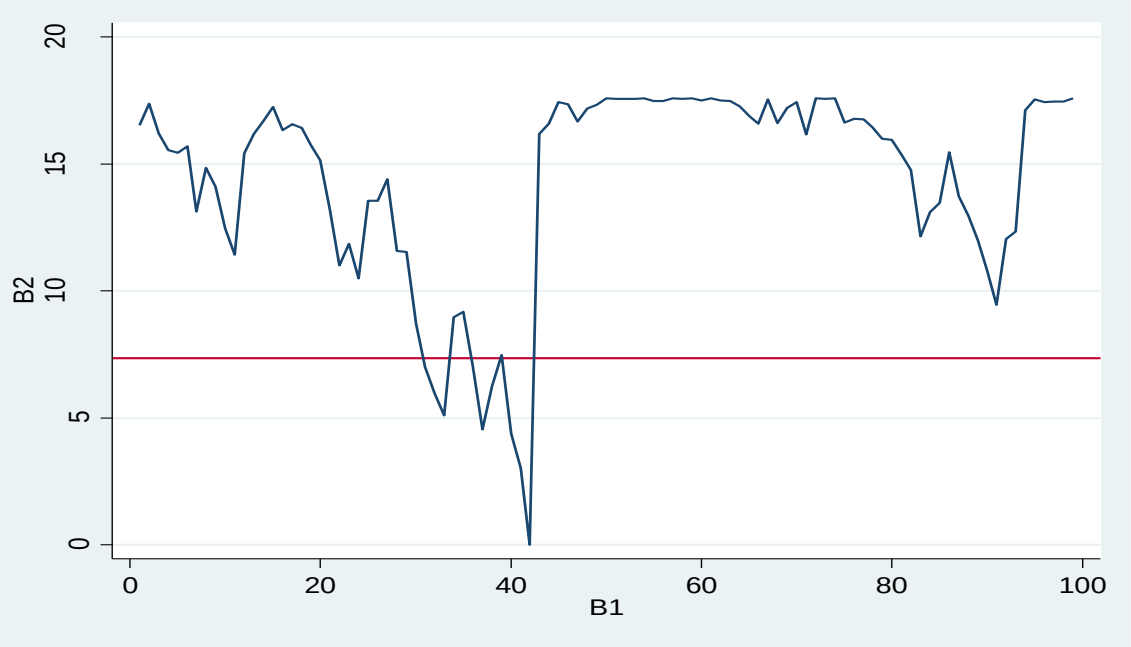
Important in here to note that the traditional product term test only for a bilinear interaction effects and failure to obtain a statistically significant interaction effects may signal the presence of an alternative function form. Thus, in addition, trade affects economic growth differently given the different level of income inequality. For that reason, linear interaction terms used above may be miss-specified so we now employ the Hansen (2000) endogenous threshold regression technique. Here we are treating *GINI* as the threshold identifying variable for *XGDP* in Figure 2.A (the same has been done for *TRADE* in Figure 2.B), that is, we search for a threshold where the relationship between *GINI* and *XGD* or *TRADE* changes (previously we conditioned the interaction on the mean value of *GINI* so in effect we are refining that decision).

Using inequality as our identifying variable in the trade-growth relationship and applying Hansen's technique, many cut-off points are identified. But only two breaks at the 45th percentile (when the focus is on exports, as shown in Figure 2.A) and 95th percentile (when the focus is on trade, as shown in Figure 2.B) are significant. Denoting the percentiles of inequality to exports

(or trade)*(XGDP/TRADE)* by α, the 95 per cent confidence interval for the threshold estimates is obtained by plotting the likelihood ratio sequence in α, $LR_{n(\alpha)}$, against α and drawing a flat line at the critical value (e.g. the 95 per cent critical value is 7.35). The segments of the curve that lie below the flat line are the 'no rejection region', that is the confidence interval of the threshold estimate.

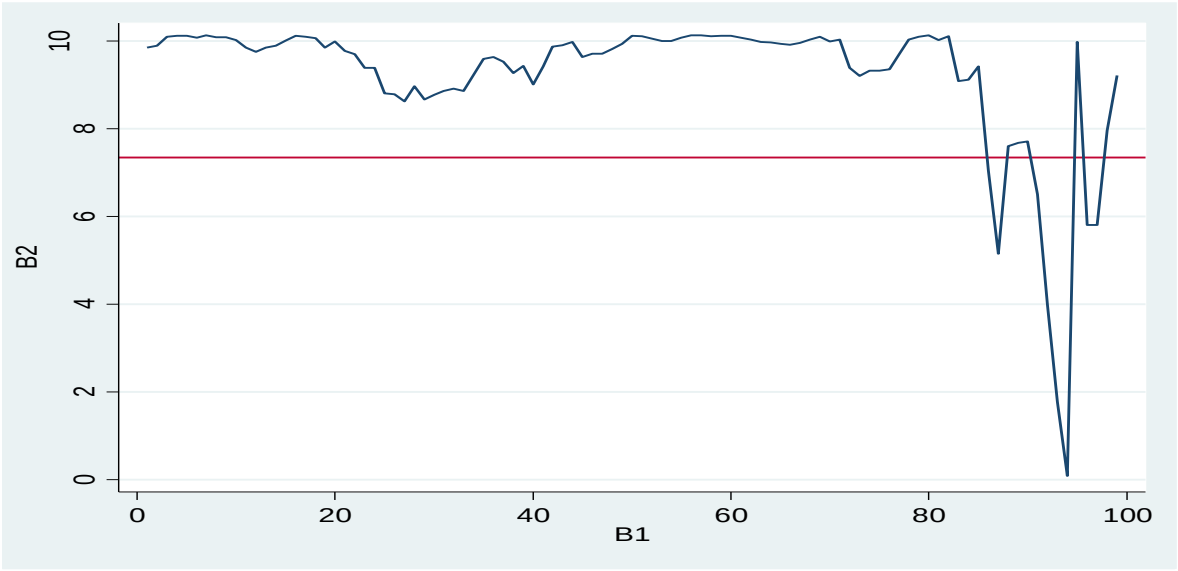
Figure 2: Endogenous sample splitting—formal threshold model

(a) 95 % Confidence interval for the inequality as threshold variable: exports



Source: Author's estimation based on the PovCal (World Bank), LIS (Luxembourg Income Study), and WDI (World Bank) databases.

(b): 95 % Confidence interval for the inequality as threshold variable: trade



Source: Author's estimation based on the PovCal (World Bank), LIS (Luxembourg Income Study), and WDI (World Bank) databases.

Since only a small portion lies in the 'no rejection region', these thresholds are significant. Other cut-off values are either marginally significant or insignificant; the 95 per cent confidence

intervals for those thresholds are wide and encompass most of the region below the flat line at the critical value. As a result we are less sure in these cases as to where the 'true' value at which the break-point in parameter lies. We consider the effect of the significant threshold in Table 4 for when the inequality is below the threshold of 45 percentiles in Table 5, for when inequality is above the threshold of 45 percentiles, both for exports and trade.

Table 4 reports the results for effect of *XGDP* in Columns 1-3 and for TRADE in Columns 4-6 on GROWTH given that GINI is below the threshold value (45th percentile). As what envisaged, low-income inequality is good for economic growth as the regression coefficient on inequality is positive and statistically significant for most specification while their interaction effects with trade openness measures is negative and statically significant for the GMM estimator. The results are corroborated when we replicate the same specifications where GINI>45percentile in Table 5. The GINI coefficient now has turned from positive to negative and most are significant, while their interaction effects are positive and statically significant for the GMM estimator. Implying that rising income inequality is bad for economic growth and that dampen the positive effects of trade openness on economic growth.

Table 4: Endogenous threshold regression estimates: inequality is below the threshold

	POLS (1)	RE (2)	SYSGMM (3)	POLS (4)	RE (5)	SYSGMM (6)
	GINI<=45 percentile					
lnGDPO	-0.581*** (-5.205)	-0.479*** (-3.589)	-0.624*** (-14.089)	-0.572*** (-5.140)	-0.468*** (-3.495)	-0.594*** (-28.711)
lnPOPLN	-0.629*** (-4.652)	-0.671*** (-3.989)	-0.937*** (-25.558)	-0.627*** (-4.679)	-0.672*** (-3.990)	-0.939*** (-18.186)
SEC	0.009 (1.428)	0.003 (0.383)	0.003 (1.049)	0.010 (1.546)	0.004 (0.488)	0.007*** (3.129)
INV	0.150*** (6.559)	0.145*** (8.825)	0.125*** (36.148)	0.151*** (6.856)	0.144*** (8.543)	0.126*** (36.201)
GINI	0.914** (1.964)	1.031* (1.664)	2.301*** (10.099)	0.721* (1.764)	0.892 (1.394)	1.686*** (9.973)
XGDP /TRADE	0.010* (1.791)	0.011* (1.696)	0.018*** (5.922)	0.002 (0.658)	0.003 (0.956)	0.008*** (5.631)
GINImnXGDP/*GINImnTRADE*	-0.004 (-0.433)	-0.010 (-0.758)	-0.034*** (-7.711)	-0.007 (-0.648)	-0.003 (-0.407)	-0.012*** (-5.695)
CONS	2.353** (2.543)	1.965** (2.013)	3.462*** (8.279)	2.383** (2.523)	1.996** (2.035)	3.115*** (11.069)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
Breusch Pagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.360			0.336
R^2 *(overall)*	0.31			0.30		
N	574.000	574.000	574.000	574.000	574.000	574.000

Notes: See Table 1.

Source: See Table 1.

Table 5: Endogenous threshold regression estimates: inequality is above the threshold

	POLS (1)	RE (2)	SYSGMM (3)	POLS (4)	RE (5)	SYSGMM (6)
	GINI>45 percentile					
lnGDPO	-0.581*** (-5.205)	-0.479*** (-3.589)	-0.571*** (-14.340)	-0.572*** (-5.140)	-0.468*** (-3.495)	-0.554*** (-12.917)
lnPOPLN	-0.629*** (-4.652)	-0.671*** (-3.989)	-0.897*** (-17.454)	-0.627*** (-4.679)	-0.672*** (-3.990)	-0.934*** (-15.434)
SEC	0.009 (1.428)	0.003 (0.383)	0.002 (0.766)	0.010 (1.546)	0.004 (0.488)	0.004 (1.532)
INV	0.150*** (6.559)	0.145*** (8.825)	0.139*** (20.780)	0.151*** (6.856)	0.144*** (8.543)	0.137*** (22.608)
GINI	-0.914** (-1.964)	-1.031* (-1.664)	-2.300*** (-10.193)	-0.721* (-1.818)	-0.892 (-1.394)	-1.806*** (-9.667)
XGDP /TRADE	0.010* (1.791)	0.011* (1.696)	0.021*** (7.344)	0.002 (0.658)	0.003 (0.956)	0.009*** (7.694)
GINImnXGDP/*GINImnTRADE*	0.004 (0.433)	0.010 (0.758)	0.038*** (8.312)	0.003 (0.485)	0.003 (0.407)	0.013*** (6.788)
CONS	3.267*** (3.118)	2.995*** (2.661)	4.863*** (12.161)	3.104*** (3.002)	2.888** (2.548)	4.384*** (12.005)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
Breusch Pagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.289			0.280
R^2 *(overall)*	0.25			0.25		
N	574	574	574.000	574	574	574

Notes: See Table 1.

Source: See Table 1.

6 Summary and implications

Following the recent rise in income inequality in advanced, emerging, and developing economies, the key question has been on what has been the role of trade and growth on all this. That is, what are the distribution effects of trade openness and economic growth? Thus, besides reviewing the latest literature and explore the patterns and trends in data with regard to income inequality, trade, and growth, this study sets out to examine and asses evidence of a link between growth, trade (exports), and income inequality. While there is no particular reason to posit a clear relationship between trade (exports) and inequality, and as inequality can be considered a proxy for the 'governance quality' it also tests for a threshold in inequality for the effect of trade (exports) on growth. This is done using a large panel of 100 countries over 30 years (1980 to 2010) and applies standard econometric techniques that address most of the econometric problems and the Hansen (2000) endogenous threshold regression technique that locates the thresholds in data, tests for their significance and constructs their confidence intervals.

Like most of the latest studies that have looked at the complex relationship between trade openness, growth, and income distribution, this study finds that, though trade openness advances economic growth, on the contrary income inequality reduces economic growth. Conditional on the level of income distribution, trade openness advances economic growth at either higher or low level of income inequality. There is as well a threshold on which income inequality, and the trade openness contingent on income inequality, is good for economic growth and the opposite is also true. The key implications of these findings are that inequality is damaging to economic growth and dampens the positive effects of trade openness on growth; so

various efforts need to be taken to redistribute incomes, to ensure sustainable and inclusive growth that is poverty reducing both in advanced and developing economies.

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Appendix A1: Data description and sources

Table A1: List of countries

Albania	France	Nepal
Algeria	Gabon	Netherlands
Angola	Gambia, The	Nicaragua
Argentina	Germany	Niger
Australia	Ghana	Nigeria
Austria	Guatemala	Norway
Bangladesh	Guinea	Pakistan
Belgium	Guinea-Bissau	Panama
Benin	Guyana	Papua New Guinea
Bhutan	Haiti	Paraguay
Bolivia	Honduras	Peru
Botswana	Hungary	Philippines
Brazil	India*	Poland
Bulgaria	Indonesia*	Romania
Burkina Faso	Iran, Islamic Rep.	Rwanda
Burundi	Ireland	Senegal
Cambodia	Israel	Seychelles
Cameroon	Italy	Sierra Leone
Canada	Jamaica	Slovak Republic
Cape Verde	Jordan	South Africa
Central African Republic	Kenya	Spain
Chad	Lesotho	Sri Lanka
Chile	Liberia	St. Lucia
China--Urban	Liberia	Sudan
Colombia	Liberia	Swaziland
Comoros	Liberia	Sweden
Congo, Dem. Rep.	Liberia	Switzerland
Congo, Rep.	Liberia	Tanzania
Costa Rica	Liberia	Thailand
Côte d'Ivoire	Luxembourg	Togo
Denmark	Madagascar	Trinidad and Tobago
Djibouti	Malawi	Tunisia
Dominican Republic	Malaysia	Turkey
Ecuador	Mali	Uganda
Egypt, Arab Rep.	Mauritania	United Kingdom
El Salvador	Mexico	United States
Ethiopia	Morocco	Uruguay
Fiji	Mozambique	Venezuela, RB
Finland	Namibia	Vietnam

Source: Author's compilation.

Table A.2: Variables definition and sources of data

Variables	Definition	Sources
GRWTH	GDP per capita growth (annual per cent)	World Development Indicators (WDI) 2013
LNGDPO	initial income measured as log of GDP per capita (constant 2005 US$) at the beginning of the period, same as lag dependent variable	WDI 2013
GINI	a measure of inequality between 0 (everyone has the same income) and 100 (richest person has all the income)	http://iresearch.worldbank.org/PovcalNet
POV	headcount poverty, measured as per cent of population living in households with consumption or income per person below the poverty line as per World Bank, 2005	http://iresearch.worldbank.org/PovcalNet
POPLN	Population growth (annual per cent)	WDI 2013
INFLN	Inflation, consumer prices (annual per cent)	WDI 2013
SEC	School enrolment, secondary (per cent gross)	WDI 2013
INV	Gross capital formation (per cent of GDP)	
TRADE	Trade (export + imports, per cent of GDP)	WDI 2013
XGDP	Exports of goods and services (per cent of GDP)	WDI 2013

Source: Author's compilation.

Table A3: Summary statistics for the main variable, 1980-2010

	Obsn.	Mean	Std. Dev.	Min	Max
GROWTH	598	1.61	2.73	-7.03	9.47
GINI	614	41.61	11.69	0.00	74.33
POV	607	28.76	24.90	0.05	90.52
lnGDPO	609	7.20	1.60	4.83	10.30
POPLN	621	1.86	1.08	-1.91	5.89
SEC	578	55.54	32.70	3.24	133.71
INV	605	22.06	6.83	3.96	47.58
XGDP	595	31.74	18.15	6.11	101.62
TRADE	595	68.37	34.67	14.51	203.83

Source: Author's contruction.

Table A4: Correlation matrix between all variables

	GROWTH	*GINI*	*POV*	*lnGDPO*	*POPLN*	*SEC*	*INV*	*XGDP*	*TRADE*
GROWTH	1.000								
GINI	-0.177	1.000							
POV	-0.138	0.171	1.000						
lnGDPO	-0.038	-0.326	-0.597	1.000					
POPLN	-0.196	0.439	0.505	-0.594	1.000				
SEC	0.141	-0.397	-0.649	0.814	-0.724	1.000			
INV	0.455	-0.167	-0.347	0.055	-0.170	0.222	1.000		
XGDP	0.096	-0.065	-0.298	0.295	-0.282	0.347	0.173	1.000	
TRADE	0.095	0.011	-0.196	0.177	-0.157	0.230	0.197	0.922	1.000

Source: Author's construction.

Table A.5: Inequality, poverty, growth, and trade by regions, 1975-2009

Regions	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09
East Asia & Pacific							
Gini	29.00	31.30	33.00	34.00	34.72	35.00	36.00
Poverty	77.67	59.825	54.72	43.385	31.55	16.78	12.48
Growth	6.33	6.64	9.18	8.36	7.56	7.84	9.74
Export (per cent GDP)	11.79	16.30	17.96	24.70	30.36	36.86	42.60
Trade (per cent GDP)	23.66	32.68	36.94	49.37	57.04	70.43	78.96
Latin America & Caribbean							
Gini	51.20	53.80	50.33	50.67	53.71	51.40	50.12
Poverty	12.87	14.465	11.32	10.52	10.79	8.22	6.47
Growth	5.13	1.68	2.50	3.24	2.59	2.50	5.53
Export (per cent)	13.00	15.64	17.34	16.69	19.97	22.54	25.67
Trade (per cent)	29.16	32.13	34.20	35.84	40.71	45.35	49.55
OECD Countries							
*Gini**	27.40	27.68	28.76	30.00	32.07	33.20	35.70
*Poverty**	15.92	15.23	15.30	17.07	18.41	18.88	20.77
Growth	3.38	2.23	3.76	2.21	3.04	2.43	0.97
Export (per cent)	16.38	18.23	17.59	18.04	21.00	22.56	27.10
Trade (per cent)	33.51	37.16	35.66	36.11	41.64	45.69	54.91
Middle East & North Africa							
Gini	..	..	41.92	39.00	39.96	39.13	35.10
Poverty	7.87	5.91	4.31	4.09	3.89	3.6	2.70
Growth	6.12	1.49	0.91	5.11	3.29	4.69	5.21
Export (per cent GDP)	27.85	38.09	27.84	31.66	31.79	40.63	52.73
Trade (per cent GDP)	62.38	77.21	61.95	68.76	61.71	72.42	93.02
South Asia							
Gini	..	31.27	30.56	31.60	32.35	34.22	34.66
Poverty	59.35	54.855	51.71	46.99	51.71	50.85	35.97
Growth	3.82	5.48	5.71	4.70	6.23	5.43	7.61
Export (per cent GDP)	7.25	7.18	7.03	10.11	12.16	15.06	22.26
Trade (per cent GDP)	16.61	18.50	17.14	21.74	26.39	31.74	50.54
Sub-Saharan Africa							
Gini	..	42.19	53.19	51.70	42.42	41.49	45.27
Poverty	53.37	50.91	56.70	57.83	57.58	55.17	47.51
Growth	2.35	1.52	1.96	0.40	3.34	4.98	5.24
Export (per cent GDP)	27.76	26.48	27.35	25.95	28.64	31.69	33.11
Trade (per cent GDP)	56.92	55.48	53.00	53.08	58.73	63.77	68.83

Source: Author's estimation based on the PovCal (World Bank), LIS (Luxembourg Income Study), and WDI (World Bank) databases.

Appendix B: More results

Table B.1: Determinants of cross-country growth, with trade openness measures

	POLS (1)	RE (2)	SYSGMM (3)	POLS (4)	RE (5)	SYSGMM (6)
lnGDPO	-0.542*** (-4.361)	-0.448*** (-3.433)	-0.655*** (-5.465)	-0.534*** (-4.330)	-0.391*** (-2.577)	-1.088*** (-9.305)
lnPOPLN	-0.228*** (-4.060)	-0.731*** (-4.412)	-1.206*** (-10.317)	-0.692*** (-5.442)	-0.648*** (-3.844)	-1.066*** (-5.660)
SEC	0.004** (2.126)	0.005 (0.723)	0.049*** (4.589)	0.012** (1.933)	0.003 (0.415)	0.046*** (7.798)
INV	0.155*** (8.478)	0.147*** (8.957)	0.130*** (11.159)	0.156*** (8.480)	0.158*** (8.936)	0.091*** (5.501)
XGDP (TRADE)	0.002 (0.871)	0.011* (1.848)	0.009** (2.206)	0.001 (0.139)	0.002 (0.457)	0.010** (2.357)
CONS	-1.212*** (-5.294)	1.842* (1.941)	3.966*** (4.782)	2.195** (2.181)	1.403 (1.267)	6.049*** (6.816)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
Breusch Pagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.157			0.203
R^2 *(overall)*	0.42			0.29		0.31
N	534	534	534	528	528	528

Notes: See Table 1.
Source: See Table 1.

Table B.2: Determinants of cross-country growth, with interaction terms

	POLS (1)	RE (2)	SYSGMM (3)	POLS (4)	RE (5)	SYSGMM (6)
lnGDPO	-0.494*** (-4.462)	-0.383*** (-2.839)	-0.643*** (-9.418)	-0.491*** (-4.017)	-0.343** (-2.240)	-0.900*** (-14.019)
lnPOPLN	-0.620*** (-4.200)	-0.657*** (-3.840)	-0.934*** (-18.577)	-0.617*** (-4.556)	-0.561*** (-3.217)	-0.804*** (-16.830)
SEC	0.009 (1.708)	0.001 (0.193)	0.010*** (3.740)	0.010 (1.708)	0.001 (0.137)	0.030*** (9.028)
INV	0.148*** (6.665)	0.143*** (8.659)	0.112*** (16.956)	0.148*** (7.961)	0.151*** (8.414)	0.106*** (13.245)
GINI	-0.043** (-2.468)	-0.056** (-2.559)	-0.112*** (-11.991)	-0.051*** (-2.611)	-0.062** (-2.510)	-0.065*** (-4.506)
XGDP (TRADE)	0.012** (2.003)	0.013** (2.019)	0.010*** (3.187)	0.003 (0.980)	0.004 (1.187)	0.006*** (4.549)
GINImnXGDP *(GINImnTRADE)*	0.001* (1.788)	0.001** (1.968)	0.002*** (7.566)	0.001** (2.138)	0.001* (1.904)	0.001*** (3.832)
CONS	1.900** (2.088)	1.498 (1.544)	4.099*** (9.548)	2.102** (2.081)	1.251 (1.128)	5.448*** (13.199)
Period Dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test	0.000	0.000	0.000	0.000	0.000	0.000
Breusch Pagan(Prob>chi2)		0.000			0.000	
AR(1) /Pr> z	0.000		0.000	0.000		0.000
AR(2)			0.216			0.204
R^2 *(overall)*	0.311			0.300		
N	570	570	570	505	505	505

Notes: See Table 1.
Source: See Table 1.