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Abstract

This paper examines the relationships between the Gini coefficient, trade-openness, foreign aid and foreign direct investment flows. Panel data estimates show that trade openness can be effective for changing income inequality, but its effectiveness depends on the stage of development. Simulation results show that the Gini and openness can be negatively or positively correlated — it depends on the capital intensity and on the degree of openness. Overall, the results suggest that trade and financial openness can be effective policies for reducing inequality in low income countries, if they significantly increase the marginal productivity of labour through capital intensive methods of production.

JEL classification: E10, F41
Keywords: Gini coefficient, openness

1 Introduction

It has been more than forty years since Hirschman and Rothschild (1973) drew attention to the changing tolerance for inequality in the process of economic development. Citing the civil wars in Pakistan and Nigeria taking place in that period, these authors argued that the "tunnel effect" – the willingness of certain segments of the population to remain behind, accepting relative deprivation while others get ahead, in the hope that the advancement would later become more widespread – may be short lived. These authors challenged the prevailing conventional wisdom of Kuznets (1955) and Kaldor (1957).

Kuznets formulated the relationship between economic growth and inequality as an inverted-U curve. In the early stages of development, as an economy moved from an informal rural structure to an industrialized one, there would be a transition process of greater inequality as the industrial sector grew at the expense of the agrarian rural sector. As Turnovsky (2013) observes, the Kuznets explanation of an inverted-U curve rests on "dual economy" dynamics.

Kaldor's reasoning was more direct. The rich save more of their income than the poor, so that redistribution in favor of the rich would lead to greater savings and thus resources for investment and growth.

Kuznets and Kaldor offer different views of the inequality-growth relation. In the Kuznets view, inequality increases as a result of the initial stages of growth while in the Kaldor scenario, inequality is needed to generate growth. As Deaton (2013) notes, inequality is part and parcel of development. As some members of the population become successful in making the "Great Escape" from poverty and deprivation, others may be left behind. A key question is what policies enhance the changes of succeeding generations to make a similar great escape?

In the years, since the Hirschman-Rothschild challenge, and the conventional wisdom handed down by Kuznets and Kaldor, there has been progress in our understanding of the relationship between growth and inequality. The belief that economic growth generally alleviates poverty and reduces income inequality is now widely-held and supported empirically by many studies. Dollar and Kray (2002), for example, show in their highly cited article entitled "Growth is Good for the Poor," that economic growth and poverty reduction are related on a one-to-one basis. In a later paper, Dollar and Kray (2004) argue that increased trade leads to economic growth as well as poverty reduction in poor countries. Few, if any, can dispute that fact that the advances in economic growth in many parts of the world, particularly in East and South Asia, have brought hundreds of millions out of poverty.

The last forty years have also witnessed the growth and spread of new technology as well as trade and financial liberalization across the world. Both of these are seen as conduits of growth but their implications for income distribution are less clear-cut. A recent study by Jaumotte, Lall and Papageorgiou (2008) suggested that while technological change has been a significant driver of the rise in inequality across both developed and developing countries, the contribution of globalization has been relatively minor. This is because trade liberalization generally results in a reduction in income inequality while financial liberalization generally results in an increase in income inequality. Thus the effects of globalization in trade and finance on income inequality tend to offset each other.

The finding that the effect of globalization on inequality is minor has significant implications. Does it mean that designing policies to promote education, skills and technological progress are the only viable options to promote growth and equality? Is openness no longer an effective avenue for a low income country, with rich natural resources, but with a largely low-skilled labour force, to achieve growth and equality? Which mechanisms ensure that growth (via trade and/or financial liberalization) are or are not conducive to promoting income equality?

This first part of the paper examines empirically the relationship between income inequality, economic growth, and openness based on an annual data set of 42 countries (with GDP per capital close to or below the world's GDP per capita) for the period 1992-2007. Is economic growth more likely to reduce income inequality in countries which are relatively more open?

Openness is usually measured as the ratio of trade (sum of exports and imports) to GDP. We also examine openness in terms of the ratio of foreign direct investment as well as foreign aid relative to GDP.

The data are also decomposed into three subsets - low income countries (which includes almost all countries eligible for Poverty Reduction and Growth Trust (PRGT) support in International Monetary Fund lending programmes), lower-middle income countries (corresponding to classification suggested by the World Bank) and upper-middle (comprising countries usually classified as emerging markets). Breaking the panel set into three groups allowed us to analyze the effect of growth and relative income on inequality, conditioned on the stage of development. Furthermore, countries designated as PRGT-eligible are expected to be more receptive to foreign aid inflows, while those countries designated as emerging markets are expected to be more receptive to foreign direct investment.

The panel results with fixed country and time effects show a significant negative association between the Gini and growth, as well as significant relationships between the Gini and trade and financial openness. However both the intensity and the direction of effect varied across the three subsets mainly because the panel results masked a myriad of possibilities. For example, a closer look at the correlations between the Gini and openness (both trade and financial) showed that they varied from close to -1 to close to +1.

In order to understand better the relationships between openness (trade and financial) and income inequality (as measured by the Gini coefficient), the second part of this paper develops, calibrates and simulates a model of a small open economy. Our specification captures key features noted by the IMF, namely that the countries in our datasets tend to be heavily dependent on exports of natural resources; they are less diversified and vulnerable to terms of trade shocks (especially of food and oil); their financial system is centered around banks and the exchange rate is usually fixed or pegged.

We simulate the model for shocks to the export sector (in the form of export demand and terms of trade changes), for varying degrees of openness. We also explore the importance of labour intensity in the production of traded and non-traded goods for understanding the mechanisms that affect income inequality.

The paper is organized as follows. Section 2 of the paper is devoted to the empirical analysis while section 3 sets out the model. In section 4, the stylized model is simulated to yield insights about the empirical results. Concluding remarks are in section 5.

2 Empirical Analysis

2.1 Data

The panel data set consists of annual data from 1992-2007 for 42 countries, all with GDP per capita close to or below the world's GDP per capita. The variables are: the Gini coefficients on inequality[1], GDP growth rates (dy), relative per-capita GDP (ry), that is the country's per-capita GDP relative to the world per capita GDP, government spending to GDP ratio (gy), openness in trade (op). The data set also includes the foreign aid to GDP ratio (ay) and the foreign direct investment to GDP ratio (fy), these being variables that represent financial openness in terms of receptivity to capital-account inflows.[2]

Table 1 gives the sample means (in percentage terms) for each country in the data set between 1992 and 2007. Since the data set spans a range of economies with very different characteristics, we also ranked them according to their average GDP per capita and divided them into three classes - low income, lower-middle and upper-middle income using the World Bank classification as a guide. Twelve of the PRGT countries are in the low-income group (with GDP per capita under 35 per cent of the world GDP per capita), the other five are classified as lower-middle income countries. The 10 upper-middle income countries have GDP per capital around the world's average GDP per capita.

Table 1 shows great variation among the indicators. In terms of GDP per capita relative to the world's GDP per capita, the poorest country is Tanzania with a sample mean of 10.5 per cent. All PRGT countries plus Pakistan have sample averages under 50 per cent. Countries with per-capita income close to the world's per capita GDP are the emerging countries which includes the South American countries of Costa Rica, Venezuela and Brazil, the African countries which include Tunisia and South Africa and the Asian country of Thailand.

The highest mean Gini coefficient is for Brazil and the lowest is for Bulgaria. For economic growth, the top three performers are Thailand, Sri Lanka and Iran, while Jordan has the highest sample mean value for the government spending to GDP ratio. The Index of trade openness spans the range from 20.5 (Brazil) to 120.3 (Honduras). Some countries received virtually no foreign investment, such as Bangladesh, while the foreign aid flow for Mozambique is more than a third of its GDP.

Table 2 summarizes the descriptive statistics of these indicators for the full sample of 42 countries as well as the three income groups. The data show that the Gini coefficients and the ratio of government spending to GDP are similar across the samples. Openness and the ratio of foreign direct investment to GDP is also surprisingly similar across the subsets. However, the Aid/GDP ratio is much higher for the low-income countries.

As Deaton (2013) points out, sample means may mask important changes taking place over time. To better understand the relationships between the Gini coefficient and per-

[1] While we are only concerned with income inequality, we recognise that there are other measures of inequality. For example, regional inequality is important, especially for very large economies such as India and Brazil. Daumal (2010) found with time-series estimation that Brazil's trade openness contributed to a reduction in regional inequality while the opposite was true for India.

[2] The data, with the exception of the foreign aid and foreign direct investment ratios are described in Solt (2009) and used in recent papers by Delis, Hasan, and Myonidis (2013) and Delis, Hasan, and Kazakis (2013) to examine, respectively, the relationship between foreign bank ownership with income inequality, and banking-sector de-regulations with inequality.

capita income and openness, we plot scatter diagrams relating the Gini to these two variables at the beginning of the sample and at the end of the sample, 1992 and 2007, respectively.

Figure 1 shows that both the per-capita income and the degree of openness have increased markedly from the beginning to the end of the period. The x-symbols represent the scatter data for 1992 and the o-symbols, the scatter data for 2007. In both figures, there is a discernible shift to the right, in the horizontal axis, of the o-symbols relative to the x-symbols, for many (but not all) of the countries.

Table 3 gives the correlation coefficients for the full data set, and for the 3 subsets, based on the pooled sample. While pooled sample results do not take into account country or time-specific effects, a number of interesting patterns emerge. We see that for the overall sample, relative GDP, the government spending ratio, and openness are significantly correlated with the Gini, but not growth, nor the foreign direct investment and foreign aid to GDP ratios. For the upper-middle income countries, both foreign aid and FDI flows are negatively correlated with the Gini, while for the low-income countries, they are positively correlated with the Gini.

Since we are especially interested in the relationship of the Gini with the trade and financial measures of openness, we looked more closely at the empirical correlations of each country in the data set. The mean, minimum and maximum correlations are shown in Table 4. The most important result to note is the fact that the correlations span the range of possibilities from -1 to +1 for each of the openness variables. This is an issue we take up in the simulation section.

2.2 Panel Estimates

The correlations reported above are bivariate relations in the pooled data sets. To further explore the determinants of inequality in these countries,[3] we regress the Gini index, GN_{it} on economic growth dy_{it}, relative income (computed as the ratio of per-capita GDP divided by World per capital GDP), ry_{it}, the government spending-GDP ratio, gy_{it}, the index of trade openness, op_{it}, the foreign aid-GDP ratio, ay_{it} and the foreign direct investment-GDP ratio, fy_{it}.

$$GN_{it} = \alpha_i + \alpha_t + \beta_1 dy_{it} + \beta_2 ry_{it} + \beta_3 gy_{it} + \beta_4 op_{it} + \beta_5 ay_{it} + \beta_6 fy_{it} + \epsilon_{it}; \qquad \epsilon_{it} \tilde{} N(0, \sigma_\epsilon^2)$$

We estimated the model with both country-specific and time-specific fixed effects[4], represented by α_i and α_t. The reason time-specific fixed effects is important is that during

[3] Many studies have examined the inequality-growth relation with economic growth as the dependent variable. Majeed (2010), for example, identified credit market imperfections for generating a positive relation of inequality on growth within the Asian region. The argument is similar to that of Kaldor: only the rich are able to generate sufficient savings for development when there are significant credit frictions.

In the new economic growth literature, the role of inequality has been in dispute. Developing from the work of Barro and Sala-i-Martin (1995), Benabou (1996) and Birdsall, Ross and Sabol (1995) found evidence that inequality had negative effects on economic growth. However, Forbes (2000) soon challenged these results. Using panel data estimation methods, she found that in the short and medium run, inequality had positive effects on growth, and these results were robust across samples, variable definitions, and model specifications.

[4] We also estimated models with only country-specific and only time-specific fixed effects as well as the random effects model. Hausmann Chi-squared tests show that the the model presented here outperformed the pure country-specific and time-specific fixed-effects specificaiton.

the sample period, 1992-2007, several important events took place which had effects across countries in the sample. A major event occurred in the early 1990's when the collapse of the Soviet Union led to the opening of the former Soviet block countries to greater trade. Other significant events, associated mainly with the financial crises of the 1990's beginning with the Mexican crisis of 1995 and the Asian crisis of 1997, led to financial contagion effects across the Western Hemisphere and across East Asia. Similarly the AIDS crisis was a scourge both to health and national income across Africa in the 1990's. Our results show that the time-specific fixed effects matter a great deal.

The results of the panel estimation appear in Table 5. Results are presented for all the countries in the sample as well as separately for the countries classified as low income, lower-middle income and upper-middle income.

Gini, growth and government spending

A key empirical result from our panel estimation is that economic growth and relative income have significant effects on inequality. A closer look at the sub-samples reveal that for the relatively more prosperous countries, improving relative income improves the Gini, but for the poorer countries, growth of income, rather than the relative level of income, matters for reducing inequality. The relative level of income actually increases inequality.

This result is not surprising. Given that income is very low for most of the population in the low-income countries, a wide-spread increase in income is necessary to alleviate poverty and improve inequality. This is more likely to be achieved by growth.

Higher government spending as a share of GDP, increases inequality. Rudra (2004) reported a similar result. Based on a panel estimation of 35 developing countries and 11 advanced economies, she found that only specific types of spending, such as education, were effective in the developing world for reducing inequality compared with advanced industrialized economies. She argued that public spending programmes in the lower income countries have much greater political lobbying and clientism, thus reducing their redistributive effects. However, Rudra did not consider government spending in terms of investments in infrastructure, which would raise labour productivity in home goods.[5]

Gini, FDI and Foreign Aid

The results show that the effect of foreign direct investment and foreign aid to GDP ratios on the Gini are mixed. The positive sign for the FDI ratio is consistent with that reported by Basu, and Guarigliab (2007) and Feenstra and Hanson (1997). The former found that FDI promotes growth while reducing the agricultural share of total GDP, thus increasing inequality, while the latter found that FDI increases wage inequality, from evidence on Mexico's maquiladora industries.

With respect to foreign aid, like us, Calderón and Chong (2006) find little evidence that foreign aid reduces income inequality for low income economies. Both Easterly (2007) and Deaton (2013) have pointed out why foreign aid can have negligible to perverse effects on both growth and income inequality. The aid which these authors consider is not aid

[5] Lim and McNelis (2013) also suggested looking at the stance of government spending. Their analysis showed that pro-cyclical spending, especially on domestically produced labor-intensive goods, can reduce income inequality, but not otherwise

in the form of emergency assistance, such as response to an earthquake, but long-term aid flows for development.

Deaton (2013) notes a number of reasons why such aid can increase inequality. One explanation is that aid, in the form of health assistance for reducing child mortality, or the provision of anti-reteroviral drugs in the campaign against AIDS, allows poorer people to live longer, and thus increases the proportion of relatively poor people in the population. But, as the quality of health as well as longevity improves for the poorest segments of the population, their share of income should increase in the longer term (as indicated by the negative sign for the middle-income countries).

But there are other perverse aspects of foreign aid which might explain the non-significant effect on inequality for the low-income group. Foreign aid takes place by government-to-government transactions. Having access to foreign aid flows allows recipient governments to be less accountable to domestic constituents, since it reduces their reliance on taxes. This observation is especially pertinent for aid donated by Non-Governmental Organizations (NGO's), especially since aid funding is fungible. If NGO's provide education or health care which otherwise would be the responsibility of the national governments, then more money can be diverted to servicing other agendas at the expense of attention to the lower-income segments of the population.

Gini and trade openness

The results show that trade openness has negligible effects for low income countries, but has significant negative effects for the middle income countries. This suggests that increasing trade openness in low-income countries may, with further economic development, lead to improvements in income inequality.

The empirical results pertaining to inequality and trade openness is usually explained with reference to conditions in the labour markets. Gourdon, Maystre, and de Melo (2008) pointed out that initial endowments, particularly with respect to skilled labour, matters when assessing the effects of openness on inequality and poverty. Using changes in tariff revenue expressed as a percentage of total revenue as the measure of openness, they find that trade liberalization has strong positive effects on inequality in countries where a high proportion of the labour force has little or no education.

Acar and Dogruel (2012) applied panel regression methods to study wage inequality in selected Middle Eastern and Northern African (MENA) countries and find that per-capita GDP and female labour-force participation have positive effects on inequality (as measured by the Theil index) while openness has negative effects.

Studies about inequality have been conducted across time as well as across countries. Anderson (2005) points out that while most empirical time series studies show that greater openness increased inequality of wages, cross-sectional studies tend to show that increased openness had little effect on inequality. He conjectures that inequality associated with increased demand for skilled labour was offset by other industry effects.

For example, Munschi (2012) studied a panel of industrial data between 1975-2002 for Bangladesh and the results show a decrease in overall wage inequality across industries. In this case, the increased demand for goods resulting from trade liberalization, based on comparative advantage, was produced with labour-intensive methods which had the effect of diminishing overall wage inequality as the wages of the least-skilled improved.

As Turnovsky (2013) points out, the varied character of empirical findings about growth and distribution of income or wages or wealth should not be surprising, since growth and distribution are endogenous variables. Following Ehrlich and Kim (2007), these empirical results provide evidence of empirical associations, but not necessarily evidence of causality between these variables. Moreover, the countries in the panel are quite different and may not be adequately captured by a panel model which assumes similar economic reactions except for fixed effects. The country-specific correlations noted above suggest a richer specification may be required.

We turn now to the use of general equilibrium models to obtain some understanding of the way the variables identified here, openness, FDI and Aid, affect income inequality.

3 DSGE Model and Calibration

The stylized low-income open-economy model contains heterogenous agents who follow the standard optimizing behavior characterized in dynamic stochastic general equilibrium models. The agents have different initial endowments. Their utility functions follow the Gorman (1961) specification, which facilitates the modeling of the entire group as a single, representative agent at the macro-aggregate level.

The model has a production sector which produces two types of goods - tradeables with prices determined globally, and non-tradeables with market-clearing prices. The model also includes a financial sector which accepts deposits from households, borrows from foreigners and lends to the public sector and to firms. The public sector manages government expenditure, sets the exchange rate and implements monetary policy.

Many of these characteristics have been embedded in models cited by Turnovsky (2013) in his survey of research on growth and inequality. However we go beyond previous work in that we incorporate a banking sector and an initial distribution of nominal money holdings amongst the economic agents. Our setup attempts to capture the relevant dynamics not just of a small open economy (as in Chen and Turnovsky (2010)), but of a low-income small open economy.

Our goal is to set up a model to help understand certain aspects of the drivers of income equality. In particular, we show how economic activity generated by the shocks to terms of trade or export demand (for natural resources) can reduce inequality. We also show how foreign aid, and foreign direct investment condition the way in which these shocks affect openness and inequality.

We do not consider the effect of technological change and growth *per se*. As noted in the empirical section, the negative effect of economic growth on inequality is clear, so our interest is in understanding how trade, FDI and aid flows affect income inequality, given a small open-economy setting with recurring shocks to export demand and terms of trade, the main driving forces of income in these economies.

3.1 Consumption and Labour

The economy has H heterogenous agents and each agent has one unit of time which is divided between work L^i and leisure V^i :

$$\begin{aligned} L^i + V^i &= 1; \qquad i = 1, ..., H \\ L + V &= H \end{aligned} \tag{1}$$

Following Correia (1999, 2010) and García-Peñalosa and Turnovsky (2009, 2011), we adopt an isoelastic utility function with the Gorman (1961) polar form property[6] to facilitate the analysis of aggregate macroeconomic behavior with a single aggregate entity. This allows the path of income inequality to respond to shocks to aggregate income.

The representative aggregate entity, at period 0, optimizes the intertemporal welfare function:

$$\max_{C,L,K^h,M} \mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{\eta} (C_t)^{\eta} (V_t)^{\omega\eta} G_t^{\chi\eta} \right) \tag{2}$$

where β is the discount factor, C_t is an index of effective consumption, $1/(1-\eta)$ is the intertemporal elasticity of substitution, ω represents the elasticity of leisure in utility. The parameter χ measures the relative importance of public spending in private utility. The symbol $\mathbf{E}_0$ is the expectations operator at time $t = 0$.

Our choice of utility function is influenced by two considerations. First, as Canova and Paustian (2011) point out, typical business cycle models, with only consumption and leisure in the utility function, generally cannot replicate the empirically established positive response of consumption to government spending. We add government spending in the utility function on the assumption that such spending enhances the utility of private spending. Second, the Gorman form adopted here allows us to model a distribution of heterogeneous households and avoids the need to pre-determine the share of Ricardian to rule of thumb consumers.[7]

The aggregate agent consumes domestically produced goods C_t which is a composite of non-traded home goods C_t^h and internationally exported goods C_t^x:[8]

$$C_t = \left[(1-\gamma)^{\frac{1}{\theta}} \left(C_t^h \right)^{\frac{\theta-1}{\theta}} + (\gamma)^{\frac{1}{\theta}} \left(C_t^x \right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{3}$$

The parameter θ is the intratemporal elasticity of substitution between the domestically produced non-traded home (C_t^h) and export (C_t^x) good and the parameter γ represents the share of export good in the consumption of domestically produced goods. Minimizing expenditures gives the demand for non-traded home good and traded export good as:

[6] Other types of utility functions are also amenable to Gorman aggregations. Correia (1999), for example, used $u(C, l) = C - \chi l^{\varphi}$, $\chi > 0, \varphi > 0$

[7] Canova and Paustian (2011) have also noted that the use of this latter assumption, in order to be empirically useful, requires a extremely large percentage of such rule-of-thumb consumers relative to Ricardian consumers.

[8] The microfoundations with differentiated goods using the the Dixit-Stiglitz aggregator have not been spelled out since they are now well known.

$$C_t^h = (1-\gamma)\left(\frac{P_t^h}{P_t^c}\right)^{-\theta} C_t \tag{4}$$

$$C_t^x = \gamma\left(\frac{P_t^x}{P_t^c}\right)^{-\theta} C_t \tag{5}$$

The domestic goods price index P_t is given by the following formula:[9]

$$P_t^c = \left[(1-\gamma)\left(P_t^h\right)^{1-\theta} + \gamma\left(P_t^x\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{6}$$

The household sector are also the owners of the capital goods in the non-tradeable sector, K^h which accumulates according to the law of motion:

$$K_t^h = (1-\delta)K_{t-1}^h + I_t^h \tag{7}$$

where I_t^h are imported investment goods at the price $S_t P_t^{k*}$ (S_t is the exchange rate and P_t^{k*} is the international exogenously determined price in foreign currency; $P_t^k = S_t P_t^{k*}$). The term δ controls the replacement of the imported capital goods; industries engaged in importing raw materials or intermediate goods are likely to have a higher value of δ.

The economic agent receives dividends Π_t, returns to capital, $R_t^k K_t^h$, wage payments $W_t L_t$ and pays income taxes $\tau^w W_t L_t$, where W_t is the economy-wide wage rate and τ^w is the income tax rate. We assume that savings are held in the bank, as deposits (M_t) which earns interest at the rate R^m. The budget constraint is:

$$(1-\tau^w)W_t(H-V_t) + (1+R_{t-1}^m)M_{t-1} + R_t^k K_t^h + \Pi_t = (1+\tau^c)P_t^c C_t + M_t + P_t^k I_t \tag{8}$$

and τ^c is the tax on consumption.

The macro-aggregate agent chooses consumption, labour, capital, and deposits to maximize intertemporal utility, given by equation (2), subject to the budget constraint, (8), and the law of motion for the capital stock, (7). The agent chooses non-trivial solutions in that $C_t > 0$, $L_t > 0$, $K_t^h > 0$, $M_t > 0$ taking as given the vector of prices for labour, consumption and investment goods, $\{W_t,\ P_t^c, P_t^k\}$, the returns for money and capital, $\{R_t^m, R_t^k\}$, total dividends Π_t, the tax rates on labour income and consumption, $\{\tau^w, \tau^c\}$, the current and expected government spending, $\{G_t, G_{t+1}\}$, and the initial stock of capital and money holdings, $\{K_{t-1}^h,\ M_{t-1}\}$.

Maximizing (2) subject to (8) and (7) yields the following Euler conditions:

$$\omega C_t = \frac{(1-\tau^w)W_t V_t}{(1+\tau^c)P_t^c} \tag{9}$$

$$\frac{(C_t)^{\eta-1}(V_t)^{\omega\eta}G_t^{\chi\eta}}{(1+\tau^c)P_t} = \mathbf{E}_t\left[\beta(1+R_t^m)\frac{(C_{t+1})^{\eta-1}(V_{t+1})^{\omega\eta}G_{t+1}^{\chi\eta}}{(1+\tau^c)P_{t+1}^c}\right] \tag{10}$$

$$(1+R_t^m)\left(P_t^k - R_t^k\right) = \mathbf{E}_t\left[P_{t+1}^k(1-\delta)\right] \tag{11}$$

[9] This is derived using the definition, $P_t C_t = P_t^h C_t^h + P_t^x C_t^x$, and the two demand equations.

where the symbol $\mathbf{E}_t$ represents the expectations operator at time t.

The first equation, given by (9), tells us that the marginal disutility of labour is equal to the after tax real wage, weighted by the marginal utility of consumption. The second equation (10) is the familiar Keynes-Ramsey rule for optimal saving. The marginal disutility of forgone consumption today is equal to the expected discounted value of the return on deposits multiplied by the utility in the next period. Finally, the last equation (11) is the asset-pricing equation for capital. The price of investment goods today, P_t^k, is equal to the return on the investment goods plus the discounted expected capital gain.

3.2 Production and Pricing

There are two types of production and pricing activity for tradeable and non-tradeable goods. We assume that the same nominal wage rate W_t holds across sectors, so that labour is fully mobile. Total dividends Π_t paid to the household sector represent the sum of dividends from the firms in each sector.

3.2.1 Export Goods

The export good is a natural resource and inexhaustible. The output Y_t^x is demanded by households C^x and foreigners X_t (exports):

$$Y_t^x = C_t^x + X_t \tag{12}$$

$$\ln(X_t) = \rho^x \ln(X_{t-1}) + (1-\rho^x)\ln(\overline{X}) + \epsilon_t^x, \qquad \epsilon^x \tilde{} N(0, \sigma^x) \tag{13}$$

The demand for the export good is assumed to follow an autoregressive process where $\overline{X}$ is the steady-state level of export demand and ϵ^x is a shock term with mean 0 and standard deviation σ^x.

The firm meets demand using labour (L_t^x) and the natural resource K^x. We assume a Cobb-Douglas production function:

$$Y_t^x = \overline{Z^x}\,(K_t^x)^{\alpha^x}\,(L_t^x)^{1-\alpha^x} \tag{14}$$

The symbol $\overline{Z^x}$ is a fixed technological factor.

The export good sells at a price P_t^{x*} which is determined exogenously, and follows an autoregressive stochastic process:

$$\ln(P_t^{x*}) = \rho^p \ln(P_{t-1}^{x*}) + (1-\rho^p)\ln(\overline{P^{x*}}) + \epsilon_t^p, \qquad \epsilon^p \tilde{} N(0, \sigma^p) \tag{15}$$

The export sector thus responds to both quantity (export demand) and price (terms of trade) shocks.

The export firm borrows the entire wage bill, $W_t L_t^x$, for which they impute the interest cost $(1 + R_t^n)$:

$$N_t = W_t L_t^x \tag{16}$$

In this analysis, we assume that the firm runs an overdraft system and can borrow without limits. However, while there are no quantity constraints, the amount of loans affects the cost of borrowing and will be factored into the interest rate R_t^n charged by the financial institution.

The firm remits dividends Π_t^x to households each period, which represent the profits of the firm:

$$\Pi_t^x = S_t P_t^{x*} Y_t^x - (1 + R_t^n) W_t L_t^x - P_t^z K_t^x \tag{17}$$

The symbol S_t is the exchange rate expressed as domestic price of a foreign unit of currency, with $P_t^x = S_t P_t^{x*}$. The domestic price of the resource, P^z, represents the "shadow price" of the resource.

Minimizing total costs subject to the production function constraint yields the following first-order conditions for the exporting firms:

$$\frac{\alpha^x (1 + R_t^n) W_t}{(1 - \alpha^x) P_t^z} = \frac{K_t^x}{L_t^x} \tag{18}$$

$$P_t^x = \frac{\left((1 + R_t^n) W_t\right)^{1-\alpha^x} \left(P_t^z\right)^{\alpha^x}}{\overline{Z^x}} \cdot \left(\frac{1}{(\alpha^x)^{\alpha^x} (1 - \alpha^x)^{1-\alpha^x}} \right) \tag{19}$$

The first equation (18) tells us that the firm hires capital and labour up to the point where their relative marginal products are equal to their relative costs. The second equation (19) sets the price, in domestic currency units, to equal the marginal cost.

3.2.2 Non-traded Goods

The firm producing non-traded home goods Y_t^h combines labour L_t^h and capital K_t^h in a Cobb-Douglas production function:

$$Y_t^h = G^k \overline{Z^h} \left(K_t^h\right)^{\alpha^h} \left(L_t^h\right)^{1-\alpha^h} \tag{20}$$

The symbol L^h denotes the labour services hired by the firms. The coefficient α^h is the factor share of capital and Z^h is a productivity term (which is fixed in this model). The term G^k represents the contribution of the public sector to augment productive capacity (for example building better infrastructure for non-traded goods).[10]

The market clearing equation are given by the following equations

$$Y_t^h = C_t^h + G_t \tag{21}$$

$$G_t = G_t^c + G_t^k \tag{22}$$

$$G_t^k = \varsigma G \tag{23}$$

Domestic non-traded output Y_t^h is consumed by households C_t^h and by the government G_t, which is further decomposed into government consumption expenditure G_t^c and government capital expenditure G_t^k. For simplicity, we have assumed that capital expenditure is a fixed proportion ς of total G.

Total profits are given by the following equation:

$$\Pi_t^h = P^h Y^h - W_t L_t^h - R_t^k K_t$$

[10] This setup is similar to that of Bouza and Turnovsky (2012). However these authors also assume that government spending also improves productivity in the traded-goods producing sector as well. A key policy parameter in their setup is the allocation of government spending between the two sectors. Since our focus is not on the government sector, we have adopted a simple specification.

Note that we have assumed that the non-traded sector cannot borrow, to create a differential between the cost of labour in the two sectors. Minimizing total costs subject to the production function yields the usual first-order condition that the relative costs of the factors match the relative marginal products.

$$\frac{(\alpha^h)W_t}{(1-\alpha^h)R_t^k} = \frac{K_t^h}{L_t^h}$$

We assume flexible prices for monopolistically competitive firms. In this case, the price is set equal to the marginal cost:

$$P_t^h = \frac{(W_t)^{1-\alpha^h}(R_t^k)^{\alpha^h}}{\overline{Z^h}G_t^k} \cdot \left(\frac{1}{(\alpha^h)^{\alpha^h}(1-\alpha^h)^{1-\alpha^h}}\right) \tag{24}$$

The domestic price level P_t^h is thus a function both of the wage cost W_t and the rental price of capital R_t^k.

3.3 Financial Activity

Households have limited participation in financial markets. We assume an initial distribution of money holdings across the agents in the model and the endowments determine their share of capital. Since we are concentrating on inequality in low-income economies, where financial markets are not well developed, we assume that the relevant nominal asset for initial endowments is money, rather than government bonds. Changes in relative returns (to money, capital and bonds) can have an impact on inequality in this model.

Banks accept deposits M_t from households and pay an interest rate R_t^m. They hold reserves as a variable proportion of deposits, Φ_t^m:

$$\Phi_t^m = \overline{\Phi}^m + \varphi^m(M_{t-1} - \overline{M}) \tag{25}$$

where $\overline{M}$ is the steady state level of deposits and $\overline{\Phi}^m$ is the steady-state reserve ratio. The banks lend an amount N_t to the exporting firms. We assume that banks face a processing cost for loans equal to $\Phi_t^n N_t$ where Φ_t^n varies depending on the amount of loans processed:

$$\Phi_t^n = \overline{\Phi}^n + \varphi^n(N_{t-1} - \overline{N}) \tag{26}$$

Similar to deposits, $\overline{\Phi}^n$ is the steady-state lending cost and $\overline{N}$ is the steady-state total lending by the financial sector. The term Φ_t^n can also include the cost to the banks from setting aside resources as loan-loss reserves.

Banks also lend to the government (through the purchase of government bonds, B_t) and receive a risk-free rate on these bonds given by R_t. Finally, banks can borrow internationally F_t at the international rate R_t^*, but we also assume an asset-elastic foreign interest-rate risk premium term Φ_t^s modelled as:

$$\Phi_t^s = \overline{\Phi}^s + \varphi^s(F_{t-1} - \overline{F}) \tag{27}$$

Again, the steady state international borrowing is given by $\overline{F}$ while $\overline{\Phi}^s$ is the steady-state risk premium.

The bank maximizes the present value of its dividends, subject to the balance sheet identity:

$$\begin{aligned}\Pi_t^b &= (1+R_{t-1})B_{t-1} + (1+R_{t-1}^n)N_{t-1} \\ &\quad - (1+R_{t-1}^* + \Phi_{t-1}^s)F_{t-1}S_t - (1+R_{t-1}^m)M_{t-1} \\ s.t: B_t &+ (1+\Phi_t^n)N_t = S_tF_t + (1-\Phi_t^m)M_t\end{aligned}$$

This expressions tells us that the cash flow of the bank comes from its gross returns from bonds (lending to government sector) and loans (lending to firms) plus new deposits (borrowing from the household sector) and from foreign liabilities (borrowing from foreigners), less gross interest on deposits and foreign liabilities as well as the costs associated with loans and reserve deposits. Optimizing the present value with respect to B_t, N_t, M_t and F_t and substituting out the implied discount factor, yields the familiar interest parity relationship and the spreads between the rates:

$$(1+\Phi_t^n)\,(1+R_t) = (1+R_t^n) \tag{28}$$

$$(1-\Phi_t^m)\,(1+R_t) = (1+R_t^m) \tag{29}$$

$$(1+R_t)S_t = (1+R_t^* + \Phi_t^s)S_{t+1} \tag{30}$$

In this set-up, the deposit rate is always below the risk free government bond rate while the lending rate is always above the risk-free rate. Note that auditing and deposit insurance costs are incorporated into the deposit and lending rates.

3.4 Macroeconomic Policies and Debt

The tax rates levied on wage income and consumption are fixed and G_t depends on the stance of fiscal policy (which is fixed in this analysis). All government spending falls in the home goods sector and the government borrows to finance its expenditure.

Many low income economies operate in a pegged exchange rate regime; $S_t = \overline{S}$. This means that: $R_t = R_t^* + \Phi_t^s$ and the evolution of foreign bonds becomes:

$$\overline{S}F_t = (1+R_{t-1}^* + \Phi_{t-1}^s)\overline{S}F_{t-1} + \overline{S}P_t^{m*}I_t - \overline{S}P_t^{x*}X_t \tag{31}$$

The foreign bonds are liabilities in the banking system.

The evolution of domestic debt is given by the government budget constraint:

$$B_t = (1+R_{t-1})B_{t-1} + P_t^hG_t - \tau_t^wW_tL_t - \tau_t^cP_tC_t - Q_t - P_t^zK_t^x \tag{32}$$

where Q_t is the cost of regulations[11]

$$Q_t = \Phi_t^mM_t + \Phi_t^nN_t + (1+R_t^n)N_t - (1+R_{t-1}^n)N_{t-1} \tag{33}$$

As noted above, the domestic banks hold the domestic government debt as assets in their balance sheet.

[11] This variable together with the asset-sensitive interest rates ensure that domestic and foreign debt stabilises following shocks.

3.4.1 Openness, Foreign Direct Investment and Foreign Aid

The index of trade openness for the model is defined in the traditional way as:

$$\Phi_t = \frac{\overline{S}P_t^{m*}I_t + \overline{S}P_t^{x*}X_t}{Y_t}$$

where the variable Y_t is defined as:

$$Y_t = P_t^h Y_t^h + P_t^x Y_t^x \tag{34}$$

Openness can also come about through financial flows, especially through foreign direct investment and foreign aid. In the simulations below, we modify the model to allow for these effects.

To model the effect of FDI, we allow foreigners to own the capital K^h and to repatriate the profits. The base model is changed in three ways: first, the household budget constraint excludes returns to capital, second the investment decision is discounted by the return to portfolio investment and third the returns to FDI are repatriated (i.e. profits are treated as returns to multinationals).

$$(1-\tau^w)W_t(H-V_t) + (1+R_{t-1}^m)M_{t-1} + \Pi_t = (1+\tau^c)P_t^c C_t + M_t \tag{35}$$

$$(1+R_t^* + \Phi_t^s)\left(P_t^k - R_t^k\right) = P_{t+1}^k(1-\delta) \tag{36}$$

$$S_t F_t - (1+R_{t-1}^* + \Phi_{t-1}^s)S_t F_{t-1} = R_t^k K_t^h - S_t P_t^{x*} X_t \tag{37}$$

To model the effect of foreign aid (FA), we modify the model by treating foreign aid as equivalent to paying for the investment goods with the funds going to the government sector:

$$B_t = (1+R_{t-1})B_{t-1} + P_t^h G_t - \tau_t^w W_t L_t - \tau_t^c P_t C_t - Q_t - P_t^z K_t^x - FA \tag{38}$$

$$FA = \kappa S_t P_t^{m*} I_t \tag{39}$$

where κ is the proportion supplied by foreign aid. This will then be comparable to the base case except for the generosity of foreigners in paying for a proportion of the investment goods in K_t^h.The evolution of domestic debt is given by the government budget constraint, but in the absence of foreign aid, all G_t is paid for domestically, otherwise, G_t is effectively donated by foreigners through foreign aid. This setup is similar to the one followed by Bouza and Turnovsky (2011).

3.5 Distribution of Initial Endowments

The model is completed by incorporating a module to assess the distributional effects. The base distribution of income is derived by endowing each agent with an initial quantity of money, M_0^i, held in the form of bank deposits.[12] This endowment then determines the share h^i of total profits Π_t that each agent receives from firms:

$$\Pi_t^i = h^i \Pi_t \tag{40}$$

[12] The initial distribution of endowments of wealth, in money holdings is the source of heterogeneity. We thus abstract away from idiosyncratic shocks to agents. Our model makes use of a "representative agent" theory of distribution [see Turnovsky (2011) and Caselli and Ventura (2000)].

where Π_t^i represents distributed dividend payments to each agent. Over time, deposits M_t^i and gross nominal post-tax income y_t^i of each agent evolves as:

$$M_t^i = (1 + R_{t-1}^m)M_{t-1}^i + (1 - \tau_t^w)W_t \left[1 - \frac{(1+\omega)\rho^i V_t}{\omega}\right] + h^i \Pi_t + h^i \left[R_t^k K_t^h - P_t^k I_t\right] \quad (41)$$

$$y_t^i = (1 - \tau^w)W_t(1 - \rho^i V_t) + (1 + R_{t-1}^m)M_{t-1}^i + h^i R_t^k K_t^h + h^i \Pi_t \quad (42)$$

where $(1 - \rho^i l_t)$ represents the labour hours and ρ^i is the proportion of total leisure computed from steady state relations based on the Euler equations (9) and (10):

$$\rho^i = \frac{1}{\overline{V}} \frac{\omega}{(1+\omega)} \frac{\overline{R^m}\,\overline{M^i} + (1 - \tau^w)\overline{W} + h^i \overline{\Pi} + h^i \left[R^k - P^k \delta\right] \overline{K^h}}{(1 - \tau^w)\overline{W}} \quad (43)$$

The base distribution was generated with a log-normal distribution and shown in Figure 2. By construction the richer members of the economy work less. The calibration is such that the income of about 90 per cent of workers is solely through the provision of labour services.

The distribution was calibrated so that sums of the agents' endowments and incomes equal their respective steady state aggregates:

$$\sum_{i=1}^{H} M_t^i = \overline{M} \quad (44)$$

$$\sum_{i=1}^{H} V_t^i = H - \overline{L} \quad (45)$$

We use the Deaton (1997) modified Gini coefficient, DG for assessing income inequality:

$$DG = \frac{H+1}{H-1} - \frac{2}{(H-1)} \frac{\sum_{i=1}^{H} p^i y_i}{\sum_{i=1}^{H} y_i}$$

where p^i is the income rank of person i, with the richest person having a rank of 1 and the poorest person having a rank of H.

3.6 Calibration and steady state values

The model is not calibrated to match the features of any particular country in the panel data set It is a generic model.

The parameter values for the structural model as well as for the shock processes appear in Table 6. The values are set for annual data. The parameter selections are quite standard. We assume that production functions in the non-traded and traded sectors have the same labour intensity because as surveyed in Bouza and Turnovsky (2011) there is no consensus as to the relativities. Arellano et.el (2009) parameterizes the non-traded sector as more capital intensive, while Kuralbayeva and Vines (2008) assume the reverse. The sensitivity of the results to alternative specifications are discussed in the section below.

The model is calibrated so that the index of openness is 0.513 which is close to the mean value in the sample panel data set. The ratio of government expenditure to GDP is

0.311 while the Deaton-adjusted Gini coefficient for the base income distribution is 0.491, a value within the empirical range. FA and FDI are not modelled as part of the base model.

The share of labour employed in the non-traded sector ($L^h/L = 65.5$ per cent) and the share of income going to labour (WL/Y) is 49.1 per cent. The steady-state share of consumption spent on exported goods (C^x/C) is 10 per cent. The proportion of non-traded goods consumed by the government sector (G/Y^h) is 39.2 per cent, while the proportion of traded goods sold overseas (X/Y^x) is 87.8 per cent.

4 Simulated Results

To understand better the empirical results, we first generate the impulses to obtain insights about the key economic mechanisms following shocks that impact on openness. In particular we shall examine the impulse responses following shocks to trade flows (via export volume and price) as well as shocks to financial flows (via FDI and foreign aid).

4.1 Impulse Responses

Figure 3 presents the results for the case of a shock to export demand and export price without any foreign direct investment or foreign aid flows while Figure 4 compares the results for the Gini with and without financial flows.

4.1.1 Export Demand Shock

Figure 3a shows the impulses following a shock to the demand for exports. As expected, the excess demand leads to an increase in the production of export goods and upward pressure is put on the wage rate to attract more labour into the export sector. This causes an increase in the price of home goods and the consumption price index. The increase in the relative price of home goods causes a switch away from the consumption of home to export goods, resulting in an increase in aggregate consumption. Household income increases and money balances increases. Profits falls initially because of the initial switch away from home-goods. Overall, there is an increase in the index of openness along with increased exports and GDP in the economy increases. The Gini measure of inequality falls as the initial increase in wages relative to profits causes a re-distribution in favour of those with higher labour to leisure ratios.

4.1.2 Terms of Trade Shock

Figure 3b shows the impulses following a shock to the price of export goods. In this case, demand by the domestic sector falls, while demand by foreigners is fixed in the model. The price of home goods and the consumption price index rises resulting in an overall fall in consumption. Wage income increases with more employment in the home-good sector, and money balances rises. Returns on assets are state-dependent with risk margins falling with falls in debt. Hence, as the value of exports increase (due to fixed demand at rising price), debt falls and associated return on capital and hence profits fall. Meanwhile, the index of openness improves and there is growth in the economy driven by domestic production. The Gini measure of inequality falls as wage income improves relative to profits.

4.1.3 Effect of Foreign Direct Investment

Up to now we have only allowed for openness via trade flows. The model is now simulated to allow for FDI by implementing equations (35) to (37) which allow foreigners to own the capital K^h and to repatriate the profits. The path of the Gini's are shown in Figure 4 (upper right and left panels). In this case, we see that the path of the Gini shows a clear worsening in inequality. The simulated results suggest that foreign direct investment adds to the opening of an economy, and fosters growth. However, since the returns to capital are not returned to the citizens, income re-distribution is not in favour of workers and inequality worsens.

4.1.4 Foreign Aid

Our simulation for assessing the effects of foreign aid (FA) assumes that the capital inflows are like foreign investment. The main change is that all profits are passed back as income to the citizens. The model is now simulated to allow for FA by implementing equations (38) to (39) with $\kappa = 0.5$.

This assumption is based on the understanding of foreign aid as aid for infrastructure, funded by organizations such as the World Bank, Asian Development Bank, African Development Bank. True, foreign aid also takes the form of emergency assistance, in response to natural disasters in the form earthquakes or Tsunami, or in response to refugees in war-torn regions. Aid also takes the form of technical assistance, for health and public policy assessment. However, the big ticket items consist of infrastructure projects, not unlike those undertaken by private foreign investment.

Figure 4 shows the response of the Gini for the same shocks discussed previously, but now with FA (lower left and right panels). The presence of FA decreases inequality for both an export demand and an export price shock. The main reason for this result is that foreign aid is channeled to support much the same type of projects which would be funded by FDI, but in the FA case, the profits are not repatriated to foreigners. The profits from the investment are repatriated to the government, with subsequent demand for services from the home-goods sector. Thus the basic insight is that when foreign aid takes the form of financing of infrastructure projects, it can be very different from FDI because ensuring that the profits accrue to the government, rather than foreigners, and provided it results in an increased demand for labour intensive goods, the effect is to improve equality (ie decrease the Gini).

4.2 Stochastic Simulation Experiments

In this section, we shock the model to generate 500 simulated values. In particular, we assume that there will be no assistance to growth through special foreign direct investment (FDI) or foreign aid (FA). The simulations are conducted allowing for external shocks (through export volume and price changes). The autoregressive and shock parameters that determine the shocks to export volume and export price are kept constant in all simulations, that is all simulations were subjected to the same set of shocks.

Since we are particularly interested in the relationship between the Gini and openness, the model was re-calibrated for different values of productive activity. Specifically, the

deep parameters that determine household behavior ($\beta, \eta, \omega, \chi, \gamma, \theta$) were unchanged; likewise we held the policy parameters ($\tau^w, \tau^c, \varsigma$) and the parameters that affect the dynamics of the risk premiums $\varphi^m, \varphi^n, \varphi^s$) constant.

Our focus in the simulations is to generate a number of economies ranging from low to high degrees of openness. The three parameters that were changed were the two parameters that determined the factor share of capital α^h, α^x and the parameter which determined the rate of capital accumulation δ (which in this model is also equivalent to the determination of the import-content of capital). The terms α^h, α^x play a role in determining labour's share of income from the demand side, given labour supply conditions. The term δ plays a crucial role in the determination of the imported investment goods, I_t^h which features prominently in the index of trade openness.

$$\begin{aligned}
\Phi_t^o &= \frac{S_t P_t^{m*} I_t^h + S_t P_t^{x*} X_t}{Y_t} \\
Y_t^x &= \overline{Z^x} \left(K_t^x\right)^{\alpha^x} \left(L_t^x\right)^{1-\alpha^x} \\
Y_t^h &= G^k \overline{Z^h} \left(K_t^h\right)^{\alpha^h} \left(L_t^h\right)^{1-\alpha^h} \\
K_t^h &= (1-\delta) K_{t-1}^h + I_t^h
\end{aligned}$$

Three values were selected for each of the three parameters - a low, medium and high value. The medium value for all three parameters were $\alpha^h, \alpha^x = \delta = 0.5$, with the low value being in the range $0.1 - 0.3$ and the high in the range $0.7 - 0.9$. The results are not sensitive to small variations in these ranges. The key results appear in Table 7.

The results are grouped according to their import of raw materials/intermediate goods ($\delta = 0.1, 0.5, 0.9$). Cases 1-3 import the least while cases 8-12 have the highest import content.

The average Φ_t^o in column 3, are the steady-state indexes of openness for each of the 12 artificial economies created. In other words, the first set of parameters (case 1, $\delta = 0.1, \alpha^h, \alpha^x = 0.2$) yields an economy with an index of openness of 0.255 while the third set of parameters, case 3, determines an economy with an openness index of 0.541. Associated with each economy is a steady-state Gini (column 2) derived from the endowment described above.

Our base set of artificial economies includes economies with a low degree of openness (for example case 1, Φ_t^o=0.255) to economies with a high degree of openness (for example case 12, Φ_t^o=0.872). The Ginis also vary from low inequality (for example case 2, Gini=0.215) to high inequality (for example case 7, Gini=0.692).

Each artificial economy is then subjected to the same set of export demand and price shocks and the correlation between the 500 simulated Gini and openness index computed. The correlations are in column 4.

Let us consider the cases with $\delta = 0.1$. Since all three cases are subjected to the same export demand and price shocks, the variations in openness came from the variations in imports associated with the different production structures. For these three cases, we see that the correlations with the Gini are all positive. because the gains are small and accrue exclusively to those who are owners of capital.

For the next 4 cases with $\delta = 0.5$, (numbered 4-7 in Table 7), the correlation of the Gini with the index of openness (Φ_t^o) varies from negative to positive. Comparing cases 5 with 2 and cases 6 with 3, we see that the economy with the higher import-content in the capital required to produce home-goods have negative correlations of the Gini with openness because the distribution of gains is broader. However, a comparison of cases 6 with 7 shows that the more capital intensive economy (case 7) actually produces a positive correlation. Since both sectors are highly capital intensive, the distribution of income in the form of wages (the main form of income for the majority of economic agents) is severely limited.

For the next 5 cases with $\delta = 0.9$, (cases 8-12), we see that the correlation of the Gini with the index of openness (Φ_t^o) are all negative with the largest negative value corresponding to the most open economy. In particular, comparing cases 12 with 7 show that despite the high capital intensity in both sectors, the economy with the higher import content in the non-traded sector, opens the economy to more international shocks and the gains from trade are distributed more broadly.

The same mechanisms also explain the results when we compare case 8 with case 11, two economies with the same capital intensity in the export-sector. However, case 8 has higher labour intensity in the non-traded sector than case 11.

For the 3 economies where the export-sector is more capital intensive then the home-good sector ($\alpha^x > \alpha^h$) (cases 2,5,9), and with similar steady-state Ginis and Φ_t^o, the correlation of the Gini with openness becomes negative when the import content is sufficiently large. A similar situation occurs for those cases when production is very labour intensive in both sectors ($\alpha^x = \alpha^h = 0.2$, cases 1,4,8); the correlation varies from positive to negative again depending on the import-content.

These results are thus consistent with the empirical results, that low-income labour intensive economies benefit, in terms of reducing inequality, from greater openness to trade. They affirm that GDP and openness are key factors for reducing inequality. But, we also stress that correlations between the Gini and openness can vary from strong to almost negligible and from negative to positive. Increasing openness, per se does not imply increasing equality. Capital intensity in production and the nature of imported capital goods matter for the response of inequality to increased openness.

5 Concluding Remarks

Our panel results show that economic growth leads unambiguously to a reduction in inequality while increasing trade openness can increase or decrease the Gini. Foreign direct investment and aid flows have negligible effects for low-income countries, but to the extent that they have any effect, they favour the middle-income countries. Overall, the panel results show how mixed results associated with trade and financial openness mute the overall effect of globalization on inequality.

These panel results are consistent with other empirical results reported in the literature. However, a closer look at the data reveals that the correlations between the Gini and openness for the countries in our sample vary from -1 to +1. To understand better why this variation takes place, we specified, calibrated and simulated a stylized DSGE model of a small low-income open economy.

We conducted simulation experiments to understand more clearly the relationship between openness and income inequality. We compared impulse response paths and correlation coefficients as we varied both the capital intensity in the traded and non-traded sectors and the capital replacement ratio.

The impulse response paths show that the key to understanding whether trade openness, foreign direct investment and foreign aid flows have negative or positive effects depend on the dynamics between wages and profits and thus on the degree of capital intensity in production. Favorable Gini outcomes come about because of the distributive effects to wages and labour (when there are favorable shocks) and because of increased productivity of labour in sectors which have high capital intensity.

The results of this paper, both in the empirical analysis and in the simulations, suggest that for low-income labour-intensive economies, income equality can be promoted by adopting policies that favour openness and more capital-intensive methods of production. Increasing trade openness along with increasing marginal productivity of labour, can sow the seeds for growth and income equality.

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Table 1: Macroeconomic Indicators, 1992-2007 (Percentage Sample Means)

		Gini	*dy*	*ry*	*gy*	*op*	*ay*	*fy*
Low	Tanzania*	34.225	2.219	10.583	19.519	48.295	14.955	2.838
	Madagascar*	45.417	-1.542	14.399	10.762	62.026	12.813	1.741
	Uganda*	42.203	3.196	15.144	31.155	32.593	14.754	3.053
	Zambia*	51.369	1.716	17.468	15.590	24.073	21.422	5.517
	Nigeria*	45.123	3.274	19.384	8.804	56.354	1.435	3.795
	Mozambique*	45.403	3.469	20.654	24.114	58.167	33.483	3.918
	Ghana*	39.849	1.471	22.580	23.364	89.783	9.965	2.254
	Bangladesh*	29.485	2.081	27.877	9.253	30.414	2.959	0.431
	Senegal*	43.813	0.023	28.040	15.389	65.167	10.095	1.522
	Mongolia*	32.459	0.288	30.251	16.884	92.522	14.659	3.951
	Kenya*	46.684	0.015	30.383	11.961	53.779	5.582	0.633
	Nicaragua*	53.785	-0.592	31.863	26.034	66.894	15.818	3.667
Lower-Middle	Cote d'Ivoire*	35.403	-1.153	36.345	12.737	76.161	5.431	1.813
	Cameroon*	45.831	-0.746	38.021	8.945	37.086	5.579	1.121
	Moldova*	35.562	-0.365	43.050	29.073	87.424	5.085	4.293
	Pakistan	31.002	1.953	44.077	15.765	33.897	1.791	1.298
	Bolivia*	54.022	1.403	48.131	14.202	55.391	8.619	5.172
	Honduras*	54.147	0.466	50.439	18.241	120.266	7.796	3.763
	Philippines	44.548	1.596	56.889	12.903	99.609	1.083	1.714
	Sri Lanka	36.973	3.579	63.254	23.723	68.771	3.359	1.336
	Algeria	35.681	0.964	66.402	13.389	70.219	0.484	0.900
	Egypt	31.714	2.641	67.540	7.520	52.993	2.687	2.417
	Jordan	39.283	-0.455	68.347	40.990	115.108	6.297	6.000
	Morocco	39.768	1.134	70.614	12.566	54.645	1.663	1.449
	Peru	48.513	1.556	72.544	12.754	35.143	0.779	3.411
	El Salvador	50.679	1.762	76.655	14.635	54.019	2.356	2.137
	Ecuador	54.655	0.910	78.310	17.125	52.474	0.747	1.924
	Guatemala	56.300	1.203	80.883	13.079	60.777	1.380	1.315
	Turkey	42.038	2.143	92.462	15.950	39.994	0.107	1.029
	Romania	28.873	1.126	95.836	23.174	44.395	0.762	3.567
	Ukraine	29.097	-0.876	97.889	25.247	85.331	0.841	2.481
Upper-Middle	Costa Rica	47.481	2.438	142.754	18.800	83.762	0.269	3.801
	Bulgaria	27.614	1.824	99.791	26.967	99.817	1.535	8.119
	Iran	42.292	3.503	100.497	12.329	59.802	0.123	0.715
	Dominican Rep	50.756	3.480	102.199	8.931	66.881	0.416	3.183
	Tunisia	40.969	3.417	110.514	11.324	110.210	1.105	2.950
	Thailand	43.768	3.856	115.194	12.200	117.923	0.277	3.230
	Jamaica	42.537	0.819	123.320	15.708	103.269	0.879	4.755
	South Africa	57.951	1.309	126.221	20.914	49.721	0.297	1.209
	Brazil	58.743	0.763	128.290	19.383	20.517	0.026	2.378
	Venezuela	46.529	0.323	130.938	19.137	55.203	0.049	2.373
	Mexico	50.107	1.567	143.844	13.434	42.318	2.853	0.042

Note: * PRGT eligible country

Table 2: Statistical Properties of Indices (Percentage)							
	Gini	*dy*	*ry*	*gy*	*op*	*ay*	*fy*
Full sample (42)							
mean	43.323	1.375	67.616	17.237	65.076	5.234	2.763
median	43.390	1.423	66.178	14.923	59.253	1.652	2.055
minimum	23.430	-17.900	9.484	5.892	13.310	-0.661	-2.499
maximum	61.780	15.572	166.476	52.362	144.492	74.137	32.947
Low-Income Countries (12)							
mean	42.485	1.301	22.386	17.736	56.672	13.162	2.777
median	42.930	0.957	22.378	15.921	55.475	11.137	2.210
minimum	26.210	-9.350	9.484	5.892	17.406	0.367	-0.014
maximum	60.460	15.572	38.479	35.698	133.348	74.137	11.471
Lower-Middle Income Countries (20)							
mean	41.431	1.033	67.374	17.949	67.176	2.919	2.763
median	41.060	1.330	67.766	14.764	61.556	1.593	1.710
minimum	23.430	-17.900	27.718	7.302	23.858	0.000	-2.499
maximum	61.780	9.158	129.971	52.362	141.148	19.163	32.947
Upper-Middle Income Countries (10)							
mean	48.113	2.147	122.377	15.216	70.960	0.350	2.747
median	47.438	2.121	124.808	14.335	64.024	0.163	2.645
minimum	35.670	-4.434	80.573	7.992	13.310	-0.661	-0.070
maximum	60.480	9.112	166.476	22.906	144.492	3.345	9.425

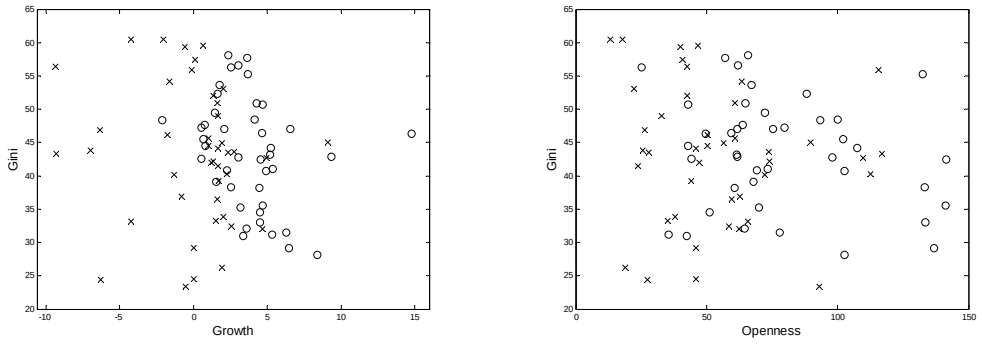

Figure 1: Gini versus Growth and Openness (x=1992, o=2007)

Table 3: Correlation Coefficients with the Gini (pooled data sets)						
	dy	ry	gy	op	ay	fy
Full-set	-0.048	0.165*	-0.142*	-0.132*	0.048	-0.015
Low	-0.208*	0.043	0.189*	-0.102	0.259*	0.185*
Lower-middle	0.001	-0.244*	-0.325*	-0.002	0.208*	-0.057
upper-middle	-0.299*	0.243*	0.500*	-0.726*	-0.378*	-0.141**
				Note:	* Significant at the 5% level	

Table 4: Correlations with the Gini (summary of country-specific results)			
	Openness	FA	FDI
Full set of 42 countries			
mean	0.185	-0.099	0.082
minimum	-0.911	-0.887	-0.740
maximum	0.958	0.894	0.868
Low Income			
mean	0.049	0.034	0.088
minimum	-0.911	-0.887	-0.530
maximum	0.958	0.894	0.677
Lower-Middle			
mean	0.474	-0.119	0.088
minimum	-0.887	-0.689	-0.408
maximum	0.917	0.679	0.791
Upper-Middle			
mean	-0.229	-0.218	0.062
minimum	-0.885	-0.750	-0.740
maximum	0.952	0.607	0.868

Table 5: Fixed Effects Panel Estimates: 1992-2007						
	dy_{it}	ry_{it}	gy_{it}	op_{it}	ay_{it}	fy_{it}
Full dataset	-0.197*	-0.033**	0.209*	0.051*	0.037	0.075
Low-Income	-0.429*	0.354*	-0.063	0.090*	0.023	0.084
Lower-Middle	-0.155*	-0.002	0.230*	0.099*	-0.189*	-0.049
Upper-Middle	0.039	-0.095*	-0.158	-0.068*	-1.176*	0.174**
	Note: * Significant at 5% level;**Significant at 10% level					

Table 6: Parameter Specification

Parameters	Definitions	Calibrated Values
β	discount factor	1/1.04
η	relative risk aversion	-0.5
ω	labour supply elasticity	0.5
χ	government spending in utility	0.15
γ	share of tradeables in consumption bundle	0.5
θ	intratemporal substitution elasticity	2.5
$\varphi^m, \varphi^n, \varphi^s$	risk premium parameters	0.01, 0.01, 0
ρ^x, ρ^p	autoregressive terms for shock processes	0.5, 0.5
σ^x, σ^p	standard deviation for shocks to X, P^{x*}	$0.1\overline{X}$, $0.1\overline{P^{x*}}$
τ^w, τ^c	tax rates	0.1, 0.05
ς	share of public capital expenditure in G	0.012
δ	share of import replacement in capital	0.5
α^h, α^x	parameters in production function	0.5, 0.5

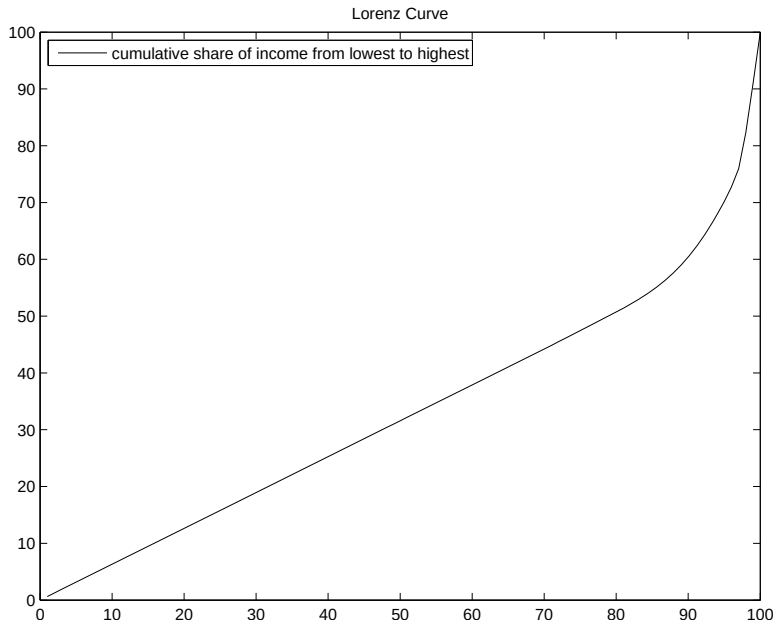

Figure 2: Lorenz Curve

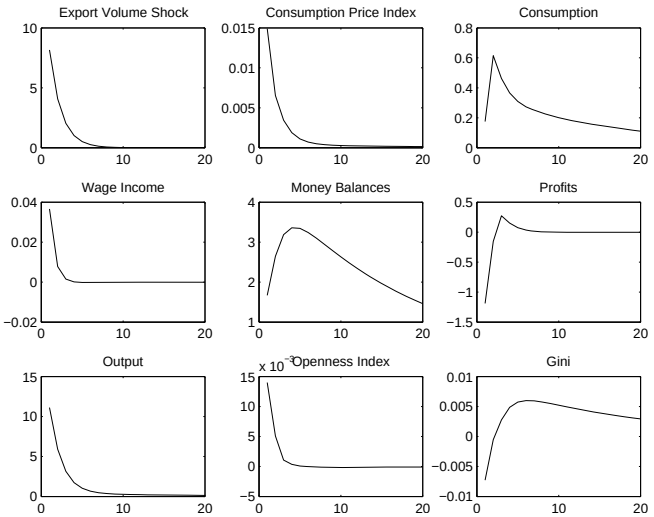

Figure 3a: Impulse Reponses following a shock to Export Demand

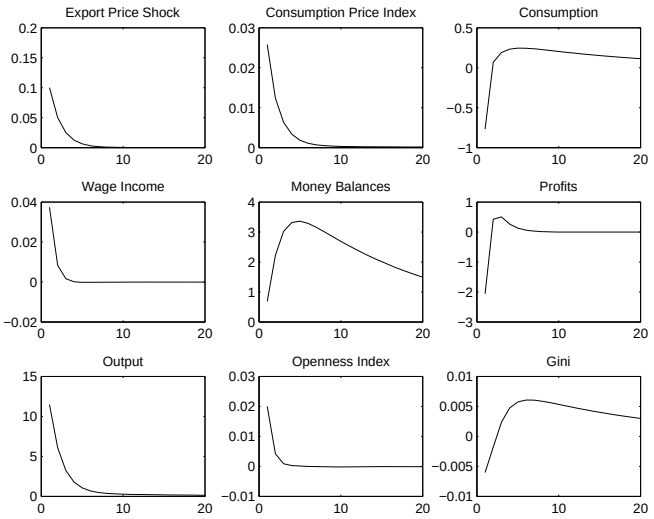

Figure 3b: Impulse Reponses following a shock to Export Price

Figure 3: Impulse Responses

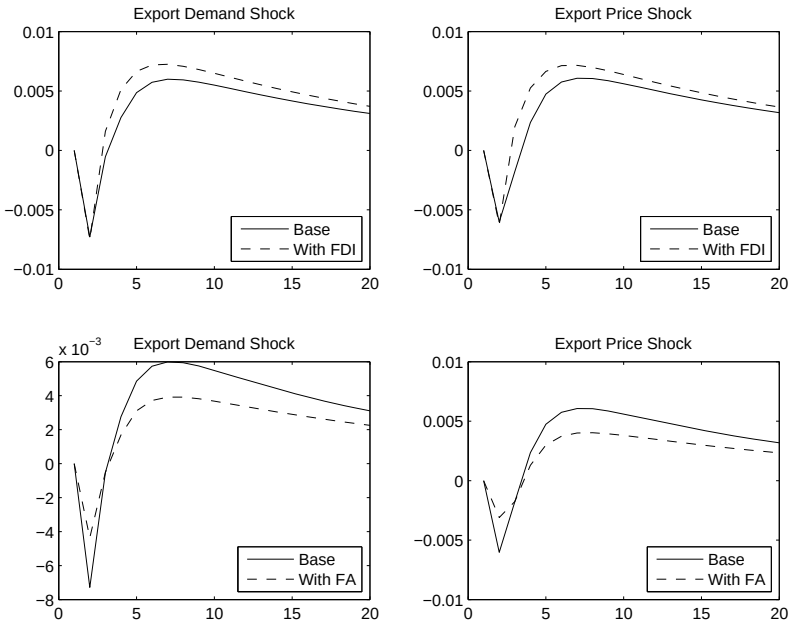

Figure 4: Alternative Paths of the Gini

Table 7: Sensitivity Analysis

	Average		Correlation	parameters		
case	Gini	Φ_t^o	{Gini,Φ_t^o}	δ	α^h	α^x
1	0.277	0.255	0.398	0.1	0.2	0.2
2	0.215	0.257	0.599	0.1	0.2	0.8
3	0.469	0.541	0.779	0.1	0.5	0.5
4	0.293	0.303	-0.156	0.5	0.2	0.2
5	0.229	0.307	-0.190	0.5	0.2	0.8
6	0.489	0.626	-0.023	0.5	0.5	0.5
7	0.692	0.859	0.383	0.5	0.8	0.8
8	0.295	0.310	-0.068	0.9	0.2	0.2
9	0.231	0.313	-0.204	0.9	0.2	0.8
10	0.492	0.637	-0.207	0.9	0.5	0.5
11	0.609	0.851	-0.491	0.9	0.8	0.2
12	0.696	0.872	-0.621	0.9	0.8	0.8