INCOME INEQUALITY AND DEVELOPMENT: OVERVIEW AND EFFECTS OF NORTH-SOUTH TRADE

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Introduction

The trend of rising income inequality in countries of all levels of development has sparked significant attention in both economic literature and the media in the last two decades. Goldberg and Pavcnik (2007) note rises in income inequality paralleling periods of rising trade liberalization in Colombia, Chile, and Argentina. Wei and Wu (2002) show that inequality rose in China during its period of rapid globalization as well. Understanding the factors influencing these increases in income inequality is important for implementation of policy and optimizing growth rates. Income inequality has been shown to have several implications for macroeconomic performance\(^1\). Alesina and Perotti (1993) show that income inequality and investment are inversely related; consequently, economic growth is weakened by high levels of inequality. With that said, perhaps one of the most salient models of international trade, the Heckscher-Ohlin model, has failed to predict the current trends of rising income inequality in lower and middle income nations. Heckscher-Ohlin is a model of exchange between two countries, with two factors of production (in this analysis, skilled and unskilled labor), and two sectors utilizing these factors of production. The Heckscher-Ohlin theorem states that countries will export in the sector which uses intensively the factor production that is relatively

\(^1\) For a more detailed description of the channels through which income inequality affects macroeconomic performance, I direct readers to appendix B
abundant in that country. Next, the Stolper-Samuelson theorem states that a rise in the price of a good that uses intensively a factor of production will increase the real return to this factor of production. Since exports increase the price of a good relative to autarky, Heckscher-Ohlin theory suggests that a country that is relatively skill abundant will export goods that require high amounts of skill for production, and consequently the wages of skilled workers will increase while the wages of unskilled workers will fall. In this way, income inequality is expected to increase. The converse is true for a country endowed with abundant amounts of unskilled labor: income inequality is expected to decrease. Since unskilled labor is generally the abundant factor in developing countries, Heckscher-Ohlin predicts that trade should reduce income inequality for developing nations experiencing trade with more developed nations.

Davis and Mishra (2006) state that, “It is time to declare Stolper-Samuelson dead.” This statement comes as a response to the rising levels of income inequality in the trade-intense developing world, which is counter to the predictions of the Stolper-Samuelson theorem. I provide some evidence of rising levels of income inequality in countries of varying levels of development. Figure 1 displays the trends of inequality measured in terms of the Gini coefficient\(^2\) for a group of developed countries. These trends are consistent with the predictions made by the Heckscher-Ohlin model and Stolper-Samuelson theorem due to the fact that developed nations are typically skill-abundant.

\(^2\) Section II presents an overview of the Gini coefficient and how it is measured.
In the case of developing and middle-income economies, a similar trend to the case of developed economies can be found. This is precisely where the predictions of Heckscher-Ohlin and Stolper-Samuelson are inconsistent with empirical evidence. Figure 2 displays trends of income inequality in developing and middle-income economies over four decades.

One characteristic of the nations displayed in Figure 2 is that they are prominent exporters to high-income economies. In addition to the countries presented in the figures...
above, Goldberg and Pavcnik (2007) find similar trends of rising inequality in Brazil, Colombia, and Mexico during the late 1980’s/early 1990’s. They also note that this trend appears to begin at the advent of major trade reforms for these nations (for instance, in the case of Mexico, the implementation of NAFTA). For theoretical explanations of rising income inequality in developing economies, I direct readers to appendix C.

In this analysis, I utilize a panel dataset to examine the trade factors correlated with income inequality (measured as a Gini coefficient) and test the predictions of the Heckscher-Ohlin model. In order to account for the possibility of unobserved differences across countries, I construct fixed-effect regression models. The coefficient of interest is on a term interacting the level of development (measured as log per capita GDP) and merchandise exports to high-income economies (measured as a share of total merchandise exports). In this way, I am able to analyze the effects of exporting to high-income countries at varying levels of development. I then construct additional fixed effects models involving a dummy variable that indicates whether or not a country is considered “developing.” The criteria for inclusion into this development indicator differs by model according to thresholds of per capita GDP in 2006 (the final year in the time series). Consequently, the results from this second set of fixed-effect models display the effects of exporting to high-income economies for countries beneath a particular threshold of per capita GDP. I find that the increases in income inequality resulting from trade with developed nations is more pronounced for countries on the lower end of the development spectrum. In this instance, since developing nations are expected to be unskilled-abundant, the consequences of trade between high-income and
low-income nations run counter to the predictions made by the Heckscher-Ohlin model for developing nations: income inequality actually rises in both countries.

The paper is structured as follows: Section I provides a brief overview of the Heckscher-Ohlin model and its predictions for income inequality; Section II presents the measurement of the Gini coefficient, the dependent variable in all specifications; Section III is a description of the data set; Section IV describes the model specifications used in the regression analysis; Section V explains the results of the various specifications; Section VI concludes.

I: The Heckscher-Ohlin Model and Predictions

The Heckscher-Olin (HO) model predicts returns to production factors based on relative differences in factor endowment between two nations. First, Heckscher-Ohlin assumes perfect competition (no firms have enough market power to set prices) and equivalent levels of technology. Next, the simple HO model is that of two countries, with two sectors, and two factors of production (for this analysis I consider skilled and unskilled labor) which can move freely between sectors within a country but not between countries. Finally, HO assumes that the only difference between the countries is their relative factor endowments. There are two results of the HO model which impact income inequality: the Heckscher-Ohlin theorem and the Stolper-Samuelson theorem.

The Heckscher-Ohlin theorem states that countries will export goods that use intensively the factor of production which they have an abundant supply of. That is to say, a country that is endowed with relatively high skilled labor will export goods which require the use of this skilled labor (for example, computer design). The Stolper-
Samuelson theorem states that international trade will lead to an increase in the real return of the abundant factor. The intuition is simple, since countries export goods which use intensively their abundant factor, the relative price of the goods will increase compared to the price under autarky. When the price of a good that uses a particular factor of production rises (in this case, skilled labor), then the wages of skilled laborers will increase. In order for equilibrium to be maintained, the relative wage of the other factor of production (unskilled labor) will decrease.

Perhaps the most important result of the Heckscher-Ohlin model and Stolper-Samuelson theorem, at least under the lens of this analysis, is their implication for the distribution of wages. Consider the standard Heckscher-Ohlin model with the two factors of production being skilled and unskilled labor. The two countries will be denoted Home (H) and Foreign (F). Let us also assume that Home is relatively skill abundant compared to Foreign. By the Heckscher-Ohlin theorem, Home will export skill intensive goods and Foreign will export unskilled/labor intensive goods. The standard HO model suggests that trade will lower the relative price of unskilled/labor intensive goods for Home since they are importing them from Foreign, and the converse for skill intensive goods. Then the relative wage of skilled labor will rise for Home, while the wage of unskilled laborers will fall (Stolper-Samuelson theorem). The converse is true for Foreign, the relative wage of skilled labor will decrease and the relative wage of unskilled labor will increase. As a result, inequality rises for Home and falls for Foreign. This idea can be extended to models with more than two factors of production (see Deardorff (1982)). Since high-income nations are typically skill-abundant, and low-income nations are typically labor
abundant, it follows that North-South trade should increase income inequality in developed nations, and decrease income inequality in developing nations.

II: Income Inequality and its Measurement

Throughout this paper, particularly in the final sections, a term known as the Gini coefficient will be used. The Gini coefficient, first introduced by Gini (1912), is a measure of the dispersion of a nation’s income. The Gini coefficient is the most prominent measure of income inequality. The Gini coefficient is calculated as the ratio of the area between the line of perfect equality and the Lorenz Curve\(^3\) (let this area be denoted as K) to the area beneath the line of equality (say, \(J = \int x \, dx\)). The Lorenz Curve is a cumulative distribution function of the income of a population (so it is strictly increasing, see \(f(x)\) in the Figure 3 for an example). Informally, Gini coefficient (G) is then \(G = K/J\). More formally, let us say that the cumulative distribution function of the income of a population is denoted by \(f(x)\), and the function denoting the line of perfect equality is simply the identity function \(x\). Then the Gini coefficient is calculated in Figure 3 below:

---

\(^3\) Readers should consult appendix A for more information regarding the Lorenz Curve
where the above integrals are evaluated on [0,1]. From this interpretation, one sees that the higher the value of the Gini coefficient, the greater the difference between the Lorenz Curve of the population and the line of perfect equality. In this way, higher Gini coefficients represent higher levels of inequality.

III: Data Description

I utilize a diverse panel data setting in order to analyze the possible impacts of North-South trade on income inequality in countries of varying levels of income. The panel consists of 91 countries in several regions over an annual time series from 1968 to 2006 (39 years). Data on income inequality, measured as a Gini Coefficient, is taken from the University of Texas Inequality Project, an extension of the Deininger-Squire (1996) data set also used by Barro (1999).

The other variables in the specifications include real per capita GDP and various measures of trade and industry activity. All observations other than Gini coefficients are
taken from the World Bank’s World Development Indicator database. In the following specifications, the intersection of observations for interaction variables is empty in some members of the cross-section; consequently, some countries were removed in order to balance the panel to a final 91 countries. The original data set contains many more countries. However, it is likely that observation sparse countries produce inaccurate data, in this way the precision of the analysis may be improved.

**Section IV: Model Specifications**

The goal of this analysis is to test whether or not North-South trade increases income inequality for developing nations, counter to the intuition of Heckscher-Ohlin. Since low-income countries are generally abundantly endowed with unskilled labor, this will test Heckscher-Ohlin’s predictions that trading with high-income economies will decrease income inequality for low-income countries. For my analysis, I estimate ten different models. All specifications utilize one-way fixed-effects clustering by cross-section in order to account for cross-country unobserved heterogeneity. Unobserved heterogeneity simply means that there are unobserved characteristics specific to each country, which could be anything from cultural biases to idiosyncratic structural differences in production or technology\(^4\). Fixed-effects corrects for these unobserved characteristics. It is important to note that fixed-effect models require a balanced panel; consequently, some countries are removed from the original UT data set\(^4\). The dependent variable in all specifications is inequality measured as the Gini coefficient. Recall that

\(^4\) For a detailed description of the fixed-effects equation and how unobserved heterogeneity is dealt with, I refer readers to appendix D.
higher coefficients indicate higher levels of income inequality. The Gini coefficient takes values on the interval [0,100], where 0 denotes perfect equality.

The specifications for my analysis are simply minor deviations from the following baseline interpretation:

\[
gini^{F.E.}_{it} = \beta_1 (\log(\text{gdppc})^{F.E.}_{it}) + \beta_2 (\text{manufacturing}^{F.E.}_{it}) + \beta_3 (\text{agriculture}^{F.E.}_{it}) + \beta_4 (\text{trade}^{F.E.}_{it}) + \\
\beta_5 (\text{exports}^{F.E.}_{it}) + \beta_6 (\log(\text{gdppc}) \times \text{exports}^{F.E.}_{it}) + \varepsilon_{it}
\]

including effects of the level of income (measured as log per capita GDP), trade (measured as sum of imports and exports as a percentage of GDP), and industry composition (agricultural and manufacturing value added as shares of GDP). Industry composition variables are included as control variables.

The variable of \( \beta_5 \) differs between some models: models A-1 and A-2 use exports as a share of GDP, and models A-3 through A-6 examine only exports to high income economies as a share of GDP\(^5\). These variables are used exclusively in different models not only to analyze whether inequality rises as a result of a growing export sector or exporting specifically to high-income economies, but also due to the fact that they are somewhat collinear (Pearson Correlation Coefficient: 0.6193). By utilizing separate specifications to analyze differences in the impact of exports and exports specifically to high income economies on income inequality, I also avoid the possibility of severe multicollinearity. If two explanatory variables are correlated, then including both in the specification will inflate standard errors and obscure the significance of the variables, this

\(^5\) The World Bank classifies high-income economies based on GNI per capita. In 2013, the cutoff for high-income economies is a GNI per capita of $12,746.
is multicollinearity. Multicollinearity does not bias coefficients in linear regression; but, makes it more difficult to find statistical significance due to increased standard errors.

The interaction term (for which $\beta_6$ is the coefficient) multiplies log per capita GDP by exports (or exports to high-income economies). The interaction term is included in models A-2, A-5, and A-6. Depending on the coefficients $\beta_1$, $\beta_5$, and $\beta_6$, I will be able to analyze the effects of exports/trade (and exports specifically to high-income economies) on income inequality based on varying levels of income for a country. For instance, if the coefficients for log per capita GDP and exports are positive, but the coefficient of the interaction term is negative, then one sees that exporting to high income economies increases income inequality more so for a low-income nation than for a high-income nation. The interaction terms play the largest role in this test of the Heckscher-Ohlin predictions for low-income economies; thus a great deal of focus will be placed on these coefficients.

Finally, a notable deviation from this baseline interpretation occurs in models A-1, A-2, A-3 and A-5, where the variable measuring trade is removed. This is due to the fact that trade and exports are highly collinear; indeed, total exports as a share of GDP and trade achieve a correlation coefficient of nearly 0.97845. In this way, the variables follow very similar trends (the multicollinearity is nearly perfect), so one is really in need of a single variable. Exports will be used and interpreted as an increase in trade. Exports to high-income economies shares a correlation coefficient of 0.5641 with trade, suggesting a less severe, but still significant, problem of multicollinearity. It is important to note that omitting trade may bias coefficients as a result of violating the Gauss-Markov
assumption (while multicollinearity does not). Consequently, one should use caution when interpreting the results, as there is a tradeoff between multicollinearity and omitted variable bias. Results for these initial specifications can be found in table A.

In order to further analyze the role that the level of income plays in exporting to high-income economies, I construct additional fixed-effect models substituting log GDP per capita in the interaction term with an indicator variable denoted “developing(k),” which takes on a value of 1 if an observation is considered to be from a developing nation. The estimated equation of models B-k for k ∈ {1,2,3,4}, is then:

\[
\text{gini}_{F.E,it} = \beta_1(\log(gdppc)_{F.E,it}) + \beta_2(\text{manufacturing}_{F.E,it}) + \beta_3(\text{agriculture}_{F.E,it}) + \beta_4(\text{trade}_{F.E,it}) + \\
\beta_5(\text{exports}_{F.E,it}) + \beta_6(\text{developing}(k)\ast\text{exports}_{F.E,it}) + \varepsilon_{it}
\]

The criteria for whether or not a nation is considered “developing” is the only difference between specifications. For k=1, a nation is considered “developing” if per capita GDP is below $2000 in the year 2006\(^6\). For k=2, the cutoff criteria for per capita GDP is $5000. For k=3, the cutoff is $12000. Finally, for k=4 the cutoff criteria is highest at $20,000 per capita GDP in 2006.

These models allow for the analysis of the effects of exporting to high-income economies on income inequality for various income groups. Since the threshold for development is based on the final value of the time series, this model assumes that countries considered developing in 2006 are also considered developing through the

\(^6\) The criteria for development is based on the end of the time series due to the fact that information for estimating thresholds of income level is available for 2006. In 1968, the threshold for development is more difficult to determine, and little information on the subject is available.
entire period of observations. Results of models utilizing indicator variables for development are summarized in table B. In the results section, I briefly discuss the differences between these models and additional models that exclude trade as a variable; however, the differences are very subtle and in favor of the results already presented in table B.

Section V: Results

In this section, I move through the models in tables A and B one by one, noting differences and implications as a result of omitting and adding different variables. After completely moving through the models in each table, I provide a brief conclusion of the results presented by the specifications. I direct readers to table A for the initial discussion.

Consider model A-1 which presents the coefficients for the baseline, but excluding trade due to near perfect correlation with exports. The coefficient for per capita GDP is positive, but not significant. This suggests that the level of development of a country has little to no impact on its level of income inequality. The coefficients on the industry composition variables are both negative and significant. This suggests that an increase of 10 percentage points of the GDP composed of by agricultural output will reduce the Gini coefficient by roughly 0.97. Similarly, an increase of 10 percentage points of the GDP composed of by manufacturing output will reduce the Gini coefficient by 1. These results are intuitive, as some increases in the share of GDP composed of by these industries are likely results of increases in labor. If more individuals are able to
receive a wage, then income inequality will decrease. Finally, the coefficient on exports as a share of GDP is negative and statistically significant. This suggests that export intense, and indeed trade intense, economies experience lower levels of income inequality than countries that are less open to trade. This model suggests that an increase of 10 percentage points in exports as a share of GDP will decrease the Gini coefficient by approximately 0.31.

Moving on to model A-2, the term interacting exports as a share of GDP and log per capita GDP by multiplication is included. In this way, one can analyze the effects of exports and trade based on the level of income. To begin with, the coefficients and significance of the industry composition variables has changed very little, suggesting little to no correlation with the interaction term. The coefficient on GDP per capita has shifted signs, but is still not significant. Furthermore, the coefficient on exports as a share of GDP has decreased substantially and remains significant. These decreases in coefficients are a result of the inclusion of the interaction term, whose coefficient is positive and significant at the 10% level. Since the coefficient on exports can be interpreted as the average effect of exports on income inequality while other variables are held at 0, one must interpret this change in coefficient by comparing it to some fixed level of log per capita GDP between models A-1 and A-2. Consider a country with a real per capita GDP of 5000 (log per capita is then 8.517). Fix a reasonable level of exports as a share of GDP; in this case, the mean of 34.79. Then model 1 states that an increase in 10 percentage points of exports as a share of GDP will decrease Gini by .31. In model 2, this identical change in export share results in a change of Gini by: 8.517*(0.07) - .94
= -.34. Since the predicted difference is small, one sees that this change in the coefficient of exports is correcting for the effects of the interaction term.

In order to demonstrate the implications of this significant interaction term, I construct a simple, hypothetical example. Consider two countries: Home (H) has a per capita GDP of $20,000 (9.903 log per capita GDP), and Foreign (F) has a per capita GDP of $2000 (log per capita GDP of 7.6). A change in the share of GDP composed of exports by 10 percentage points will result in the following change in the Gini measure for the respective countries H and F:

\[
\Delta H = (9.903 \times 0.07) - .94 = -.247 \quad > \quad \Delta F = (7.6 \times 0.07) - .94 = -.408
\]

From this, one sees that increases in export sector as a share of GDP will decrease inequality more so for a developing country than for a developed country. This is the general case, and should not hastily be linked to the predictions of Heckscher-Ohlin for trade between high-income and low-income (skill abundant and unskilled abundant) countries. These results do not discriminate between exports to high-income economies (detailing the North-South trade case) and general exports. These results imply that increasing the level of openness to trade will on average cause a reduction in income inequality with all other variables held constant. Furthermore, there is evidence at the 10% level that this effect is more pronounced for low-income countries than for low-income countries.

I now shift my focus to the models examining exports specifically to high income economies as a share of GDP. Consider model A-3 in table A. The coefficient for GDP per capita is still negative and insignificant at all levels, echoing the results of the
previous models that suggest little impact for the level of development on income inequality with all other variables held constant. Additionally, the coefficients for the industry composition variables change by only a modest amount, and remain significant. This suggests minor correlation between these variables and the level of exports to high-income economies. Including exports to high-income economies removes the bias incurred in previous models for these variables (negative bias for agriculture, positive bias for manufacturing). Most notably, the coefficient for exports to high income economies as a share of GDP is positive and significant at the 5% level. This implies that exporting to high-income economies increases income inequality with all other variables held constant. For example, an increase of 10 percentage points in merchandise exports to high-income economies as a share of GDP is expected to increase the Gini coefficient by nearly 0.31.

Recall that the difference between models A-3 and A-4 is the inclusion of the variable measuring trade as a share of GDP. Model A-4 subjects the variable measuring exports to high-income economies to a multicollinearity problem; but, presents the possibility of removing omitted variable bias due to the fact that trade is found to be statistically significant at all levels. Indeed, the standard error for the coefficient on exports to high-income economies has increases slightly due to this multicollinearity; however, the coefficient changes by a miniscule amount due to very minor bias and is still found to be statistically significant at the 5% level. Additionally, the variables for industry composition have shifted more closely to those estimated in model A-2, suggesting even less correlation between exports to high-income economies and these
industry variables than predicted by model A-3. Furthermore, the coefficient on log per capita GDP has shifted to positive, but possesses much less significance than in model A-3. In this way, one sees that including trade as a share of GDP results in a very minor multicollinearity problem; but excluding it results in a minor omitted variable bias problem. In either case, using different specifications has allowed for the understanding of this problem; and no substantial changes in both significance and coefficient magnitude can be noted. In general, I find that exporting to high-income economies appears to have a positive effect on income inequality with all other variables held constant.

Now that the baseline interpretation has been established for this variable set, I move on to discussing the coefficient of interest: the term interacting log per capita GDP with merchandise exports to high-income economies as a share of GDP. Similar to model A-2, the inclusion of the interaction term modifies the magnitude of the coefficient for log per capita GDP, but the coefficient remains insignificant. Furthermore, the coefficient for exports to high-income economies has increased dramatically, and remains significant at the 10% level. Since the interaction term is negative and significant at the 5% level, the coefficients for exports to high income economies and per capita GDP have increased due to correlation. In general, the interpretation of this is similar to the example given for model A-2. The coefficients change to better fit observations when the significant interaction term is included in the model.

As in model A-2, I provide an example for the interpretation of the interaction term. This is precisely where the predictions made by the Heckscher-Ohlin model run
counter to those made in this analysis. Consider two hypothetical countries, Home (H) and Foreign (F). Assume that H is developed, sporting a per capita GDP of $40,000 (log: 10.597); while F is developing with a per capita GDP of $2000 (log: 7.6). Fixing the level of exports to high-income economies near the mean (34.79% of GDP), then this model predicts that a change of 10 percentage points to 44.79% of GDP will result in a change in Gini for H and F respectively by:

\[ \Delta H = -1.378 + 1.08 = -0.3 \quad \Delta F = -0.99 + 1.08 = 0.09 \]

The model predicts a decrease in income inequality for H, and an increase in income inequality for F. This final result is the most important, as the Heckscher-Ohlin models predicts that exporting to a high-income economy will decrease income inequality for a unskilled/labor abundant country (F in this case). The interaction term implies that the positive effects of exporting to high-income economies on income inequality are more pronounced for low-income economies. The following figure is a set of plots for the effect of exports to high-income economies on income inequality for countries of varying levels of income (per capita GDP of: $2000, $5000, $12000, $20000). These slopes are adjusted for the coefficient of exports to high-income economies (without interaction) as well.
As one can see, there is a positive effect of exports to high-income economies on income inequality for the country with a GDP per capita of 2000. For all other countries above this level of development, this effect is found to be negative. This model predicts that a country with a level of per capita GDP of approximately 4054.9446 will experience no changes in income inequality resulting from exports to high-income economies.

The final model in table A includes the previously omitted trade variable into regression A-5. A small change in coefficients for log per capita GDP, manufacturing output, and agricultural output can be noted, as was the case in when trade was added in model A-4. The significance of these variables has not changed from model A-5. The coefficient on trade is once again found to be negative and statistically significant at the 5% level, suggesting that increasing the level of openness to trade reduces income inequality in the general case. Most interestingly, the coefficient on the interaction term
is attenuated and achieves higher standard errors; consequently, the interaction term is found to no longer be statistically significant (though it is very near to the 10% level). This is a result of two things. First, including trade removes any bias incurred in the previous model that was initially attributed to the interaction term. Second, since there is correlation between trade and the interaction term, we subject the interaction term to a problem of multicollinearity. The result is a slightly higher estimated standard error than would be the case if the two variables were not correlated. A larger data set would reduce this issue of inflated standard errors resulting from multicollinearity. In short, this model barely fails to reject the hypothesis (at the 10% level) that the income of the exporting economy makes a difference with regard to the positive impact that exporting to high-income economies has on income inequality.

This initial set of fixed-effect models presents some evidence that exports to high income economies increase income inequality more so for developing countries. Model A-2 finds evidence at the 10% level that a larger export sector will reduce income inequality more so for developing nations than for developed nations. Models A-3 and A-4 have found evidence at the 5% level that exporting to high-income economies increases income inequality regardless of the level of income of the exporting economy. Model A-5 finds evidence at the 5% level that exporting to high-income economies increases income inequality more so for countries on the lower end of the development spectrum than for high-income economies. When trade is included in model A-5, this effect is found to not be significant at any level, though nearly significant at the 10% level. This change in significance is possibly a result of multicollinearity. Overall, I find
some evidence that exporting to high-income economies has a more substantial impact on income inequality for developing nations; wherein income inequality will either increase by a larger amount (or decrease by a smaller amount) than for a developed country. This is counter to the predictions made by the Heckscher-Ohlin. Recall that the Heckscher-Ohlin model predicts that North-South trade will reduce income inequality for the unskilled/labor abundant (low-income/developing) economy. These models predict a larger effect of positive income inequality for exporting to high-income economies in developing economies.

Finally, I will examine the regressions including an indicator variable that takes on a value of 1 if a country satisfies the criteria for a “developing” economy. Since including trade into model A-5 yielded less significant results, I take a measure of caution and subject the model to a possible problem of multicollinearity by including trade in all regressions. Consequently, if significance is found under multicollinearity, then it is likely that significance will be found under a model omitting trade; additionally, I avoid the possible issue of omitted variable bias since trade is found to be significant in all indicator variable regressions. Indeed, upon estimating identical models without the trade variable included, the indicator variables are found to have either identical significance and magnitude, or higher levels of significance in the case of B-1 and B-4.

Consider model B-1, where the criteria for being included in the “developing” indicator is set at a 2006 per capita GDP of $2000. This model captures differences for countries only in the lowest income bracket (roughly 28% of the panel). Upon examining the differences between models A-5, A-6 and B-1, one will notice that these models all
suggest similar roles for the coefficient and significance of log per capita GDP, industry composition, and trade. One sees, then, that discretizing the level of development has not influenced our estimates a great deal. The model does not correct for these variables because the effects of the indicator interaction term are nearly orthogonal to those of these variables. Additionally, the coefficient for exports to high-income economies is further from significant than before; suggesting that the effects of exporting to high-income economies on income inequality is captured entirely in the interaction term. Consequently, one should turn to the interaction term to understand the possible impacts of exporting to high-income economies. The coefficient is positive and significant. Figure 5 shows the plots for changes in income inequality (measured as the Gini coefficient) for changes in exports to high-income economies for countries considered “developing” and “developed” under this criteria.

This reinforces the results of previous models that the effects of exporting to high-income economies on income inequality are more pronounced for developing economies. These
plots suggest that countries in the lowest income bracket of the panel experience much higher returns to income inequality as a result of exports to high-income economies than the rest of the panel. This contradicts the predictions made by the Heckscher-Ohlin model, as increases in exports to high-income economies are expected to reduce income inequality for unskilled/labor abundant (low-income) economies.

Moving on to model B-2, recall that the criteria for “developing” under this model is a per capita GDP of less than $5,000 in the year 2006. A marked change in coefficient is found for log per capita GDP, but the statistic remains far from significant. Additionally, this model suggests a slightly larger, but still statistically insignificant, role for exporting to high-income economies regardless of the level of development. Figure 6 displays the expected changes in Gini coefficient resulting from changes in exporting to high-income economies for countries considered “developing” and “developed.”

The coefficient on the interaction term in this model is much smaller, but still statistically significant. When considering this result, and the rise in coefficient for exports to high-
income economies, one should note that the difference in slopes is much smaller than those displayed in figure 5. This suggests a smaller, but still significant difference in the impact of exporting to high-income economies on income inequality for countries in either side of this development threshold. This result is consistent with the ideas expressed in model B-1, suggesting a trend of reduced positive impact of exporting to high-income economies on income inequality as one moves up the development spectrum.

Model B-3 sets the criteria for development at $12,000 GDP per capita in the year 2006. This model presents an interesting change in significance and magnitude on the coefficient for exports to high-income economies (without interaction). This is a result of the restructuring of the criteria for the indicator variable. Since the coefficient on the interaction term is now negative, one sees that there is minor correlation between a level of development beyond this criteria and exports to high-income economies. The coefficients for exports and per capita GDP have shifted to correct for the inclusion of this interaction term in order to fit observations, as in previous models. The interaction term in this model is not statistically significant at any level, suggesting no difference in the impact of exports to high-income economies on income inequality for countries on either side of this threshold of development. Consequently, I find that upper-middle and middle-income economies may very well experience the smallest impact from exports on income inequality. This suggests a possible U-shape for the effect of exporting to high-income economies on Gini coefficient as log per capita GDP increases toward higher-income nations. In other words, it may be the case that low income and high income
economies experience augmented effects from exporting to high-income economies on income inequality; while middle-income countries experience a diminished effect on income inequality. The next model allows one to test this hypothesis by setting the criteria for development at its highest point.

The final model including the indicator, B-4, sets the criteria for “developing” at a threshold of $20,000 GDP per capita in the year 2006. Any country with a per capita GDP below this level is considered “developing” and is therefore influenced by the interaction term. As in model B-3, the coefficient for exports to high-income economies has increased slightly, and remains significant. This, once again, suggests minor correlation between level of income and the level of exports to high-income economies. Upon examining this correlation, it is found to be minor, but statistically significant (correlation coefficient 0.1733). This correlation is manifest in the significance and magnitude of the coefficient for exports to high-income economies in models B-3 and B-4. The coefficient rises to fit observations as in previous models. Perhaps the most interesting difference between this model and previous ones in this indicator variable framework is that the coefficient on the interaction term is negative and significant. This suggests that exports to high-income economies increase income inequality more so for the most developed countries than for the rest of the panel (which under this criteria includes low and middle income economies). Figure 7 displays the effects of exports to high-income economies on Gini for countries considered “developing” and “developed” under this criteria.
Here, one sees that this model predicts an augmented effect of exporting on income inequality for skill abundant (developed) economies compared to relatively less skill abundant (low and middle-income) economies.

When considering both the results of this model, and model B-1, I find that there is a possibility for a U-shaped effect; wherein middle-income economies experience the smallest effect on income inequality as a result of exporting to high-income economies. Consequently, I provide an additional estimation for this U-shaped effect utilizing a similar method as in the above indicator regressions. Results are presented in appendix F.

Section VI: Conclusion

In my analysis, I constructed fixed-effects models to analyze the impact of exports to high income economies on income inequality for countries of varying levels of development. I find that exporting to high-income economies increases income
inequality regardless of the level of income of a country. Furthermore, I find that this increase in income inequality is more pronounced for low-income economies that export to high-income economies. This result is contrary to the predictions of the Heckscher-Ohlin model; which predicts a decrease in income inequality for an unskilled/labor abundant (low-income/developing) country that trades with a skill abundant (high-income/developed) economy. Additionally, I find that increasing openness to trade reduces income inequality in the general sense; but this reduction may be lower for high-income economies. This suggests that the allocation of exports to high-income economies determines the resulting effects of trade on income inequality for economies of any income level. However, it is important to note that the effects of exporting to high-income economies on income inequality appear to be of a much higher magnitude than the reductions in income inequality resulting from increases in openness; this is particularly the case for developing economies. In short, I find that Heckscher-Ohlin’s prediction of a reduction in income inequality for a low-income economy does not hold under the lens of this analysis. Consequently, I conclude that North-South trade results in equivalent or, more likely, higher levels of income inequality for unskilled/labor abundant economies. Additionally, I find that there is the possibility of a U-shaped effect of exporting to high-income economies on income inequality based on the level of income of an economy. Appendix F presents strong evidence in favor of this hypothesis. The most plausible explanation for the fact that North-South trade increases income inequality for developing nations is offshoring/outsourcing. Costinot and Vogel (2010) construct an equilibrium model of trade and incorporate matching functions to show that
offshoring results in a pervasive rise in income inequality for both developed and developing economies. Considering the large share of offshoring destinations in the panel, these models may in part capture this offshoring effect on income inequality.

Feenstra and Hanson (1994) examine Mexican manufacturing firms and note a marked rise in the demand for skilled labor. An increase in the demand for skilled labor in an unskilled/labor abundant economy will result in a rise in income inequality. Further research should examine firm-level and wage data to examine shifts in demand for skilled labor in low-income economies as a result of increased levels of exporting to high-income economies, outsourcing, and offshoring.

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7 Appendix E presents a brief summary of the offshoring effects theorized in Costinot and Vogel (2010).
8 Popular offshoring countries in the panel include: Argentina, Brazil, Chile, China, Colombia, Costa Rica, Czech Republic, Malaysia, Mexico, Romania, Singapore, Thailand, and Ukraine.
References


APPENDIX

A. The Lorenz Curve

The Lorenz Curve, introduced by Lorenz (1905), is expressed as a cumulative distribution function of income. Therefore, the area under the curve at a particular point (some point on the x-axis representing a bottom percentile of the population) represents the cumulative amount of wealth held by this percentile of the population. As with all cumulative distribution functions, the Lorenz curve is monotone increasing. In order to calculate the Gini coefficient, one must compare the Lorenz curve of the population in question with the line of perfect equality, which is simply a linear cumulative distribution function (in fact, it is the identity mapping on [0,1]).

B. Implications of Income Inequality on Macroeconomic Performance

In order to stress the importance of understanding trends of income inequality, I highlight the primary theoretical channels through which inequality can affect macroeconomic performance. The categories I define here are outlined in Barro (1999), and I direct readers to papers explaining each channel in more depth in this section. There are four primary theories connecting income inequality and economic growth and investment: Political Economy, Social Unrest, Credit-Market Imperfections, and Saving Rates. Several empirical papers have been written on the relationship between income inequality and economic growth. Conclusions are mixed, with several papers reporting different signs on their regression parameters. Barro (1999) reports that inequality tends to spur growth in high income nations, and slow growth in low income nations. However, Barro reports that the overall relationship he finds is weak; likely a result of different impacts for different levels of income. I utilize the same inequality data as

Government policy and redistributive measures can have a large impact on investment behavior. If there is substantial inequality within an economy, then policies oriented to redistributing wealth more equally can create distortions for economic decision makers and reduce investment, and consequently economic growth. Models for this mechanism of growth reduction analyze inequality following redistributive decisions by governments, and show that those economies with lower ex-post inequality are also expected to achieve higher rates of growth. Furthermore, if the state of income inequality is such that lobbying can occur to prevent redistributive measures, then this comes at a cost which could have been allocated to investment. For a more in-depth discussion of the political economy channel, I direct readers to Benabou (1996).

It is very intuitive that income inequality can promote social unrest and crime among members of the population in the lower percentiles of income. If inequality is high enough, this unrest can extend to revolutions or instability in political and private institutions. This impacts growth in several ways. As one may recall from basic principles, reported gross domestic product does not incorporate non-market and illegal activity. In this way, any output produced through illegal activity distorts the true output of a nation. Furthermore, instability within a nation creates an environment where property rights are not enforced. As a result, agents have less incentive to consume. Finally, social unrest and the threat of violent shifts in regime reduce the probability that foreign nations will invest and do business with firms in an economy. An excellent analysis of this relationship can be found in Alesina and Perotti (1993).

In the case of credit-market imperfections, relative restrictions in the access to credit induce difficulties for low-income households to take advantage of investment. For instance,
low-income households may choose to opt out of formal education as an investment. This results in a reduction of the growth rate. This is further complicated by redistributive measures causing distortions (as stated above). Finally, it is possible that investment is required to reach a certain threshold for a household or firm in order to be effective. For example, completion of schooling tends to increase growth much more at the secondary level than the primary level. If households are unable to borrow, then investments such as this will not reach their optimal threshold. For more rigorous treatments of this topic, readers should see Barro (1997) and Piketty (1997).

Finally, if it is the case that the rate of saving and income are positively correlated, which some papers have supported (Alvaredo, Atkinson, Piketty, and Saez (2013)), then inequality and growth are positively correlated. If a redistributive measure were put in to place, then the aggregate savings rate (investment) could potentially fall. If investment is reduced, then theory predicts that growth will slow. In this way, a higher concentration of wealth near the top results in greater investment than in the case of perfect equality.

C. Relevant Literature on Theoretical Alternatives to Heckscher-Ohlin

Several economists offer explanations as to why income inequality rises with globalization in developing countries. In this section, I provide a synopsis of the intuition behind three ideas put forth to explain the phenomenon. The primary channels I consider here are labor-market frictions, innovation, and finally skill-biased technological change. Appendix E presents another theoretical alternative, offshoring, as in Costinot and Vogel (2010). It is important to note that several of these ideas involve relaxing some assumption of the Heckscher-Ohlin model, implying that the basic model is not satisfactory for predicting trends of income inequality.

There are several approaches to analyzing labor market frictions in the framework of globalization. I explore two of them in this section: specific factors and costs induced by workers due to industry switching (recall that HO assumes costless movement of factors of
production within a nation. Anderson (2009) constructs a specific factors model where workers select a sector for which specific skills are acquired. The worker then can be thought of as a specific factor of production. Anderson shows that idiosyncratic productivity shocks to industries can pose substantial risk to the incomes of specific factor workers. Furthermore, Anderson shows that globalization increases income inequality by reducing the income of the poorest specific factors the most.

Artuç et al. (2008, 2010) construct a model under the assumption that factors of production cannot move costlessly between industries, but can switch at any time. Keeping in mind the fact that gross flows of labor between industries exceed net flows, that is to say workers within two industries switch in opposite directions, one finds a plausible explanation for rising income inequality in the presence of globalization. Consider a worker in an import competing sector. Since the HO model predicts that wages in an import competing sector will decrease, this worker will likely switch to a different sector (either export-competing or closed) in order to receive a higher real wage. In order to do this, the worker must incur a cost. Furthermore, under the assumption of the specific factors model of Anderson (2009), this worker may incur additional costs in order to switch due to investment in specific skills.

Another theoretical relationship between globalization and income inequality lies in innovation (research and development). In the instance of Dinopoulos and Segerstrom (1999), two countries with a continuum of industries conduct research and development in order to raise their level of technology. The firm with the highest level of technology captures the entire market. Similar to Heckscher-Ohlin, countries export in the sector for which they have the highest technology. In this way, trade will encourage firms in both countries to demand skilled labor in order to conduct research and development. This increase in the demand for skilled labor results in a rise in income inequality for both countries. This scenario really only applies to
countries with similar levels of technology, so North-South trade is not a consideration in this environment.

Extending the discussion of research and development, skill-biased technological change has been shown in Feenstra and Hanson (1998) to account for a substantial amount of the increase in the real wage of skilled workers in the United States. Thoenig and Verdier (2002) utilize a model of defensive skill-biased technological change to show that globalization causes firms to favor shifts toward higher demand in skilled labor. They also show that this is the case in both North-North trade and North-South trade. In order to remain competitive in the global market, firms must minimize their information leakage and reduce the risk that foreign firms will be able to replicate their production processes. In order to increase the difficulty of replication and reduce information spillover, firms are forced to shift toward more technologically advanced methods and therefore demand more skilled labor (whose wages are endogenously higher). Consequently, globalization causes firms to select based on skill and increase income inequality. A similar model is presented in Acemoglu (1999). The case for North-South trade is similar in that imitation by firms in less industrialized nations is more of an issue due to less developed legal institutions limiting laws on intellectual property rights.

D. Fixed Effects and the Within Estimator

Unobserved heterogeneity is the assumption that there is some omitted variable that is correlated with the dependent variable and at least one explanatory variable. Furthermore, this omitted variable varies between countries but not over time. One can think of this variable as being anything from cultural attitudes to idiosyncratic differences in technology or environmental conditions. Denote this omitted variable by \( U_i \). Then the true regression equation is:

\[
y_{it} = \alpha + \beta_1 x_{it} + \beta_2 z_{it} + U_i + \epsilon_{it}
\]
In order to cope with omitting $U_i$, the fixed effect model takes the unit level means of all observed variables within the cross-sections. This equation is as follows:

$$y_i = \bar{\alpha} + \beta_1\bar{x}_i + \beta_2\bar{z}_i + U_i + \bar{\varepsilon}_i$$

where variables with a bar over them represent within country means. Since $\alpha$ and $U_i$ do not vary over time, the means are equivalent to all observations for these variables. Subtracting this equation from the true regression equation yields our fixed effect (Within) estimation:

$$y_{it} - y_i = \beta_1(x_{it} - \bar{x}_i) + \beta_2(z_{it} - \bar{z}_i) + \varepsilon_{it} - \bar{\varepsilon}_i$$

The terms $U_i$ and $\alpha$ drop out of the equation, thus removing the bias from the omitted $U_i$. This equation is similar to those estimated in section IV.

**Appendix E: A Simple Model of Offshoring**

Costinot and Vogel (2010) consider the two-country case, Home (H) and Foreign (F), where Home is relatively skill abundant compared to foreign. They examine the implications of a positive shift in productivity for Foreign; this is similar to offshoring in that Home’s firms hire workers from Foreign to use Home’s level of technology for production. Under the lens of their model, Costinot and Vogel show that this shift in the level of production is analogous to increasing Foreign’s supply. Furthermore, offshoring results in task upgrading for workers in Foreign since the offshored tasks are relatively skill intense compared to the ones already existing in Foreign. In addition to this, since the relatively unskilled tasks have been offshored to Foreign, task upgrading occurs in Home as well. Consequently, for any pair of workers in either country, the wage of the more skilled worker rises, while the wage of the less skilled worker remains the same or falls. The result of this shift in productivity for Foreign is ultimately a rise in inequality for both countries.

**Appendix F: Estimations for the U-Shaped Effect of Exports on Income Inequality**
This section examines the possibility of a U-shaped effect of exporting to high-income economies on income inequality as one moves up the development spectrum as suggested by models B-k. Consequently, I test for this effect. Results for this estimation are displayed in table C.

The first estimation examines countries on extreme ends of the income spectrum into an indicator variable denoted “Extreme-Income.” The criteria for being included into this classification is either satisfying the criteria for B-1, or failing to satisfy the criteria for all of the previous indicator variable specifications. In other words, a country is considered to be of an “extreme” income level if the 2006 GDP per capita is below $2000, or above $20,000. The equation for this model is identical to that of the specifications for B-k, the criteria for inclusion into the indicator class is just modified. I include one specification with the trade variable, and one specification without in order to examine differences resulting from possible multicollinearity and omitted variable bias.

These models both suggest a similar role for per capita GDP and the industry composition variables as in previous models. The level of income of a country is not found to be significant, while industry composition variables are negative and significant. In this way, one finds that higher levels of economic activity in sectors producing merchandise goods reduces income inequality; this is likely a result of higher levels of employment. An important deviation from previous models is the negative and significant sign on exports to high-income economies in model C-1. Once again, this is due to correlation with the interaction term and fitting observations. Furthermore, one sees that including trade reduces the magnitude of this coefficient by a substantial amount, but not the standard error. Therefore, the omitted variable bias from excluding trade is a much larger problem than the multicollinearity issue. Once trade is included,
exports to high-income economies are not found to be statistically significant; contrary to the results of previous models.

Consequently, much of the explanatory power of exporting to high-income economies with respect to income inequality resides in the interaction term. In both models C-1 and C-2, the coefficient for the interaction term is positive and statistically significant at the 1% level. These results suggest a strong difference between middle-income countries and countries residing at the extremes of the development spectrum with respect to the impact of exporting to high-income economies on income inequality. The following figure presents the effects of exports to high-income economies for a country satisfying the criteria for “extreme-income” (either a high-income, or low-income economy), and a country failing to satisfy the criteria for the indicator variable (middle-income country).

These models present strong evidence for the possibility of a U-shaped effect for exports on income inequality. That is to say, the effects of exporting to high-income economies are most prominent at “extreme” levels of income, and gradually decline as one moves toward the middle of the income spectrum. Figure 9 presents a rough outline of the possible of effects of exporting
to high-income economies on income inequality across the spectrum of development. More weight is placed on the low-income spectrum due to the results of models B-1 and B-2 producing much higher magnitudes and significance than B-4. Furthermore, a significant interaction term was found in model A-5 (with near significance in model A-6), suggesting a larger effect for low-income economies.

Figure 9: Impact of Merchandise Exports to High-Income Economies on Income Inequality.
Table A. Fixed-Effects Regressions

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<tr>
<th>Variable</th>
<th>A-1</th>
<th>A-2</th>
<th>A-3</th>
<th>A-4</th>
<th>A-5</th>
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<td>[0.025]</td>
<td>[0.025]</td>
<td>[0.026]</td>
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<td>-0.099***</td>
<td>-0.135***</td>
<td>-0.122***</td>
<td>-0.133***</td>
<td>-0.122***</td>
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<tr>
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<td></td>
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<tr>
<td>Exports * Log GDP per capita</td>
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<tr>
<td>Exports to High-Income</td>
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<td>0.03**</td>
<td>0.108*</td>
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Figures in brackets denote standard errors.
9) Trade openness is calculated as the percentage of GDP composed by the sum of imports and exports.
* denotes significant at the 10% level
** denotes significant at the 5% level
*** denotes significant at the 1% level.
Table B: Indicator Variable Regressions

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<th>B-3</th>
<th>B-4</th>
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<td>[0.181]</td>
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<tr>
<td>Manufacturing Output</td>
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<td>-0.123***</td>
<td>-0.12***</td>
<td>-0.119***</td>
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<td>[0.028]</td>
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<tr>
<td>Openness (Trade)&lt;sup&gt;9&lt;/sup&gt;</td>
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<td>-0.015**</td>
<td>-0.015**</td>
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<tr>
<td>Exports to High-Income</td>
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<td>[0.016]</td>
<td>[0.017]</td>
<td>[0.022]</td>
<td>[0.024]</td>
</tr>
<tr>
<td>Exports to High-Income * developing(k)</td>
<td>0.133***</td>
<td>0.055*</td>
<td>-0.031</td>
<td>-0.046*</td>
</tr>
<tr>
<td></td>
<td>[0.036]</td>
<td>[0.029]</td>
<td>[0.027]</td>
<td>[0.028]</td>
</tr>
<tr>
<td>R2</td>
<td>0.78</td>
<td>0.78</td>
<td>0.78</td>
<td>0.78</td>
</tr>
<tr>
<td>No. Observations</td>
<td>1842</td>
<td>1842</td>
<td>1842</td>
<td>1842</td>
</tr>
</tbody>
</table>

Figures in brackets denote standard errors

9) Trade openness is calculated as the percentage of GDP composed by the sum of imports and exports

For B=1, the criteria for “developing” is $2000 GDP per capita in 2006
For B=2, the criteria for “developing” is $5000 GDP per capita in 2006
For B=3, the criteria for “developing” is $12000 GDP per capita in 2006
For B=4, the criteria for “developing” is $20000 GDP per capita in 2006

* denotes significant at the 10% level
** denotes significant at the 5% level
*** denotes significant at the 1% level
Table C: Testing U-Shape

<table>
<thead>
<tr>
<th>Variable</th>
<th>C-1</th>
<th>C-2</th>
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</thead>
<tbody>
<tr>
<td>Log per capita GDP</td>
<td>0.038</td>
<td>0.085</td>
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<tr>
<td></td>
<td>[0.178]</td>
<td>[0.18]</td>
</tr>
<tr>
<td>Agriculture Output</td>
<td>-0.077***</td>
<td>-0.083***</td>
</tr>
<tr>
<td></td>
<td>[0.024]</td>
<td>[0.024]</td>
</tr>
<tr>
<td>Manufacturing Output</td>
<td>-0.119***</td>
<td>-0.11***</td>
</tr>
<tr>
<td></td>
<td>[0.028]</td>
<td>[0.028]</td>
</tr>
<tr>
<td>Openness (Trade)³</td>
<td></td>
<td>-0.013**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.006]</td>
</tr>
<tr>
<td>Exports to High-Income</td>
<td>-0.042**</td>
<td>-0.023</td>
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<td>[0.018]</td>
<td>[0.02]</td>
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<tr>
<td>Exports to High-Income * Extreme-Income</td>
<td>0.116***</td>
<td>0.108***</td>
</tr>
<tr>
<td></td>
<td>[0.026]</td>
<td>[0.026]</td>
</tr>
<tr>
<td>R²</td>
<td>0.78</td>
<td>0.79</td>
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<tr>
<td>No. Observations</td>
<td>1853</td>
<td>1842</td>
</tr>
</tbody>
</table>

Figures in brackets denote standard errors

9) Trade openness is calculated as the percentage of GDP composed by the sum of imports and exports

* denotes significant at the 10% level

** denotes significant at the 5% level

*** denotes significant at the 1% level