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Shifting Value in a Growing World: Exploring the Relationship between Trade and Development

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Abstract

This thesis concerns the relationship between trade and human development. By using adding the human development index (HDI) to a panel data set, we study how per capita trade can impact HDI when regular HDI is used, and when non-income HDI is used. Using a GMM estimator, we confirm the finding in the literature that trade significantly impacts regular HDI and non-income. However, with current data, non-income HDI appears to be mostly impacted by trade among the poorest income groups, which suggests that there are benefits to trade, even though non-income channels. This suggests that trade is not only about income and that life expectancy and education have been increased due to trade in the poorest countries.

Zusammenfassung

Diese These befasst sich mit dem Zusammenhang zwischen Handel und menschlicher Entwicklung. Wir untersuchen wie sich der Handel auf den HDI auswirken kann indem wir den Human Development Index (HDI) zu einem Paneldatensatz hinzufügen. Mithilfe eines GMM-Schätzers bestätigen wir die Erkenntnisse aus der Literatur, dass der Handel erhebliche Auswirkungen auf den normalen HDI und den Nichteinkommen-HDI hat. Den aktuellen Daten zufolge scheint der einkommensunabhängige HDI jedoch hauptsächlich vom Handel zwischen den ärmsten Einkommensgruppen beeinflusst zu werden, was darauf hindeutet, dass der Handel auch über einkommensunabhängige Kanäle Vorteile bringt. Dies deutet darauf hin, dass Lebenserwartung und Bildung durch den Handel in den ärmsten Ländern gestiegen sind.

Contents

1 Economic Growth, Trade and Development **2**
- 1.1 Motivation . . . 2
- 1.2 Economic Growth . . . 3
- 1.3 Trade Concerns . . . 5
  - 1.3.1 Consequences of International Trade . . . 6
- 1.4 Human Development . . . 7
- 1.5 Human Development and Trade Literature . . . 9
- 1.6 Sustainable Development Goals . . . 11
- 1.7 Objectives . . . 12

2 Data Sources and Manipulation **13**
- 2.1 Data Sources and Explanation . . . 13
  - 2.1.1 Non-Income HDI . . . 17

3 Exploratory Analysis **18**
- 3.1 Correlation Analysis . . . 18
- 3.2 Plotting Analysis . . . 19

4 Econometric Analysis **22**
- 4.1 Replicating the Findings of Relevant Papers . . . 22
- 4.2 Generalized Method of Moments . . . 23
- 4.3 Goodness-of-Fit and Endogeneity Tests . . . 24
  - 4.3.1 Lags of 5 and 10 Years . . . 24
  - 4.3.2 One Lag of 2 Years . . . 26
- 4.4 Stationarity and Statistical Tests . . . 28

5 Replication of GMM Analysis 1: Difference GMM **32**
- 5.1 Finding 1: trade has positive effects on HDI for all income categories . . . 32
  - 5.1.1 Normal HDI . . . 33
- 5.2 Finding 2: trade no longer positively affects human development when the income component is excluded . . . 38
  - 5.2.1 Non-Income HDI . . . 38

6 Replication of GMM Analysis 2: System GMM **42**
6.1 Finding 1: trade has positive effects on HDI for all income categories 42
6.1.1 Normal HDI 43
6.2 Finding 2: trade no longer positively affects human development when the income component is excluded 45
6.2.1 Non-Income HDI 45
6.3 Conclusion 46

7 Forecasts **48**
7.1 Time Series Plots of HDI 48
7.2 Forecasts of HDI 50
7.3 Conclusion 52

8 Conclusion **53**

List of Figures

1.1 Economic Damage from Pandemic and Ukraine War . . . 4
1.2 Temporary Drop in GDP Growth . . . 5
1.3 Temporary Drop in Trade . . . 5
1.4 HDI Decline . . . 8
1.5 Percentage Decrease in HDI . . . 8
1.6 Reversals in HDI . . . 9
1.7 Two-Way Causality between Trade and Development . . . 11
1.8 2023 SDG dashboards by region and income group (levels and trends) . . . 12

2.1 HDI Principles . . . 16
2.2 Average HDI Growth Rates of the World . . . 16

3.1 Correlation Matrix of Full Data . . . 18
3.2 Correlation Matrices Split by OECD Status . . . 19
3.3 Plots Comparing Development and Trade - Full Data . . . 20
3.4 Plots based on OECD Status and HDI vs. Non-Income HDI . . . 21

7.1 Forecast of all data for all income groups . . . 48
7.2 Forecasts of HDI of Non-OECD Countries, by Income Group . . . 49
7.3 Forecasts of HDI of OECD Countries, by Income Group . . . 50
7.4 Forecast of all data for all income groups . . . 50
7.5 Forecasts of HDI for Non-OECD Countries . . . 51
7.6 Forecasts of HDI for OECD Countries . . . 52

List of Tables

2.1 WDI variables used to create Trade Variable 13

4.1 Test Results: Normal HDI, Heteroskedasticity 24
4.2 Test Results: Normal HDI, Endogeneity 25
4.3 Test Results: Non-Income HDI, Heteroskedasticity 25
4.4 Test Results: Non-Income HDI, Endogeneity 26
4.5 Test Results: Normal HDI, Heteroskedasticity 26
4.6 Test Results: Normal HDI, Endogeneity 27
4.7 Test Results: Non-Income HDI, Heteroskedasticity 27
4.8 Test Results: Non-Income HDI, Endogeneity 28
4.9 Variables of Interest 29
4.10 ADF Test Results 30
4.11 KPSS Test Results 31

5.1 Variable Statistics 32
5.2 Gunduz et al. (2009) - Table 3 - Est. Results for Model 1 33
5.3 Regression Results: Normal HDI, Difference GMM 34
5.4 Test Results 35
5.5 Regression Results: Normal HDI, Difference GMM 36
5.6 Amin and Hamid (2013) - Table 2 - Model 1 37
5.7 Regression Results: Normal HDI, Difference GMM 37
5.8 Gunduz et al. (2009) - Table 4 - Est. Results for Model 2 38
5.9 Regression Results: Non-Income HDI, Difference GMM 39
5.10 Test Results: Non-Income HDI, Difference GMM 39
5.11 Regression Results: Non-Income HDI, Difference GMM 40
5.12 Amin and Hamid (2013) - Table 2 - Model 2 41
5.13 Regression Results: Non-Income HDI, Difference GMM 41

6.1 Regression Results: Full Data, Normal HDI, System GMM 43
6.2 Test Result: Full Data, Normal HDI, System GMM 43
6.3 Regression Results: Normal HDI, System GMM 44
6.4 Regression Results: Full Data, Non-Income HDI, System GMM 45
6.5 Test Results: Full Data, Non-Income HDI, System GMM 45
6.6 Regression Results: Non-Income HDI, System GMM 46

Chapter 1

Economic Growth, Trade and Development

1.1 Motivation

International efforts have been made to gradually raise living standards in the world by promoting economic growth, trade, human development and international cooperation. In recent years, an ongoing medical pandemic and worries about wars in various places are warning signs that the gains of these efforts may be reversing. We are motivated to better understand how specific parts of human development are impacted by trade, so that we will know what to expect as global crises continue.

Sustainable Development

Promoting healthy economic and sustainable development are ongoing challenges in the twenty-first century. Due to differences in geography, demography, population characteristics, education, healthcare, technology and many other factors around the world, finding the right approach for all countries has become a complex puzzle. In recent decades, international cooperation has improved living standards in much of the world. According to the *United Nations*, global extreme poverty - which is defined as "a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information" which "depends not only on income but also on access to services." - fell from 35 percent to 9 percent between 1990 and 2016 (UNDP, 2017). Over one billion people were lifted out of poverty during this period. This is good news, but the onset of the Covid pandemic has started to push some people back into global extreme poverty for the first time in over twenty years (UN, 2021).

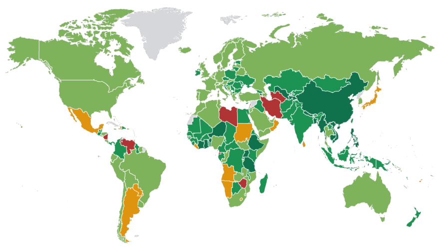
1.2 Economic Growth

Economic growth is the cornerstone of any economy. Following the work of Solow (1956), we know that growth is the product of a multiplicative relationship between capital and labor and that economic growth is somewhat of an enigma, since it is not fully explainable by all the variables that are included in standard growth models. According to Easterly and Levine (2001), roughly sixty percent of an average country's growth is accounted for by total factor productivity (TFP), rather than by the input factors (capital and labor), although the causes of this residual are unclear. The *World Bank* defines TFP (which is considered to be equivalent to technological progress) as "the relative efficiency with which an economy produces goods and services given a certain quantity of labor and capital." Technological progress plays a role in determining how efficient productive processes are, such as manufacturing. This provides economists with an indirect measure of "all income growth that cannot be explained by investment and increases in labor supply." These constituent parts form our understanding of economic growth, but understanding all the true causes of growth remains an enigma.

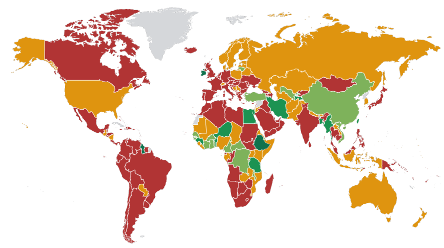
In recent decades, economists have noticed a slowdown of growth, particularly in the developed world. Some have noted that there is a linkage between the developed and the less-developed world. This manifests a situation in which, as the more-developed countries grow faster, the less-developed countries economies also grow faster. Lewis (1980) tells us that a general slowdown is an undesirable outcome internationally, since the less-developed countries would suffer, along with the more-developed ones. Lewis also tells us that "trade depends on prosperity in the industrial countries," and that "it is in the interest of the [least-developed countries] that the [most-developed countries] should grow as rapidly as they can." In a globalized world, the economic and political stability of one country affects the stability of other countries.

In addition to this slowdown, the Covid pandemic slammed the world's economies in unexpected and lengthy ways. Several maps from the IMF (2023) in Fig. 1.1 illustrate just how much damage can be attributed to the pandemic in the last few years, due to the shutting down of commercial travel and businesses, starting in 2020. They also illustrate the damage that Russia and Ukraine have suffered, due to economic sanctions relating to the Ukraine conflict, which started in 2022.

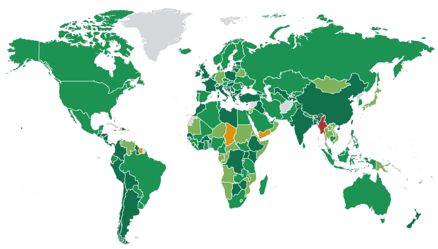
Real GDP growth - Annual percent change (IMF)



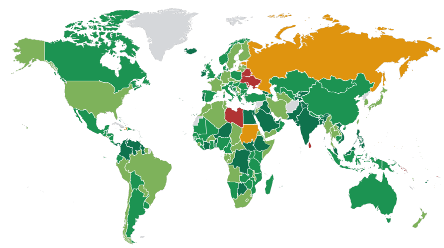
(a) 2019



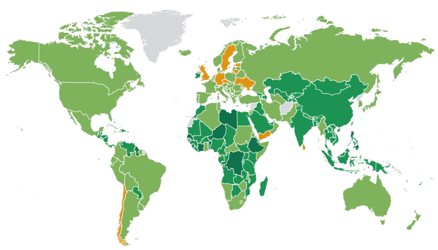
(b) 2020



(c) 2021



(d) 2022



(e) 2023

(f) Percent of Real GDP Change, by Color

Figure 1.1: Economic Damage from Pandemic and Ukraine War

The *IMF*'s concerns about future economic growth can be visualized in Fig. 1.2, where the impact of the pandemic can be seen in growth of real GDP.

Real GDP Growth (1980 - 2028)

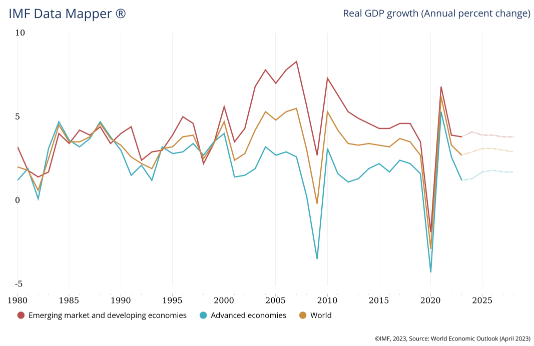


Figure 1.2: Temporary Drop in GDP Growth

Clearly the world has been affected by these crises and the effects will be felt for at least several years.

1.3 Trade Concerns

According to the OECD (2020), "The year 2020 was marked by some of the largest reductions in trade and output volumes since World War II." However, the *OECD* clarifies that "[these losses] materialised and disappeared more quickly, facilitating a V-shaped recovery in 2020." The following graph visualizes the dip in trade during 2020:

Volume of world trade and industrial production

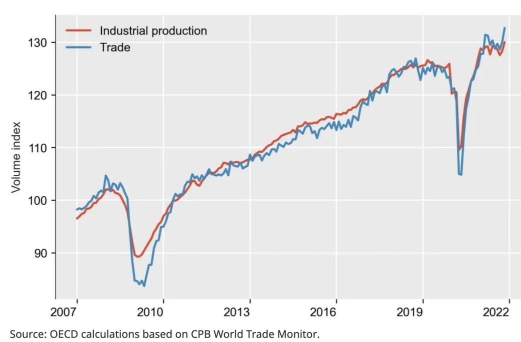


Figure 1.3: Temporary Drop in Trade

The difficulties of the last few years with the pandemic have been exacerbated by supply chain breakdowns, worldwide persistent inflation, and the advent of a war in Ukraine. These global crises are all challenging globalization and may discourage some countries from trading as freely as they once did. Whatever benefits of international trade were being felt previously will be greatly reduced if such global crises continue.

Benefits of International Trade

As the world has become more globalized, international trade has increased around the world. These benefits have been championed by many, but have not necessarily been felt in equal proportions. Though free trade is preferably to autarky for most countries, critics of trade deals have expressed concerns about who really benefits from those deals. By looking at the deeper connection between trade and human development, we may be able to ascertain whether richer or poorer nations truly benefit more than others.

Increased Access

When countries trade, they can acquire goods that they do not already have within their borders, which can allow them to enjoy consumer products that they would not be able to access normally. It can also provide them with foreign resources, which allow them to produce goods that they would not be able to manufacture otherwise. Countries which have a competitive advantage in producing goods in specific sectors can access new customers in other countries, which can increase the profitability of their firms. These firms will have more customers and will often be able to sell their goods at a lower cost, taking advantage of economies of scale to satisfy increased demand. The quality of products for consumers may also increase internationally, which can satisfy people in ways that would not have been possible otherwise.

"Spillover" Effects

Sharing technologies internationally can lead to more efficient firms, which can lead to increases in living standards from better products. Poorer countries can learn new, faster ways of producing the same goods, with new technologies.

Foreign Direct Investment

Countries can also attract more foreign direct investment into their countries, by engaging in trade deals with other nations. This could lead to infrastructure and other expensive projects in their own countries being funded from outside of their own country.

Diversifying Risks

By trading internationally, a country may also diversity its risks, which may better insulate it from an economic downturn.

1.3.1 Consequences of International Trade

Agricultural Subsidies

Western governments often subsidize their own farming industries, which makes them more lucrative, but makes it even harder for developing countries to sell their goods there. So many developing countries are already dealing with hungry populations. Therefore, opening up trade to developed countries creates a paradox in which the poorer countries require the food from the wealthier countries immediately. Rather than creating an opportunity for poorer countries to build up their agricultural sector, such interactions may instead shift the dependency in such a way that poorer countries will become reliant on food from *OECD* nations. If this happens, they will never be able to build up their own industries and become self sufficient.

If the wealthier countries expand their own farms, they will have less of a need for agricultural imports from the developing world. Therefore, the interaction of trade may end up benefiting the developed world more than the impoverished world, which appears to have the opposite of the intended effect.

Tariffs

Tariffs are said to be beneficial because they protect domestic producers from foreign competition. However, one of the supposed benefits of trade is competition itself. Developing countries can only gain revenue from free-trade agreements through tariffs that are placed on goods and services.

According to a report by the WorldBank (2002), "Average tariff rates in rich countries are low, but they maintain barriers in exactly the areas where developing countries have comparative advantage: agriculture and labor-intensive manufactures. Protection in rich countries costs developing countries more than $100 billion per year, twice the total volume of aid from North to South. Barriers in developing countries are three times higher than in *OECD* countries." Although this report was published in 2002, the sentiment still seems to ring true.

1.4 Human Development

Many economists rely on GDP or GNI per capita to gauge the level of improvement in human living standards. Another variable of interest is the human development index (HDI), consists of sub-indices concerning education, life expectancy and income per capita. The notion of creating a universal metric for human development has been a contested issue, and there have been attempts to use variations of the GDP or GNI for this purpose, but HDI is generally a reliable measure for a nations' well being.

Recent Decreases in Development

Optimism about a return to normality after the pandemic seems to have been replaced with ongoing anxiety about war in Ukraine, supply chain problems, oil shortages, inflation and environmental concerns. A 2022 Human Development Report (UNDP, 2022) showed that the Covid pandemic erased the HDI gains of the last five years in only two years Fig. 1.4.

Decrease in HDI resulting from Pandemic

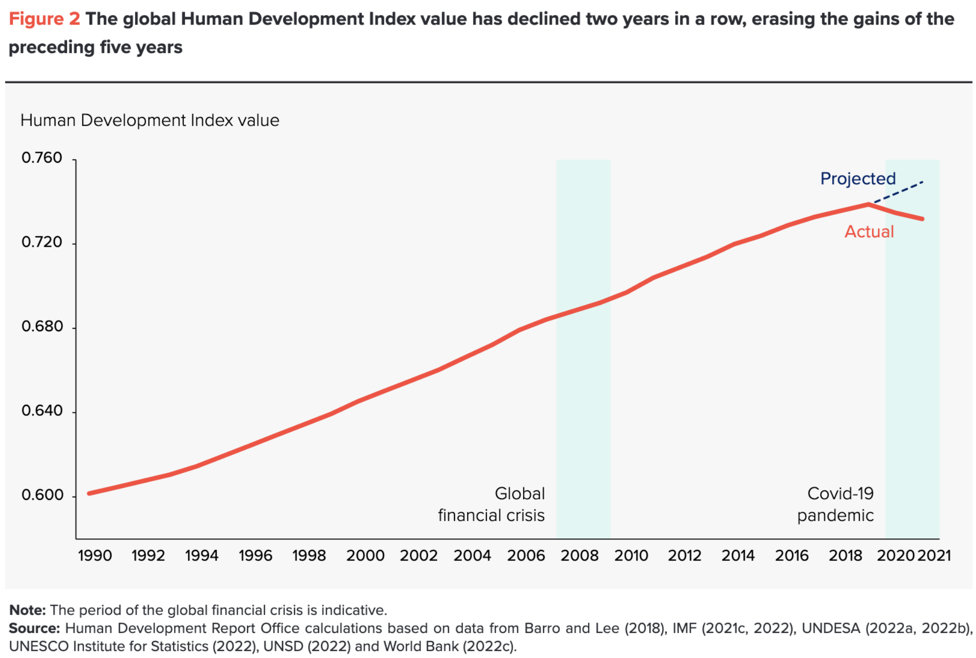


Figure 1.4: HDI Decline

This is due to the complex uncertainty which the world has suddenly been exposed to. There has been a prolonged volatility of oil prices, from both the pandemic and from the war in Ukraine. There has also been a global food crisis, which has resulted from a lack of fertilizer exports from Ukraine, and supply chain problems worldwide. If we look at Fig. 1.5, we can see the percentage of countries which have seen a decrease in their HDI in the recent pandemic, according to the UNDP (2017).

Percentage of Countries with Decrease in HDI

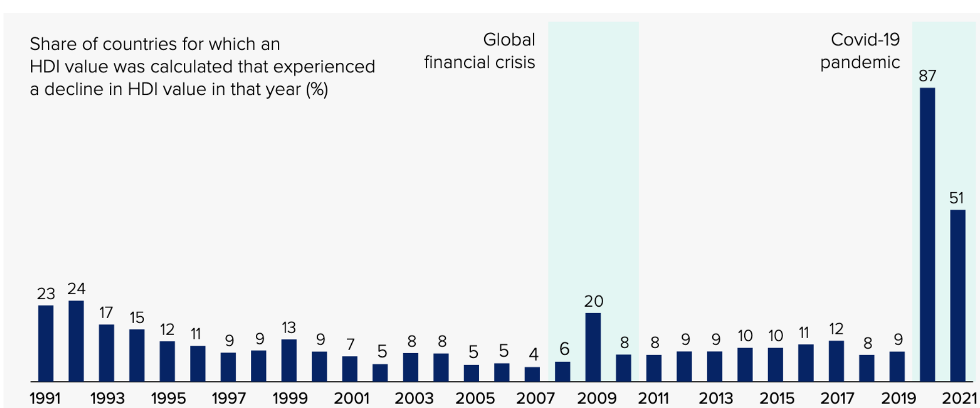


Figure 1.5: Percentage Decrease in HDI

Over ninety percent of all countries experienced a decline in their HDI during the Covid pandemic. This was far greater than the decreases resulting from the 2008 financial crisis. All countries experienced negative impacts right away, and this decline seems to be continuing. We will probably see worsening statistical indicators in the future.

Fig. 1.6 illustrates how high income countries rebounded from the economic shock of the pandemic while poorer countries did not.

Percentage of Countries with Reversal in HDI, by HDI

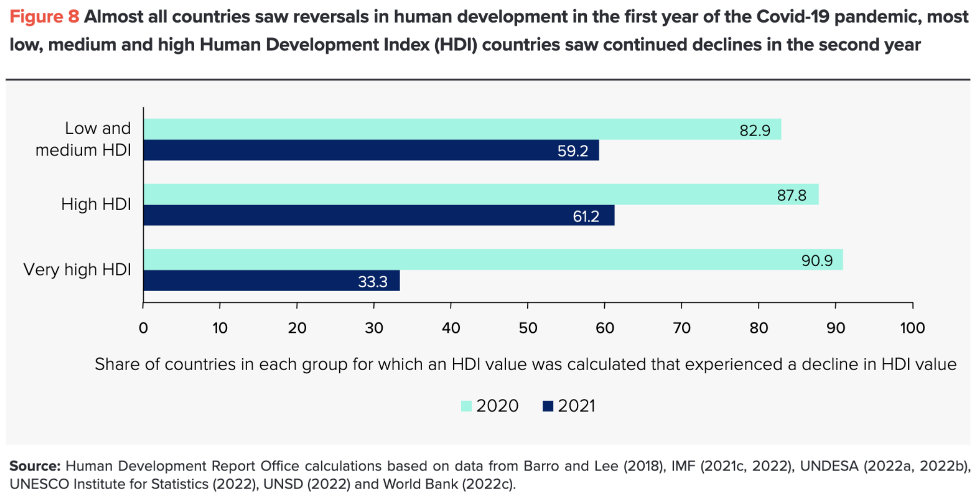


Figure 1.6: Reversals in HDI

It has becoming harder to be optimistic about improvements in future development, particularly as it pertains to international economic cooperation.

1.5 Human Development and Trade Literature

There have been several studies looking at the impact of trade on HDI.

1. "A Panel Data Analysis of the Impact of Trade on Human Development" - Davies and Quinlivan (2006)
2. "The Impact of Trade on Social Development" - Gunduz et al. (2009)
3. "Trade and Human Development in OIC countries: A Panel Data Analysis" - Amin and Hamid (2013)

Generally, they have focused on whether the impact of trade on HDI was positive and statistically significant, and whether it persisted when income was removed from the HDI calculation.

Finding 1. Trade positively impacts HDI

Finding 2. Trade no longer positively impacts HDI when the income component is removed

Davies and Quinlivan (2006)

According to Davies and Quinlivan (2006), there are two general arguments about the impact of trade on development. The "standard" argument claims that the impact of trade on development is felt through income. By having more money to spend on education, social services, and health care, trade effectively raises living standards. The "globalist" counterargument is that trade impacts non-income HDI (meaning education and life expectancy) indirectly through income and directly by increasing the goods available and by enriching the common cultural fabric of countries.

In order to model the impact of trade on human development, the authors modeled changes in the HDI as a function of per-capita trade and used the generalized method of moments (GMM) procedure in a panel data distributed lag model in order to look at the impact on per capita trade on the change in HDI. They found that as trade increased development, social welfare also improved. They also found that when non-income HDI replaced regular HDI, the estimates were insignificant, indicating that "standard" argument seemed more credible.

Gunduz, Hisarciklilar and Kaya (2009)

Gunduz et al. (2009) cited the work of Davies and Quinlivan (2006) and conducted a similar GMM estimation. They found similar results in their paper, which also looked at the effect of trade on HDI, with respect to differences in income. Trade was found to increase development across all but the lowest income group with normal HDI. With non-income HDI, they found that, "When the income component [was] excluded from HDI, the trade variable [became] significant only for the high income and higher middle income countries. This variable [was] insignificant for the lower middle and low income countries" (p. 1234).

What this meant was that the positive link between trade and HDI was still valid when the income component was excluded from the HDI calculation, but that it was valid for fewer poorer countries. The benefits of trade on poor countries seem even harder to find without the income component. This means that only countries that have already arrived at a certain threshold of development can benefit from trade. To phrase it differently, "although middle or high income countries [could] benefit from trade, it [did] not improve the human development in low income countries" (p. 1234). This observation suggests that engaging in trade is not always a good idea for a country.

Hamid and Amin (2013)

Amin and Hamid (2013) commented on the work of Davies and Quinlivan (2006) and of Gunduz et al. (2009). They also conducted a similar GMM regression to re-evaluate the same results, using data from the *Organisation of Islamic Cooperation (OIC)*. The authors claimed that there was a positive relationship between trade and HDI, but that trade only affected HDI through income channels. At the same time, trade did not affect other variables, such as educational attainment, lifespan or literacy. It found a similar conclusion to that of Gunduz et al. (2009), in which trade only affected development positively through income channels. They recommended public policies which would better reflect this knowledge.

Figure 1.7 is a schematic overview of the relationship between trade and human development, which originated in a 2006 *UN* report (UNDP, 2006), and was cited again in Amin and Hamid (2013).

Trade and Human Development

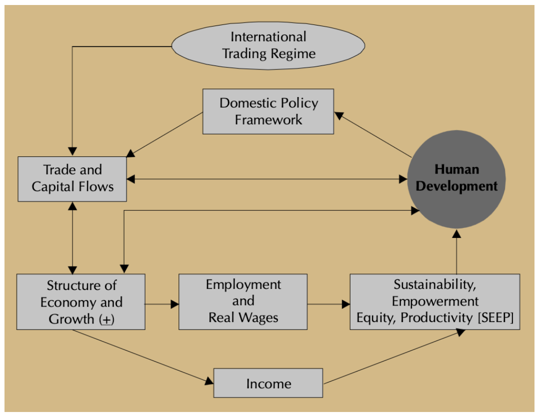


Figure 1.7: Two-Way Causality between Trade and Development

The *UNDP* claimed that increases in trade led to increases in growth. The increase in growth would lead to an increase in development, which increased trade. It is claimed that there is two-way causation between trade and human development:

$$\text{Trade} \implies \text{Growth} \implies \text{Human Development} \iff \text{Trade}$$

The important relationship between these variables has already been recognized.

1.6 Sustainable Development Goals

The *UN*'s 17 Sustainable Development Goals (SDGs) reflect international cooperation to achieve improvements in common, desirable outcomes. According to the 2023 *SDG Report* (UN, 2023), this is now the second year in which no progress has been made on these 17 goals.

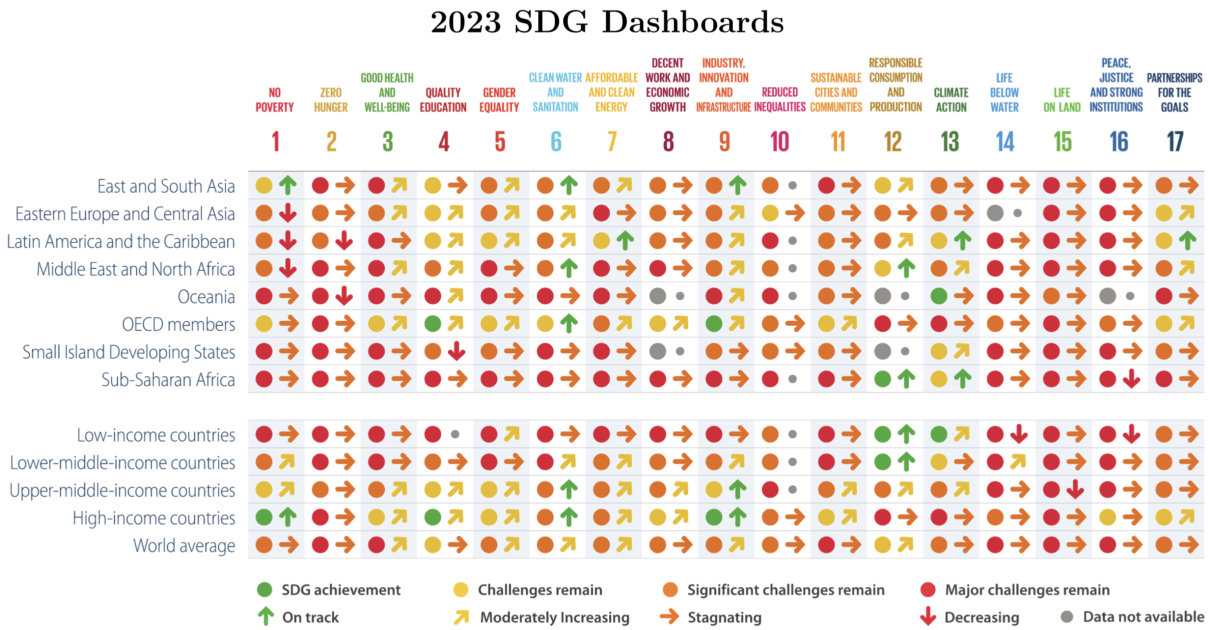


Figure 1.8: 2023 SDG dashboards by region and income group (levels and trends)

If we look at the metric dashboard in Fig. 1.8, we can see that high income countries are only on track to achieve three out of seventeen goals [1. No Poverty], [6. Clean Water and Sanitation] and [9. Industry, Innovation and Infrastructure] by the year 2030. The only goal that low and lower middle income countries are on track to achieve is [12. Responsible Consumption and Production]. Apart from those examples, other metrics have not improved and in some cases, have gotten worse. No development goal has seen improvements across all income groups. The international crises of the last few years have no doubt made these indicators much worse that they would have been otherwise.

1.7 Objectives

According to several papers, the effect of trade on HDI is positive and significant across all income groups. We intend to replicate the results of two of the three key papers that we discussed earlier, by using roughly the same statistical methods, and then re-evaluating their findings. The data we analyze will hopefully confirm old knowledge or reveal new information about the critical relationship between international trade and development. In particular, we will look at who benefits more from trade, with regard to income groups.

Chapter 2

Data Sources and Manipulation

2.1 Data Sources and Explanation

Our approach involves collecting the necessary variables to formulate our trade variable, generating *OECD* membership labels, adding income group labels, and retrieving the data from components of the HDI index. The HDI data and income group data only cover data from 1990 until 2021, which is why we will limit our analysis to this time frame. With these combined into one data set, we will be able to assess the impact of trade on development with respect to the income group that countries are in.

Logarithmic Trade per Capita

For the majority of our data, we use the World Development Indicators (WDI) from the WorldBank. We download exports, imports and population size variables for each country, in order to formulate our trade variable.

Table 2.1: WDI variables used to create Trade Variable

Variable ID	Description
SP.POP.TOTL	Population, total
NE.EXP.GNFS.CD	Exports of goods and services (current US$)
NE.IMP.GNFS.CD	Imports of goods and services (current US$)

We divide the sum of exports and imports by population size, and then take the logarithm of that expression, which gives us logarithmic trade per capita, for country i at year t.

$$trade_{i,t} = ln(\frac{Exports_{i,t} + Imports_{i,t}}{Population_{i,t}}) \tag{2.1}$$

OECD Membership Labels

There are 38 current member states in the*OECD*. 20 of them were founding members in the year 1961. 18 countries have joined the *OECD* since then, 13 of them in the time range between 1990 and 2021. There are 155 countries in our data set overall.

We obtain membership data from the OECD, including the years of accession. We also acquire the 'iso3c' country codes for each country (OECD). With this data, we formulate a list of all current *OECD* members along with their country code. Since our data ranges from 1990 to 2021, we create a binary variable, which is 0 for non-members and 1 for members. All countries which were members prior to 1990 are assigned a 1, and any countries that joined the *OECD* since then are assigned a 1, while all other countries are assigned a 0.

In our *R* code, we create a variable, listing all the codes of countries which were in the *OECD* in the year 1990. Those countries receive a 1 in the 'OECD_Status' variable, while all others are assigned a 0. Then, we write our code so that any countries that joined the *OECD* between 1990 and 2021 receive a 1 from that year onward. The first three countries are displayed in Listing 2.1:

Listing 2.1: R Code to Set OECD Status

```r
oecd_iso3c_CHL <- c("CHL") # Chile - 2010data$OECD_Status[data$iso3c
    == "CHL" & data$year >= 2010] <- 1

oecd_iso3c_COL <- c("COL") # Colombia - 2020data$OECD_Status[data$
    iso3c == "COL" & data$year >= 2020] <- 1

oecd_iso3c_CRI <- c("CRI") # Costa Rica - 2021data$OECD_Status[data$
    iso3c == "CRI" & data$year >= 2021] <- 1
```

Income Group Labels

This historical income group data is taken from the *WorldBank's GNI per capita Operational Guidelines & Analytical Classifications* document. Since the calculation for HDI changes each year, this resource is a historical record of which income group every country was in, in a given year between 1990 and 2021. Each country is separated into one of four income categories, which sometimes change from one year to the next:

Income Group 1 Low income (L)

Income Group 2 Lower middle income (LM)

Income Group 3 Upper middle income (UM)

Income Group 4 High income (H)

In our analysis, we will look at the impact of trade on development within each income group and make comparisons based on differences in our estimates.

HDI Components

The *United Nations Development Programme (UNDP)* is a valuable resource for all data concerning the Human Development Index. They possess data for the four components of HDI as well as the index itself, covering the years 1990 to 2021. The technical notes (UNDP, 2022) tell us how to combine the four component variables of HDI, to create the HDI variable. We will need this to create the non-income HDI variable.

Among the papers that we are citing in this thesis, the old HDI calculation (before 2010 - 2011) was used and HDI was only available in five-year increments at the time. We will use the mode up-to-date calculations for the entire data set. The following steps are up-to-date with the 2010 - 2011 changes in calculating HDI. There are four indicators that make up the Human Development Index:

Indicator 1 Life Expectancy at Birth

Indicator 2 Mean Years of Schooling

Indicator 3 Expected Years of Schooling

Indicator 4 Gross National Income at Purchasing Power Parity per Capita

They are joined together in the following way (UNDP, 2022):

$$\begin{aligned}
\text{LEI} &= (\text{LE} - 20)/(85 - 20) \\
\text{MYSI} &= (\text{MYS} - 0)/(15 - 0) \\
\text{EYSI} &= (\text{EYS} - 0)/(18 - 0) \\
\text{EI} &= (\text{MYSI} + \text{EYSI})/2 \\
\text{II} &= [ln(\text{GNI}_{\text{pc}}) - ln(100)]/[ln(75,000) - ln(100)]
\end{aligned}$$

giving the calculation for HDI:

$$\textbf{HDI} = \sqrt[3]{(\text{LEI x EI x II})}$$

where,

$$\begin{aligned}
\text{LE} &= \text{Life Expectancy at Birth} \\
\text{MYS} &= \text{Mean Years of Schooling} \\
\text{EYS} &= \text{Expected Years of Schooling} \\
\text{GNI}_{\text{pc}} &= \text{Gross National Income at Purchasing Power Parity per Capita} \\
\text{LEI} &= \text{Life Expectancy Index} \\
\text{MYSI} &= \text{Mean Years of Schooling Index} \\
\text{EYSI} &= \text{Expected Years of Schooling Index} \\
\text{EI} &= \text{Education Index} \\
\text{II} &= \text{Income Index} \\
\text{HDI} &= \text{Human Development Index}
\end{aligned}$$

This could be visualized as follows:

The underlying principles behind the Human Development Index

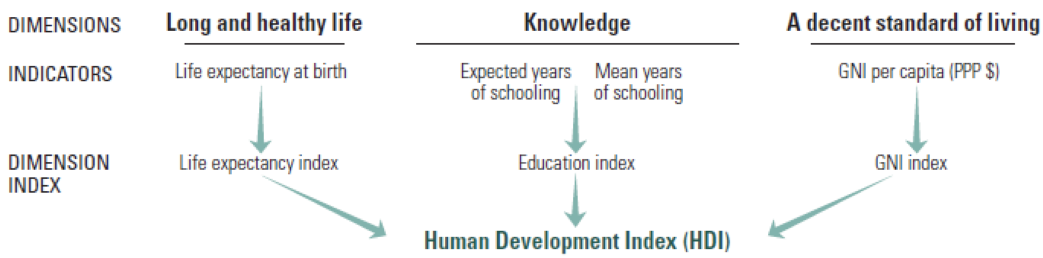


Figure 2.1: HDI Principles

An overview of the HDI growth rate rankings for the world can be seen in Fig. 2.2. Here a decade of data is averaged for each country, in order to ascertain how fast its development grew on average (percentage-wise), between 2010 and 2021 (Wikipedia, 2023):

Map of Countries by their Average HDI Growth Rates (2010-2021)

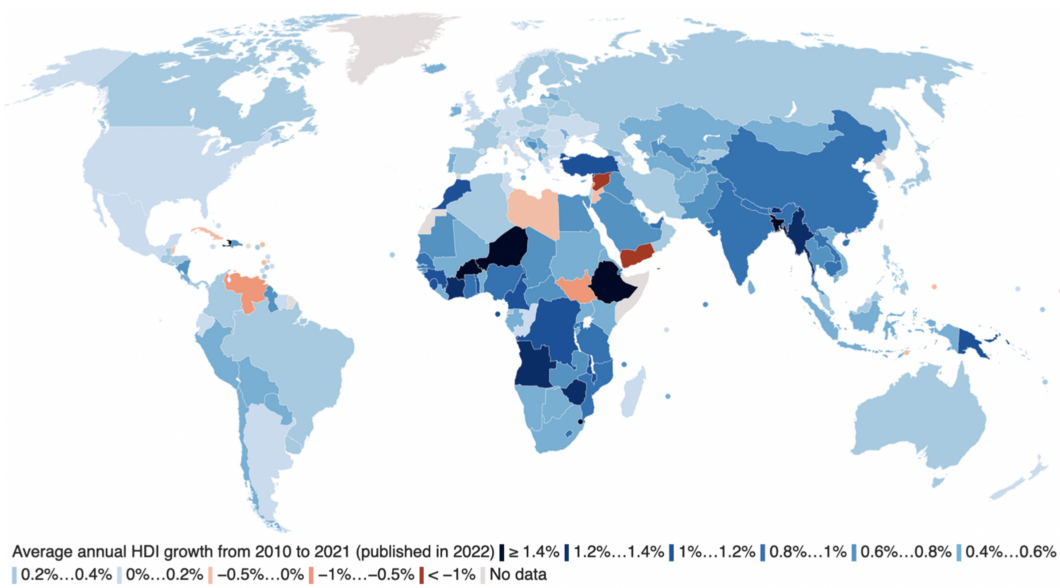


Figure 2.2: Average HDI Growth Rates of the World

Global increases in development were being witnessed in most countries, prior to the Covid pandemic.

2.1.1 Non-Income HDI

Davies and Quinlivan (2013)

In the analysis by Davies and Quinlivan (2006), a GDP index was used, rather than an income index. This was done in part to capture the broader effects of trade on social welfare, rather than only income. They altered the GDP component of HDI in their GMM model, so that rather than a third of HDI being assigned to growth, different measures of social welfare would be included.

$$\begin{aligned} HDI = &\left(\frac{1}{3}\right) \text{life expectancy index} + \left(\frac{2}{9}\right) \text{adult literacy index} \\ &+ \left(\frac{1}{9}\right) \text{gross educational enrollment index} + \left(\frac{1}{3}\right) \text{GDP index} \end{aligned} \tag{2.2}$$

Amin and Hamid (2013)

One of the other academic papers that we will be studying is Amin and Hamid (2013). The authors used a different approach to generate the non-income HDI variable, which can be seen in Listing 2.2.

$$\begin{aligned} \textbf{HDI*} &= \left(\frac{1}{3}\right)\left(\frac{log(y) - log(y_{min})}{log(y_{max}) - log(y_{min})}\right) \\ \text{where,} & \\ \text{y} &= \text{GNI per capita} \end{aligned}$$

This approach seems appropriate for our analysis. When we use this approach, our *R* code to create both forms of HDI appears as follows:

Listing 2.2: R Code to Create Non-Income HDI

```
y = data$GNIpc
LEI = (data$LE - 20)/(85 - 20)
MYSI = (data$MYS - 0)/(15 - 0)
EYSI = (data$EYS - 0)/(18 - 0)
EI = (MYSI + EYSI)/2
II = (log(y) - log(100))/(log(75000) - log(100))

# Non-Income HDI
num = (log(y) - log(min(y)))
den = (log(max(y)) - log(min(y)))
data$HDInoGNI = data$HDI - (1/3)*(num/den)
```

Now that we have our data set complete, we can begin analyzing the data in more detail.

Chapter 3

Exploratory Analysis

When we look at our data, we can ascertain several things in advance of our analysis.

3.1 Correlation Analysis

We look at correlations between trade, HDI,non-income HDI and HDI components. We conduct this analysis on the full data set, and then we split the data into *OECD* countries and non-*OECD* countries and re-run the analysis.

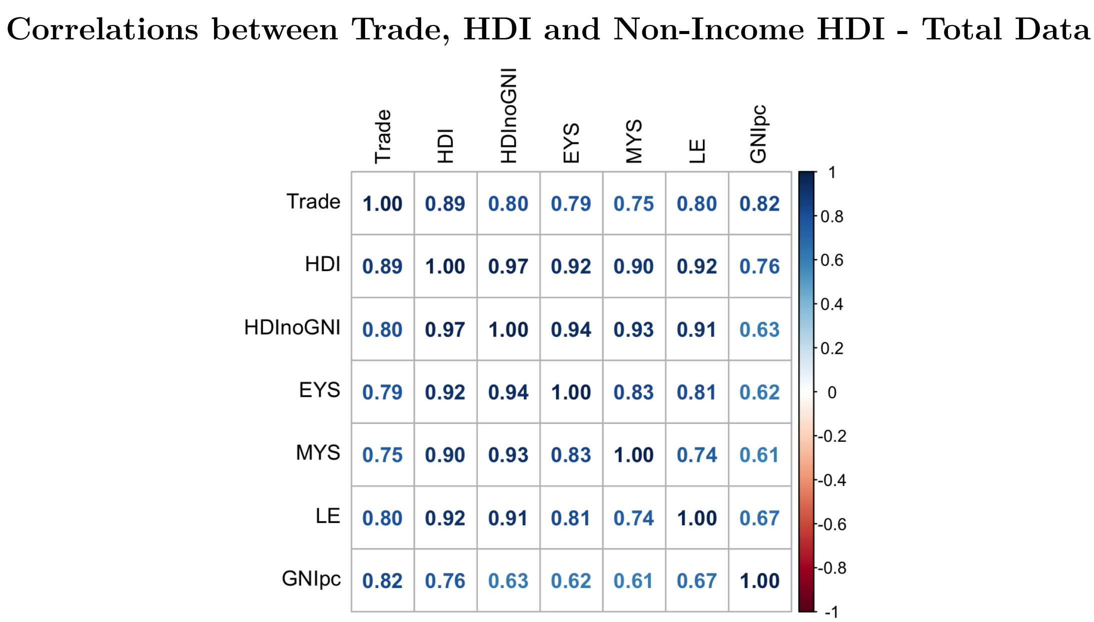
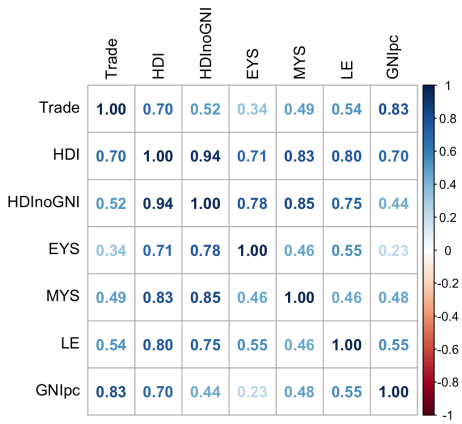


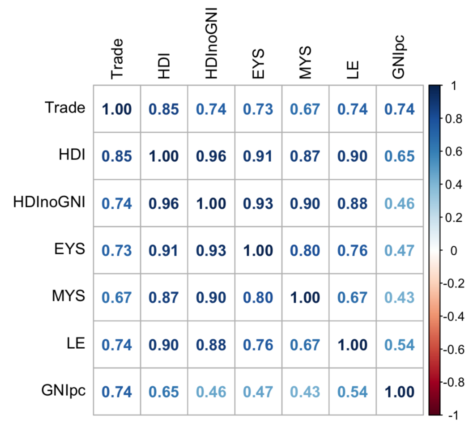
Figure 3.1: Correlation Matrix of Full Data

In Fig. 3.1, we can see that the correlation between trade and HDI is 0.89, but between trade and non-income HDI, it is only 0.80. This suggests that income is important to trade and removing it from our HDI might lower the impact that trade had on development.

Correlations between Trade, HDI and Non-Income HDI - OECD and Non-OECD



(a) OECD Countries



(b) Non-OECD Countries

Figure 3.2: Correlation Matrices Split by OECD Status

In Fig. 3.2, it appears that trade is more closely correlated with both forms of HDI in the Non-*OECD* countries than it is in the *OECD* countries. The correlation between trade and HDI is 0.70 among *OECD* countries, as contrasted with a correlation of 0.52 between trade and non-income HDI. This is quite a larger gap than the same comparison among non-*OECD* countries (0.85 and 0.74, respectively). This suggests that removing the income component from HDI, to assess the impacts of trade would have a much bigger negative effect among *OECD* countries.

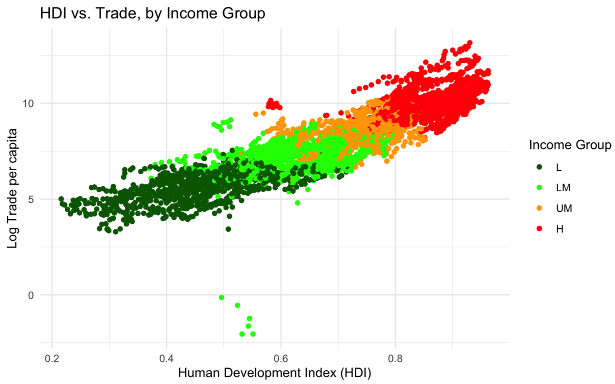
Interestingly, we notice that the correlation between trade and expected years of schooling, mean years of schooling, and life expectancy are all much higher in non-*OECD* countries than in *OECD* countries (0.73, 0.67, 0.74, instead of 0.34, 0.49, 0.54, respectively). This is quite a difference and would seem to indicate that the impact of trade on development in the non-*OECD* countries is less tied to income than it is among the *OECD* countries. The correlation between trade and income per capita is also only 0.74, rather than 0.83 in the *OECD* countries.

3.2 Plotting Analysis

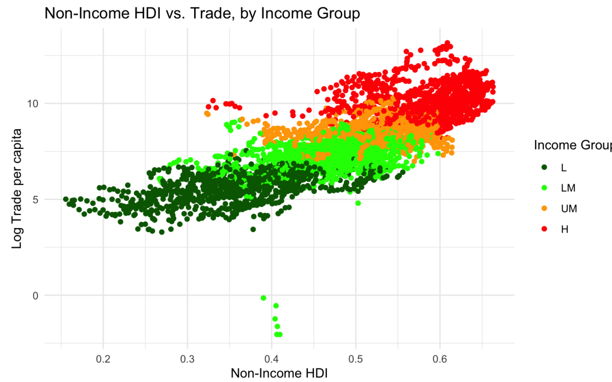
Full Data

In looking at plots of our panel data in Fig. 3.3, the relationship between HDI and logarithmic trade per capita appears positive. Both variables rise together and the higher income groups experience mutual increases in both trade and development.

Plots Comparing HDI and Non-Income HDI (Full Data)



(a) HDI and Trade



(b) Non-Income HDI and Trade

Figure 3.3: Plots Comparing Development and Trade - Full Data

When we compare Fig. 3.3a and Fig. 3.3b, we see that when income is removed from the HDI component, the x-axis reveals that development no longer reach as high as it does with normal HDI (roughly 0.6 instead of 0.8). The data points also appear to be more sparse and spread out, as though trade impacts life expectancy and education, but it does not do so in as concentrated of a fashion.

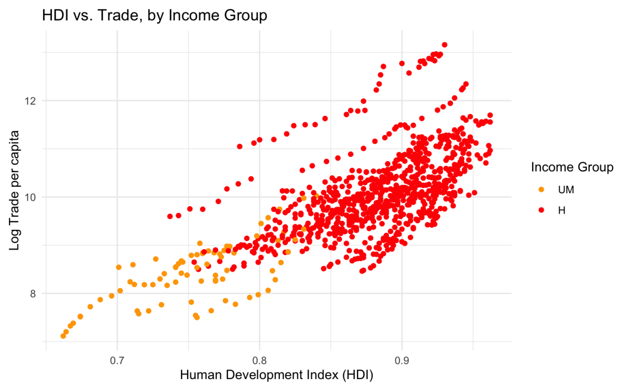
Splitting Data by OECD Membership

Some of the literature focuses on the differences between *OECD* and non-*OECD* countries. If we split up the countries in this way, we see that the *OECD* plots only contain the two highest income groups, since all *OECD* countries are in this subset.

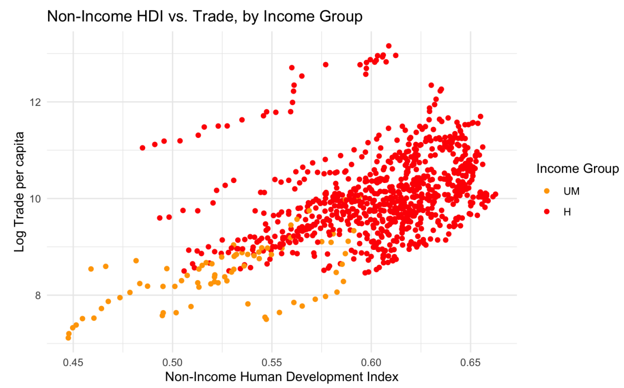
If we compare Fig. 3.4a to Fig. 3.4c, we see that on the x-axis, this plot reaches about 0.1 HDI higher than the non-*OECD* plot, reaffirming that the development of those countries is higher. If we make the same comparison using non-income HDI and trade, we compare plots 3.4b and Fig. 3.4d and find the same thing.

Non-income HDI plots appear to have more dispersed data, as though removing the income component would reveal the impact of trade to be weaker, with regard to development.

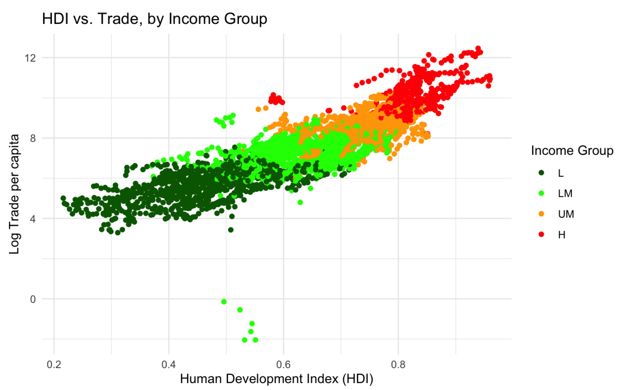
Plots of OECD vs. Non-OECD and splitting the data by HDI and Non-Income HDI



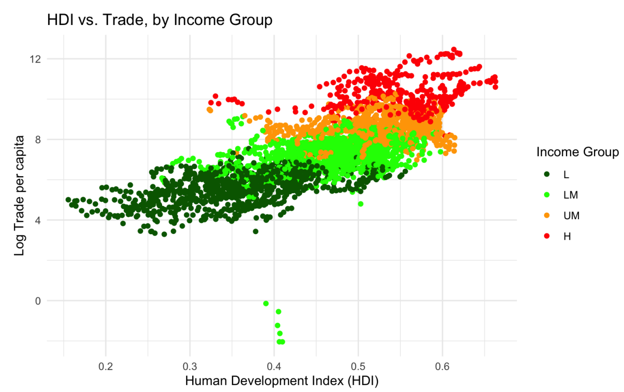
(a) OECD: HDI vs. Trade by Income Group



(b) OECD: Non-Income HDI vs. Trade by Income Group



(c) Non-OECD: HDI vs. Trade by Income Group



(d) Non-OECD: Non-Income HDI vs. Trade by Income Group

Figure 3.4: Plots based on OECD Status and HDI vs. Non-Income HDI

Chapter 4

Econometric Analysis

4.1 Replicating the Findings of Relevant Papers

There are several important papers, with findings that we will try to replicate with our own data. This will allow us to see if the results still hold today.

1. "A Panel Data Analysis of the Impact of Trade on Human Development" - Davies and Quinlivan (2006)
2. "The Impact of Trade on Social Development" - Gunduz et al. (2009)
3. "Trade and Human Development in OIC countries: A Panel Data Analysis" - Amin and Hamid (2013)

Paper 2. uses data from the *UNDP* while paper 3. uses data from the *Organisation of Islamic Cooperation (OIC)* . Prior to the 2010 - 2011 recalculation, the *UNDP* published five-year increments of HDI data from 1975 until 2005. The data in paper 2. covers the years 1980 - 2005, and paper 3. covers annual data from 2000 to 2009. Our own annual data covers the years 1990 - 2021. The original approach of paper 1. used a distributed lag model for both trade and HDI. A distributed lag function captures the time-dependent relationship of a variable over a certain time period. This shows us the dynamic effects that the variable has over time. Development does not happen overnight, it accumulates over time, and a country with high development must have had fairly high development over the last few years of its history as well. Certain policy changes are subject to a time lag in that the effects of the policy are not visible for several years. An immediate increase in development would not follow from the announcement of additional funding for education, sanitation, or access to international markets. People's expectations might change quickly, but improvements in HDI remain unaffected and cannot be detected until years later.

Manipulating Variables

Davies and Quinlivan (2006) decided to model the change in the growth of HDI instead of use HDI itself in their model. This allowed the authors to "model the growth rate of HDI as a distributed lag function of current and past changes in the country's per- capita trade, where [they] [defined] "trade" as the sum of exports and imports." The authors in all three papers either used one or two lags. These were named $HDI_{i,t-1}$ and $HDI_{i,t-2}$. The estimates for $HDI_{i,t-1}$ tended to be positive and the estimates for $HDI_{i,t-2}$ negative, indicating that lagged HDI only had a positive impact when the impacts of recent HDI were measured. We will attempt to replicate their results. We will run regressions with $HDI_{i,t}$, $HDI_{i,t-1}$ and $HDI_{i,t-2}$.

$$\begin{aligned} \Delta HDI_{i,t} &= HDI_{i,t} - HDI_{i,t-1} \\ \Delta HDI_{i,t-1} &= HDI_{i,t} - HDI_{i,t-2} \end{aligned} \tag{4.1}$$

In addition to lagged HDI predicting recent HDI, we will use logarithmic trade per capita to predict the change in HDI as well.

$$trade_{i,t} \quad = ln(\frac{Exports_{i,t} + Imports_{i,t}}{Population_{i,t}}) - ln(\frac{Exports_{i,t-1} + Imports_{i,t-1}}{Population_{i,t-1}}) \tag{4.2}$$

This should allow us to determine if trade and previous development is beneficial to current development. We will replicate two findings; first, whether trade is beneficial and to whom; second, whether the benefits of trade are only attributable to income.

4.2 Generalized Method of Moments

Many empirical research papers in economics make use of the GMM estimator. After several moment conditions are satisfied, the estimator minimizes the norm of the sample average, which makes it a special case of the minimum distance estimator (Greene, 2011). This replaces the expected value with the sample average:

$$\hat{m}(\theta) = \frac{1}{T}\sum_{t=1}^{T} g(Y_t, \theta) \tag{4.3}$$

The research papers that we will replicate all used the GMM estimator. They followed an approach in which the equation to estimate looked as follows:

$$HDI_{i,t} = \beta_0 + \beta_1 HDI_{i,t-1} + \beta_2 HDI_{i,t-2} + \beta_3 Trade + \alpha + \mu \tag{4.4}$$

where $i = 1, 2, ..., N$ and $t = 1, 2, ..., T$.

Then, the first differences of this equation were taken, and the result would be:

$$\Delta HDI_i = \beta_0 + \Delta HDI_{i,t-1}\beta_1 + \Delta HDI_{i,t-2}\beta_2 + \Delta Trade_i\beta_3 + \Delta u_i \tag{4.5}$$

where $\Delta HDI_i = (HDI_{i,t} - HDI_{i,t-1})$, $\Delta HDI_{i,t-j} = (HDI_{i,t-j} - HDI_{i,t-j-1})$, $\Delta Trade_i = (Trade_{i,t} - Trade_{i,t-1})$, and $\Delta ui = (u_{i,t} - u_{i,t-1})$.

This followed the work of Arellano and Bond (1991).

4.3 Goodness-of-Fit and Endogeneity Tests

Although we are convinced that the Arellano and Bond approach with difference GMM will work, we would like to run some basic tests on our data, ranging the full 32 years, in order to make sure that GMM is still a valid approach.

We plan to use lags of development as instruments in our model. According to Baum et al. (2002), if heteroskedasticity is present in the errors of our model, then GMM is preferable to regular instrumental variables (IV) estimation because it is more efficient. Since, the GMM estimator is more efficient than the IV estimator when heteroskedasticity is present, we will first verify if it is present by running several tests on a standard IV regression, covering the whole range of data.

Replication Details

For this paper, we will replicate two models from Gunduz et al. (2009), in which two lagged differences of HDI were added to the model. One was a five-year lagged difference and one was a ten-year lagged difference:

$$\begin{aligned} \Delta HDI_{i,t-1} &= HDI_{i,t} - HDI_{i,t-5} \\ \Delta HDI_{i,t-2} &= HDI_{i,t} - HDI_{i,t-10} \end{aligned} \tag{4.6}$$

We will also replicate two models from Amin and Hamid (2013), which will include one two-year lagged difference:

$$\Delta HDI_{i,t-1} = HDI_{i,t} - HDI_{i,t-2} \tag{4.7}$$

4.3.1 Lags of 5 and 10 Years

Normal HDI

For our replications of the paper by Gunduz et al., (2009) and for our own regressions, we will use the following model:

$$HDI_{i,t} = \beta_0 + \beta_1 HDI_{i,t-1} + \beta_2 HDI_{i,t-2} + \beta_3 Trade_{i,t} + \alpha_{i,t} + \mu_{i,t} \tag{4.8}$$

where $i = 1, 2, ..., N$ and $t = 1, 2, ..., T$.

Test	Test Stat	Deg. of Freedom	P-Value
Breusch-Pagan test	13542	2	$< 2 \times 10^{-16}$
Studentized Breusch-Pagan test	6.5	2	0.04
Shapiro-Wilk normality test (Residuals)	0.019	N/A	$< 2 \times 10^{-16}$

Table 4.1: Test Results: Normal HDI, Heteroskedasticity

When using normal HDI as a dependent variable, we find that the Breusch-Pagan statistic is 13542, there are two degrees of freedom and the p-value for our test is below 2×10^{-16}, which is about zero. The White test (studentized Breusch-Pagan test) has a test statistic of 6.5, two degrees of freedom and a p-value of 0.004. Since our confidence level is 0.05, the null hypothesis of homoskedasticity (constant variance in the errors) is rejected by both of these tests. These tests indicate that the null is likely wrong and that there is variance in our errors.

The Shapiro-Wilk test is used find out if the residuals of our model follow a normal distribution. With normal HDI, we find that the Shapiro-Wilk normality test residuals are 0.019 and the p-value is less than 2×10^{-16}. The Shapiro-Wilk test tells us that the residuals are not normally distributed.

With these tests, we have verified that heteroskedasticity is indeed present in our model and GMM is preferable to IV.

We also run a test for endogeneity of our instruments, in order to see if they are correlated with our regressors.

Test	**Test Stat**	**Deg. of Freedom**	**P-Value**	**Alt. Hypothesis**
Sargan Test	147	418	1	Overid. rest. not valid

Table 4.2: Test Results: Normal HDI, Endogeneity

The Sargan Test tells us that the instruments in our model are valid and do not exhibit issues related to overidentifying restrictions.

Non-Income HDI

With non-income HDI (HDI*), we use the model:

$$HDI^*_{i,t} = \beta_0 + \beta_1 HDI^*_{i,t-1} + \beta_2 HDI^*_{i,t-2} + \beta_3 Trade_{i,t} + \alpha_{i,t} + \mu_{i,t} \tag{4.9}$$

where $i = 1, 2, ..., N$ and $t = 1, 2, ..., T$.

Test	**Test Stat**	**Deg. of Freedom**	**P-Value**
Breusch-Pagan test	19720	2	$< 2 \times 10^{-16}$
Studentized Breusch-Pagan test	9.3	2	0.01
Shapiro-Wilk normality test (Residuals)	0.012	N/A	$< 2 \times 10^{-16}$

Table 4.3: Test Results: Non-Income HDI, Heteroskedasticity

When using non-income HDI as a dependent variable, we find that the Breusch-Pagan test has a p-value that is less than 2×10^{-16}. The White test has p-value of 0.01. Since our confidence level is 0.05, the null hypothesis of homoskedasticity (constant variance in the errors) is rejected by only one of these tests. The Breusch-Pagan test only tests for the linear form of heteroskedasticity, while the White test can detect a more general form of heteroskedasticity. We may in fact have homoskedasticity in our non-income HDI model. Perhaps the income component is responsible for this difference.

The Shapiro-Wilk test is used find out if the residuals of our model follow a normal distribution. With non-income HDI, we find that the Shapiro-Wilk normality test has a p-value below 2×10^{-16}. The Shapiro-Wilk test tells us that the residuals are not normally distributed.

Although the White test could not be rejected at a 0.05 significance level, it could have been rejected at a 0.01 level. The Shapiro-Wilk test validated the point that there is variance in our errors and GMM may be preferable to IV.

We also run a test for endogeneity of our instruments, in order to see if they are correlated with our regressors.

Test	Test Stat	Deg. of Freedom	P-Value	Alt. Hypothesis
Sargan Test	145	418	1	Overid. rest. not valid

Table 4.4: Test Results: Non-Income HDI, Endogeneity

The Sargan Test tells us that the instruments in our model are valid and do not exhibit issues related to overidentifying restrictions.

4.3.2 One Lag of 2 Years

These results mirror those of the previous model, although the regressors are somewhat different.

Normal HDI

For our replications of the paper by Amin and Hamid, 2013 we will use the following model:

$$HDI_{i,t} = \beta_0 + \beta_1 HDI_{i,t-1} + \beta_2 Trade_{i,t} + \alpha_{i,t} + \mu_{i,t} \tag{4.10}$$

where $i = 1, 2, ..., N$ and $t = 1, 2, ..., T$.

Test	Test Stat	Deg. of Freedom	P-Value
Breusch-Pagan test	13542	2	$< 2 \times 10^{-16}$
Studentized Breusch-Pagan test	6.5	2	0.04
Shapiro-Wilk normality test (Residuals)	0.019	N/A	$< 2 \times 10^{-16}$

Table 4.5: Test Results: Normal HDI, Heteroskedasticity

When using normal HDI as a dependent variable, we find that the Breusch-Pagan test p-value is less than 2×10^{-16}. The White test p-value is 0.004. Since our confidence level is 0.05, the null hypotheses of homoskedasticity (constant variance in the errors) are rejected by both of these tests and that there is variance in our errors.

The Shapiro-Wilk test is used find out if the residuals of our model follow a normal distribution. With normal HDI, we find that the Shapiro-Wilk normality test shows that: W = 0.026, p-value $<2 \times 10^{-16}$. The Shapiro-Wilk test tells us that the residuals are not normally distributed.

With these tests, we have verified that heteroskedasticity is indeed present in our model and GMM is preferable to IV.

We also run a test for endogeneity of our instruments, in order to see if they are correlated with our regressors.

Test	**Test Stat**	**Deg. of Freedom**	**P-Value**	**Alt. Hypothesis**
Sargan Test	155	463	1	Overid. rest. not valid

Table 4.6: Test Results: Normal HDI, Endogeneity

The Sargan Test tells us that the instruments in our model are valid and do not exhibit issues related to overidentifying restrictions.

Non-Income HDI

When switching to non-income HDI as a dependent variable, we find that:

$$HDI^*_{i,t} = \beta_0 + \beta_1 HDI^*_{i,t-1} + \beta_2 Trade_{i,t} + \alpha_{i,t} + \mu_{i,t} \tag{4.11}$$

where $i = 1, 2, ..., N$ and $t = 1, 2, ..., T$.

Test	**Test Stat**	**Deg. of Freedom**	**P-Value**
Breusch-Pagan test	19720	2	$< 2 \times 10^{-16}$
Studentized Breusch-Pagan test	9.3	2	0.01
Shapiro-Wilk normality test (Residuals)	0.012	N/A	$< 2 \times 10^{-16}$

Table 4.7: Test Results: Non-Income HDI, Heteroskedasticity

When using non-income HDI as a dependent variable, we find that the Breusch-Pagan statistic is: BP = 13542. There are two degrees of freedom and the p-value for our test is: p-value $<2 \times 10^{-16}$. The White test (studentized Breusch-Pagan test) has a statistic of BP = 6.5, two degrees of freedom and a p-value of 0.004. Since our confidence level is 0.05, the null hypotheses of homoskedasticity (constant variance in the errors) are rejected by both of these tests. These tests indicate that the null is likely wrong and that there is variance in our errors.

The Shapiro-Wilk test is used find out if the residuals of our model follow a normal distribution. With normal HDI, we find that the Shapiro-Wilk normality test shows that: W = 0.026, p-value $<2 \times 10^{-16}$. The Shapiro-Wilk test tells us that the residuals are not normally distributed.

With these tests, we have verified that heteroskedasticity is indeed present in our model and GMM is preferable to IV.

We also run one test for endogeneity of our instruments, in order to see if they are correlated with our regressors.

Test	**Test Stat**	**Deg. of Freedom**	**P-Value**	**Alt. Hypothesis**
Sargan Test	155	463	1	Overid. rest. not valid

Table 4.8: Test Results: Non-Income HDI, Endogeneity

The Sargan Test tells us that the instruments in our model are valid and do not exhibit issues related to overidentifying restrictions.

Conclusion

Based on these tests, we concluded that there is probably heteroskedasticity in our model and that GMM is preferable to an IV approach.

4.4 Stationarity and Statistical Tests

Before beginning our analysis, we wish to confirm that our data is stationary. A stationary process is a stochastic process which does not change over time. The mean and variance stay roughly the same and we see a straight line through the middle. If our key variables are already stationary, then we will not need to difference them by computing the differences between consecutive observations.

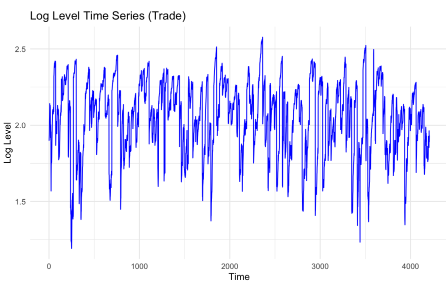
First, we plot the time series of several lagged trade and HDI variables, in order to see if there are any trends or visible patterns. The mean and variance should stay about the same over time. Then, we conduct two statistical tests, to verify further. We are interested in the following variables:

Table 4.9: Variables of Interest

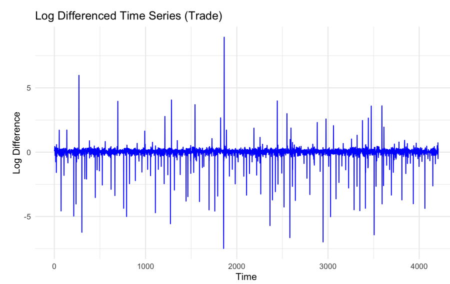
Variable	Description
$\Delta Trade_{i,t}$	Log Difference of Trade per Capita
$\Delta HDI_{i,t}$	Log Difference of HDI
$\Delta HDI_{i,t}$	Log Difference of Non-Income HDI

Visual Plots

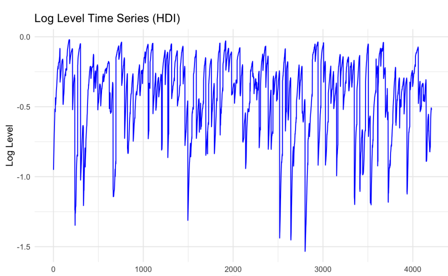
Log Level Time Series of Trade per Capita



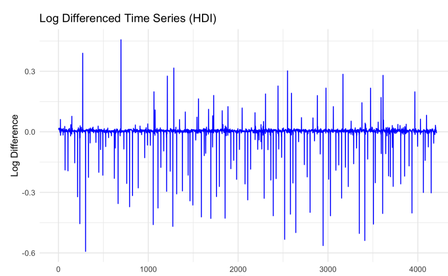
Log Differenced Time Series of Trade per Capita



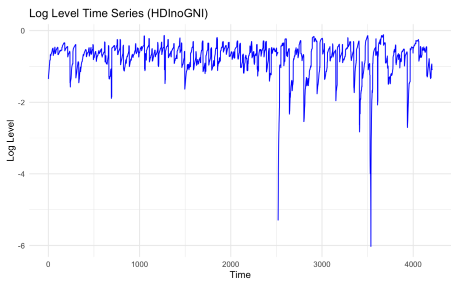
Log Level Time Series of HDI



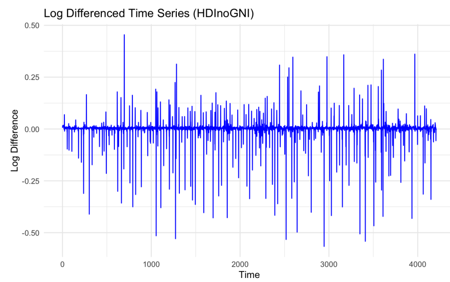
Log Differenced Time Series of HDI



Log Level Time Series of Non-Income HDI



Log Differenced Time Series of Non-Income HDI



From the visual plots of the log levels and log differences, it appears that all three of our relevant variables are stationary.

ADF Test

The Augmented Dickey-Fuller Test evaluates the null-hypothesis that our variable has a unit root. This would mean that it is not stationary and must be differenced. The lag order indicates the number of lagged differences which are included in the test. These lag orders represent the number of time periods that are used to account for auto correlation in our data. If the p-value is less than our chosen significance level (0.05), we can reject the null hypothesis and conclude that the data is stationary.

Table 4.10: ADF Test Results

Variable	ADF Test Stat.	Lag Order	p-Value	Null
$\Delta Trade_{i,t}$	-19	16	0.01	Rejected
$\Delta HDI_{i,t}$	-18	16	0.01	Rejected
$\Delta HDInoGNI_{i,t}$	-19	16	0.01	Rejected

KPSS Test

The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test evaluates the null hypothesis that the data is stationary. If the p-value is less than our chosen significance level (0.05), we can reject the null hypothesis and conclude that the data is stationary.

Table 4.11: KPSS Test Results

Variable	KPSS Level	Trunc. Lag Param.	p-Value	Null
$\Delta Trade_i$	0.0037	10	0.1	Fail to Reject
$\Delta HDI_{i,t-1}$	0.0079	10	0.1	Fail to Reject
$\Delta HDI_{i,t-2}$	0.0074	10	0.1	Fail to Reject

Interpretation of Results

Our visual graphs seem to indicate that our variables would be stationary after differencing them, which is good to verify before any GMM analysis.

From our ADF tests, the null hypothesis states that the data are non-stationary and have a unit root. From the test results, we compare the tests' p-values with the critical values for the 0.05 significance level and conclude that the null hypothesis can be rejected in all three cases, and that our variables will likely be stationary after differencing them.

From the KPSS test results, our p-values are 0.1 which is greater than the chosen significance level of 0.05. Therefore, we do not have enough evidence to reject the null hypothesis (of stationarity). This means that the data probably are stationary at a certain level.

Before, beginning our analysis, we can safely conclude that our relevant variables of importance will likely be stationary after they are differenced and that it is safe to use them in a GMM analysis.

Chapter 5

Replication of GMM Analysis 1: Difference GMM

We begin our analysis using the Arellano and Bond (1991) approach to GMM estimation, in which variables are regressed on their differences.

Table 5.1: Variable Statistics

	Mean	St. Dev.	Min	Max
HDI	0.634	0.148	0.216	0.970
HDInoGNI	0.462	0.093	0.155	0.674
EYS	11.440	2.979	2.060	19.590
MYS	7.025	3.023	0.559	13.770
LE	67.440	8.691	37.100	83.780
GNIpc	12,547	15,745	416	103,519
Population	44,021,036	170,043,588	33,745	1,412,360,000
Exports	39,508,748,075	169,518,271,986	693,281	3,554,107,681,623
Imports	36,220,120,053	150,686,544,565	1,849,551	3,093,278,310,795
Trade	7.478	1.667	−2.046	12.460

5.1 Finding 1: trade has positive effects on HDI for all income categories

For this first finding, we will analyze two tables from two of the three aforementioned papers. We will then replicate those findings and compare our own estimations. In the regressions where we replicated finding 1, the income component of HDI was included in the calculation. In regressions where we replicated finding 2, the income component was excluded.

Both papers use lagged HDI as instruments in their models. In the paper by Gunduz et al.

(2009), $HDI_{i,t-1}$ and $HDI_{i,t-2}$ refer to the previous five- and ten-year lagged differences, respectively, while the paper by Amin and Hamid (2013) only uses one, two-year lagged difference, called $HDI_{i,t-1}$.

5.1.1 Normal HDI

Gunduz, Hisarciklilar and Kaya (2009)

The first GMM regression model by Gunduz et al. (2009) showed that trade did positively impact development for all but the lowest income group. The authors claimed that this was evidence that "although middle or high income countries [could] benefit from trade, [trade did not] improve the human development in low income countries." Lagged HDI showed positive estimates for all income groups except the non-*OECD* high income group. This tells us that lagged development says a lot more about a nations development than trade, although both are beneficial.

When we analyze the estimates of $HDI_{i,t-2}$, we find that they are negative but statistically significant for all income groups. This seems to show that the effects of increases in HDI take years to be observed, but it is an accumulating process. The results displayed in Table 3 of their paper are illustrated in Fig. 5.2.

Note that high income *OECD* is the only *OECD* column and all the others refer to non-*OECD* data.The upper middle income *OECD* subset only contains about one tenth of the data that high income *OECD* contains. In our modeling, we have never found any statistically significant estimates concerning this subset, which is why we omit it from our model, although we do include its data as part of the overall *OECD* data. Here, the authors also omitted that column, possibly for the same reason.

Table 5.2: Gunduz et al. (2009) - Table 3 - Est. Results for Model 1

	H.I. OECD	H.I.	U.M.	L.M.	L.
$\Delta Trade_i$	0.017*** (0.004)	0.009* (0.005)	0.028*** (0.008)	0.014** (0.007)	-0.002 (0.007)
$\Delta HDI_{i,t-1}$	0.846*** (0.133)	0.015 (0.179)	0.885*** (0.227)	1.254*** (0.174)	1.082*** (0.156)
$\Delta HDI_{i,t-2}$	-0.260** (0.113)	0.505*** (0.154)	-0.453*** (0.146)	-0.455*** (0.109)	-0.422*** (0.142)
Constant	0.003* (0.002)	0.007*** (0.002)	0.004 (0.004)	0.002 (0.004)	0.006** (0.002)

We attempted to replicate this GMM regression. Their data ranged from 1975 to 2005, while our data from the *UNDP* stretches from 1990 to 2021. We have an unbalanced panel, in which not all countries have observations for the same number of time periods. This is because some countries have missing values for several years, while documenting observations for other years.

First, we run our difference GMM regression on the entire data set without separating our data into income groups. This will allow us to extract key statistical tests, which we will use to evaluate the choice of the model. We also run our model on *OECD* and non-*OECD* separately, in order to see the difference, but the tests only refer to the full data.

We find that trade and lagged development significantly impact present development in both the *OECD* and non-*OECD*, as it does in the overall data.

Table 5.3: Regression Results: Normal HDI, Difference GMM

	Dependent variable:		
	HDI		
	Full Data	Non-OECD	OECD
	(1)	(2)	(3)
Trade	0.019***	0.022***	0.011***
	(0.002)	(0.002)	(0.003)
lag(HDI, 5)	0.501***	0.522***	0.442***
	(0.067)	(0.075)	(0.066)
lag(HDI, 10)	0.096*	0.086	0.130***
	(0.057)	(0.066)	(0.048)
Observations	155	130	33
Note:			*p<0.1; **p<0.05; ***p<0.01

Our statistical tests tell us more about the overall model. The Sargan test is used to test the validity of instruments in our regression. The test statistic is a chi-squared distribution with 418 degrees of freedom. The high p-value of 1 in the Sargan test tells us that we fail to reject the null hypothesis of valid instruments which are uncorrelated with the error term. Therefore, the instruments in our model, which are lags of HDI, are valid and we are not experiencing endogeneity issues.

Autocorrelation test (1) is based on the null hypothesis that there is no serial correlation (autocorrelation) in the residuals of our model. If our p-values is below 0.05, which it is not, then we may have some serial correlation in our model. Autocorrelation test (2), does not detect any serial correlation either. We fail to reject the null hypothesis of in both tests. Since we do not reject the null of no autocorrelation, in both tests, we fail to confirm that there is autocorrelation, presumably because we have no such autocorrelation in our data.

We use the Wald test to test the joint significance of multiple coefficients in our model.

The p-value is about zero, indicating that at least one of the estimates in our model is statistically significant.

These tests suggest that our model is acceptable and that we should not need to worry about endogeneity of our instruments.

Test	Statistic	p-value
Sargan test	$\chi^2(418)$	146.8 ($p = 1$)
Autocorrelation test (1)	normal	0.7104 ($p = 0.477$)
Autocorrelation test (2)	normal	1.145 ($p = 0.252$)
Wald test for coefficients	$\chi^2(3)$	2248 ($p < 2 \times 10^{-16}$)

Table 5.4: Test Results

In our findings in Table 5.5, we see that estimates for the effect of logarithmic, trade per capita on recent development are positive and significant for all income groups. $HDI_{i,t-1}$ also positively impacts development for all income groups, which seems to validate the point that development is an accumulating process. Unlike the previous model, $HDI_{i,t-2}$ only has significant negative estimates for the lower middle income countries.

Our first model in Table 5.5 utilizes regular HDI and shows that the impact of trade on HDI is significant for all but one income group. This is roughly consistent with the academic literature on this topic. Lagged development is also an important variable in contributing to future development. Lagged development has a stronger impact among lower income groups, which validates the point that development is a accumulating process. This validates finding 1 from the academic literature.

Table 5.5: Regression Results: Normal HDI, Difference GMM

	Dependent variable:				
	HDI				
	L	LM	UM	H	H (OECD)
	(1)	(2)	(3)	(4)	(5)
Trade	0.030***	0.031***	0.009***	0.006	0.011***
	(0.006)	(0.006)	(0.003)	(0.007)	(0.003)
lag(HDI, 5)	0.843***	0.610***	0.551***	0.456	0.442***
	(0.164)	(0.104)	(0.091)	(0.347)	(0.066)
lag(HDI, 10)	−0.312	−0.125	0.147	0.276	0.130***
	(0.198)	(0.142)	(0.101)	(0.368)	(0.048)
Observations	54	89	67	27	33
Note:			*p<0.1; **p<0.05; ***p<0.01		

Unlike Gunduz et al. (2009), it appears that from our data, the lowest income group actually sees the strongest impact of trade on HDI. This effect seems to weaken as one climbs to higher income groups.

Amin and Hamid (2013)

This next paper also followed the work of Davies and Quinlivan (2006) and Gunduz et al. (2009). In their model, which followed a similar GMM approach to the last one, the authors found that the change in logarithmic trade per capita also produced positive, statistically-significant estimates for all income groups. The authors also found that $HDI_{i,t-1}$ had positive estimates, but that they were only significant for the lowest income group. In their paper, $HDI_{i,t-1}$ was a lagged difference of only two years, instead of five years, which could be partially responsible for the difference in outcomes.

Table 5.6: Amin and Hamid (2013) - Table 2 - Model 1

	High Income OIC	Middle Income OIC	Low Income OIC
$\Delta Trade_i$	0.0159*	0.0319**	0.0284*
	(1.7309)	(1.3116)	(1.8267)
$\Delta HDI_{i,t-1}$	0.1242	0.6562	0.8425*
	(0.3471)	(1.9865)	(1.7074)
Constant	0.0017	-0.0018	-0.0030
	(0.2713)	(-0.7269)	(-0.6769)
J-Statistic	3.25E-28	1.04E-27	4.79E-27

When we attempted to replicate this estimation, our own study showed significant estimates for trade in two out of three income groups Table 5.7.

In our own data, we subset the countries based on those listed by the authors. We also subset our time frame to the years 2000 - 2009, as they did. Among high income countries, five of six countries had data available. Among middle income countries, data was available for 14 of 20 countries. Among low income countries, data was available for 10 of 12 countries. In our regression output (Table 5.7), we see significant estimates for the middle income countries only. Since numerous countries are missing in our data, it could be that data limitations are responsible for the differences in outcome.

Table 5.7: Regression Results: Normal HDI, Difference GMM

	Dependent variable:		
		HDI	
	Low	Middle	High
	(1)	(2)	(3)
Trade	0.002	0.009***	0.007
	(0.002)	(0.003)	(0.005)
lag(HDI, 2)	0.891***	0.729***	0.626*
	(0.038)	(0.085)	(0.332)
Observations	10	14	5
Note:	*p<0.1; **p<0.05; ***p<0.01		

Lagged development also showed a strong effect on current development, which verifies the observation that future development of a country largely depends on its past state of development.

5.2 Finding 2: trade no longer positively affects human development when the income component is excluded

This finding is harder to establish and requires the removal of the income component from the HDI calculation, which creates an altered HDI variable, called HDI* in the literature or HDInoGNI in this thesis. Originally, Davies and Quinlivan (2006) took on the task of clarifying whether trade could be beneficial to social welfare and not only to income. Previously, authors had claimed that there was more to trade than just income, as though trade were able to degrade the quality of life somehow while increasing income simultaneously.

5.2.1 Non-Income HDI

Gunduz, Hisarciklilar and Kaya (2009)

Gunduz et al. (2009) followed the work of the previous authors. They did this in order to see if the impact of trade on development remained the same when income was removed from the HDI calculation. They concluded that trade had a significant, positive effect in all income groups except the two lowest groups. This led them to conclude that poorer countries did not benefit from trade and that a country would need to reach a certain level of income first, before such benefits could be realized.

Table 5.8: Gunduz et al. (2009) - Table 4 - Est. Results for Model 2

	High OECD	High	UM	LM	Low
$\Delta Trade_i$	0.012**	0.014*	0.042**	0.009	0.014
	(0.006)	(0.008)	(0.018)	(0.01)	(0.014)
$\Delta HDI_{i,t-1}$	0.641***	0.370**	0.756**	0.988***	1.149***
	(0.147)	(0.171)	(0.137)	(0.119)	(0.175)
$\Delta HDI_{i,t-2}$	0.356***	0.322**	-0.739**	-0.362**	-0.653***
	(0.105)	(0.148)	(0.31)	(0.136)	(0.173)
Constant	0.009***	0.002	0.01	0.009**	0.016***
	(0.003)	(0.003)	(0.006)	(0.004)	(0.003)

When we remove income from HDI, we still find significant estimates for all data, *OECD* countries and non-*OECD* countries.

Table 5.9: Regression Results: Non-Income HDI, Difference GMM

	Dependent variable:		
	HDInoGNI		
	Full Data	Non-OECD	OECD
	(1)	(2)	(3)
Trade	0.010***	0.011***	0.009***
	(0.002)	(0.002)	(0.003)
lag(HDInoGNI, 5)	0.554***	0.574***	0.517***
	(0.078)	(0.086)	(0.080)
lag(HDInoGNI, 10)	0.093	0.081	0.091
	(0.071)	(0.079)	(0.077)
Observations	155	130	33
Note:			*p<0.1; **p<0.05; ***p<0.01

The Sargan test implies that our instruments are valid. Only the first autocorrelation test suggests that there is no serial correlation. The second one does not. The Wald test confirms that at least one regressor had a significant impact on HDI. We will still stick with this model but will use clustered standard errors so that our standard errors are robust to any sort of heteroskedasticity or serial correlation.

Test	Statistic	p-value
Sargan test	$\chi^2(418)$	145.2 ($p = 1$)
Autocorrelation test (1)	normal	0.4081 ($p = 0.683$)
Autocorrelation test (2)	normal	2.427 ($p = 0.0152$)
Wald test for coefficients	$\chi^2(3)$	1742 ($p < 2 \times 10^{-16}$)

Table 5.10: Test Results: Non-Income HDI, Difference GMM

When we remove the income component from HDI, our estimates in the *OECD* and in the poorer non-*OECD* remain significant (Table 5.11), which partially validates finding 2. However, some of the academic literature on this topic seems to be contradicted. Gunduz et al. (2009) found that the poorer income groups saw no significant impact from trade, while we are finding the reverse.

Table 5.11: Regression Results: Non-Income HDI, Difference GMM

	Dependent variable:				
	HDI				
	L	LM	UM	H	H (OECD)
	(1)	(2)	(3)	(4)	(5)
Trade	0.015***	0.020***	−0.002	−0.006	0.009***
	(0.003)	(0.006)	(0.003)	(0.005)	(0.003)
lag(HDInoGNI, 5)	0.934***	0.418***	0.577***	0.511*	0.517***
	(0.166)	(0.086)	(0.147)	(0.303)	(0.080)
lag(HDInoGNI, 10)	−0.300*	0.027	0.112	0.312	0.091
	(0.167)	(0.162)	(0.175)	(0.212)	(0.077)
Observations	54	89	67	27	33
Note:			*p<0.1; **p<0.05; ***p<0.01		

Amin and Hamid (2013)

Amin and Hamid (2013) also carried out such an analysis and concluded that estimates of trade were significant across all income groups. Lagged development only affected development at the lowest income level, from which the authors concluded that for "middle and high income *OIC* countries, the level of development [had] reached a level where the growth in human development over the period [had] become small, rendering it insignificant."

Amin and Hamid(2013) also conducted a study, in which they removed the income component from HDI. In their calculation, they defined HDI* in the following way:

$$\begin{aligned} HDI* &= HDI - \left(\frac{1}{3}\right)\left(\frac{log(y) - log(min(y))}{log(max(y)) - log(min(y))}\right) \\ y &= GNIpc \end{aligned} \tag{5.1}$$

In their analysis, the authors concluded that trade did not have a significant impact on development in any income level, which they claimed was identical to Gunduz et al. (2009) and meant that when the income component was excluded, trade no longer had beneficial effects towards the development of a country.

Table 5.12: Amin and Hamid (2013) - Table 2 - Model 2

	High Income OIC	Middle Income OIC	Low Income OIC
$\Delta Trade_i$	0.0157	0.0169	0.0057
	(0.9194)	(0.9875)	(1.3515)
$\Delta HDI_{i,t-1}$	0.2599	0.4264	0.7565***
	(0.4349)	(1.2736)	(4.4329)
Constant	0.0004	0.0004	-2.31E-05
	(0.3776)	(0.3894)	(-0.0308)
J-Statistic	4.21E-30	2.60E-27	1.81E-27

We used the same calculation as Amin and Hamid(2013) to remove the income component from HDI for our own analysis.

Our results show that the impact of trade on HDI were insignificant for two of three income groups, which is identical to our normal HDI regression. This could be due to data limitations.

Table 5.13: Regression Results: Non-Income HDI, Difference GMM

	Dependent variable:		
	HDInoGNI		
	Low	Middle	High
	(1)	(2)	(3)
Trade	-0.002	0.009***	0.0002
	(0.002)	(0.003)	(0.003)
lag(HDInoGNI, 2)	1.010***	0.654***	0.728
	(0.045)	(0.110)	(0.600)
Observations	10	14	5
Note:	*p<0.1; **p<0.05; ***p<0.01		

Chapter 6

Replication of GMM Analysis 2: System GMM

After replicating these results, we re-run the two Gunduz et al. (2009) models with all of our data. This consists of 155 countries and 32 years of data (1990 to 2021). We switch to the Arellano and Bover (1995) approach, in which system GMM is used, employing both levels and differences in our estimations.

6.1 Finding 1: trade has positive effects on HDI for all income categories

When we run a system GMM regression on all of our data, we find significant estimates for trade and lagged HDI. We find stronger marginal effects in non-*OECD* countries than *OECD* countries.

6.1.1 Normal HDI

Table 6.1: Regression Results: Full Data, Normal HDI, System GMM

	Dependent variable:		
	HDI		
	Full Data	Non-OECD	OECD
	(1)	(2)	(3)
Trade	0.028^{***}	0.029^{***}	0.009^{**}
	(0.002)	(0.002)	(0.004)
lag(HDI, 5)	0.731^{***}	0.661^{***}	1.468^{***}
	(0.126)	(0.127)	(0.137)
lag(HDI, 10)	-0.043	0.025	-0.565^{***}
	(0.119)	(0.124)	(0.115)
Observations	155	130	33
Note:			*p<0.1; **p<0.05; ***p<0.01

Our statistical tests seem to indicate that our model is appropriate.

Test	Statistic	p-value
Sargan test	$\chi^2(460)$	116.8 ($p = 1$)
Autocorrelation test (1)	normal	0.5673 ($p = 0.571$)
Autocorrelation test (2)	normal	0.4434 ($p = 0.657$)
Wald test for coefficients	$\chi^2(3)$	53066 ($p < 2 \times 10^{-16}$)

Table 6.2: Test Result: Full Data, Normal HDI, System GMM

We find significant effects of trade on HDI in all but one income group. The high income non-*OECD* countries appear to have experienced a stronger impact than the *OECD* countries in their high income group. It seems as though those non-*OECD* benefit more from trade. Poorer regions in general appear to benefit more.

Table 6.3: Regression Results: Normal HDI, System GMM

	Dependent variable:				
	HDI				
	L	LM	UM	H	H (OECD)
	(1)	(2)	(3)	(4)	(5)
Trade	0.032***	0.022***	0.011	0.017**	0.009**
	(0.005)	(0.004)	(0.007)	(0.007)	(0.004)
lag(HDI, 5)	0.834***	0.686***	0.806***	0.847***	1.468***
	(0.133)	(0.193)	(0.142)	(0.268)	(0.137)
lag(HDI, 10)	−0.210	0.095	0.095	−0.033	−0.565***
	(0.152)	(0.236)	(0.157)	(0.268)	(0.115)
Observations	54	89	67	27	33
Note:			*p<0.1; **p<0.05; ***p<0.01		

6.2 Finding 2: trade no longer positively affects human development when the income component is excluded

6.2.1 Non-Income HDI

Table 6.4: Regression Results: Full Data, Non-Income HDI, System GMM

	Dependent variable:		
	HDInoGNI		
	Full Data	Non-OECD	OECD
	(1)	(2)	(3)
Trade	0.016***	0.017***	0.010***
	(0.002)	(0.002)	(0.003)
lag(HDInoGNI, 5)	0.806***	0.736***	1.389***
	(0.169)	(0.175)	(0.169)
lag(HDInoGNI, 10)	−0.050	0.022	−0.549***
	(0.164)	(0.170)	(0.139)
Observations	155	130	33
Note:			*p<0.1; **p<0.05; ***p<0.01

The model with all data shows the test results in Table 6.5. We will still stick with this model but will use clustered standard errors so that our standard errors are robust to any sort of heteroskedasticity or serial correlation.

Test	Statistic	p-value
Sargan test	$\chi^2(460)$	110.9 ($p = 1$)
Autocorrelation test (1)	normal	0.2161 ($p = 0.829$)
Autocorrelation test (2)	normal	1.884 ($p = 0.0596$)
Wald test for coefficients	$\chi^2(3)$	44289 ($p < 2 \times 10^{-16}$)

Table 6.5: Test Results: Full Data, Non-Income HDI, System GMM

Our regression results display significant estimates for every income group. We are using system GMM now, which is sometimes thought of as more precise. Finding 1 about trade and development is clearly true. Finding 2 appears valid, to the extent that one recognizes that there is still a positive impact with non-income HDI. Now, however, the high income *OECD* countries are doing better than the non-*OECD* countries, which is the reverse of when we used normal HDI (Table 6.5).

Table 6.6: Regression Results: Non-Income HDI, System GMM

	Dependent variable:				
	HDI				
	L	LM	UM	H	H (OECD)
	(1)	(2)	(3)	(4)	(5)
Trade	0.025^{***}	0.018^{***}	0.009^{**}	0.008^{*}	0.010^{***}
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
lag(HDInoGNI, 5)	0.810^{***}	0.831^{***}	0.724^{***}	0.895^{***}	1.389^{***}
	(0.189)	(0.299)	(0.184)	(0.167)	(0.169)
lag(HDInoGNI, 10)	−0.179	−0.087	0.152	−0.010	-0.549^{***}
	(0.213)	(0.360)	(0.173)	(0.202)	(0.139)
Observations	54	89	67	27	33
Note:			*p<0.1; **p<0.05; ***p<0.01		

6.3 Conclusion

Gunduz et al. (2009) mentioned that the poorest income group did not benefit from trade by an increase in HDI with normal HDI, and that the two poorest income groups did not benefit when income was removed from HDI. The authors concluded this by analyzing the significance levels of their estimates. When we replicated the author's findings with all of our available data (covering different time periods), we could not verify this conclusion.

Instead, it does appear that the poorest countries were the ones who benefited from trade the most. In our difference GMM model, we found that all but the high income non-*OECD* countries experienced significant effects of trade on development.

When non-income HDI was used, we found the same thing, except that both upper middle income and high income non-*OECD* countries had insignificant estimates. For the remaining estimates, the marginal effects were greatly diminished, telling us us that trade is indeed largely bound, but not exclusively bound, to income. However, this is not an exclusive relationship and the education and life expectancy variables do feel an increase in a country's development, when trade increases.

When we switched to system GMM, we noticed that high income non-*OECD* countries did experience a significant estimate, although that of upper income non-*OECD* countries had become insignificant. When non-income HDI was used, we saw significant estimates for all income groups, as it pertained to trade and five-year lagged development.

Chapter 7

Forecasts

Western economies appear to be entering ongoing economic downturn and we would like to conduct several forecasts of HDI to gauge how recent years will affect future development. We will look at seven data sets:

1. All data for all income groups
2. Non-OECD data for Low Income countries
3. Non-OECD data for Lower Middle Income countries
4. Non-OECD data for Upper Middle Income countries
5. Non-OECD data for High Income countries
6. OECD data for Upper Middle Income countries
7. OECD data for High Income countries

Our data for this project consisted of 155 countries and 32 years of data (1990 to 2021). The time series of HDI for the seven data sets are as follows:

7.1 Time Series Plots of HDI

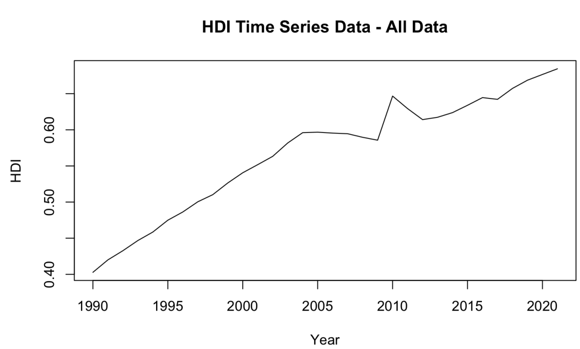
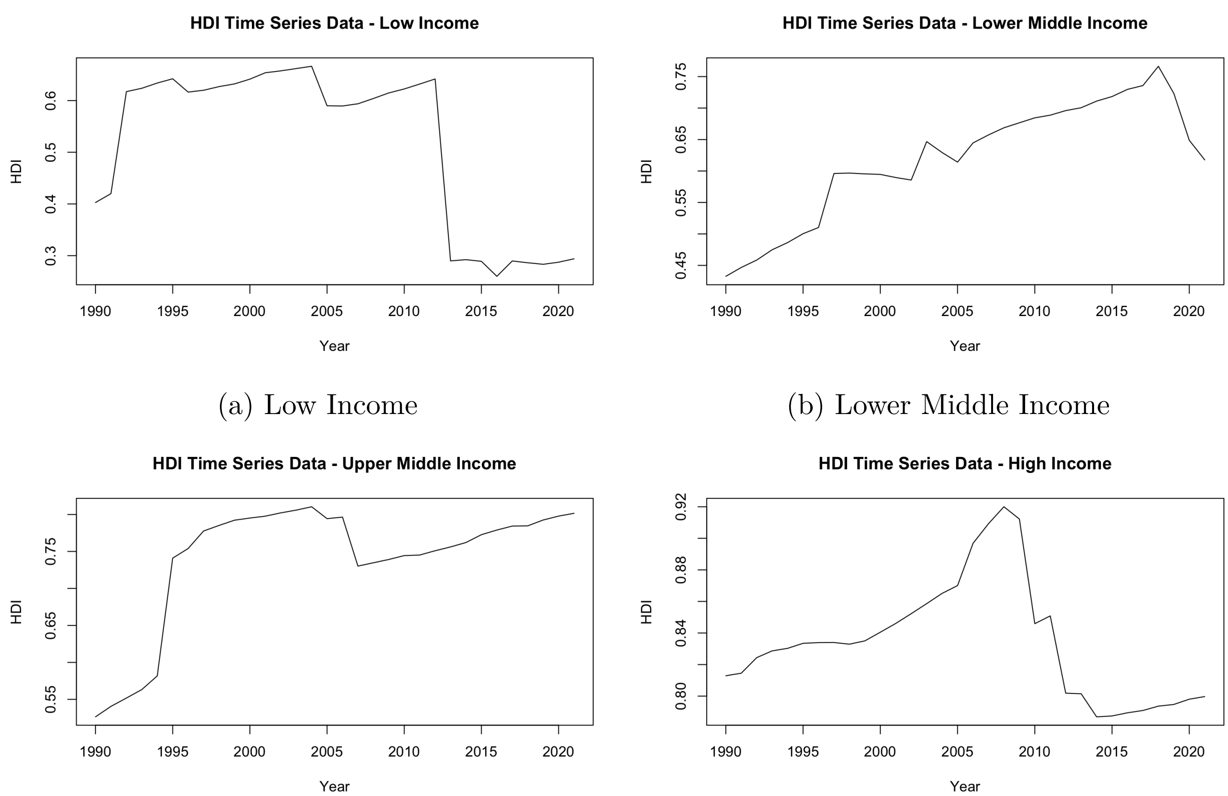


Figure 7.1: Forecast of all data for all income groups

In our overall data Fig. 7.1, HDI seems as though it was increasing around the world over the last 30 years. The 2008 recession did cause a drop, but HDI recovered afterwards. However, the current global crises appear to be more severe.

Time Series of HDI for Non-OECD Countries



(a) Low Income

(b) Lower Middle Income

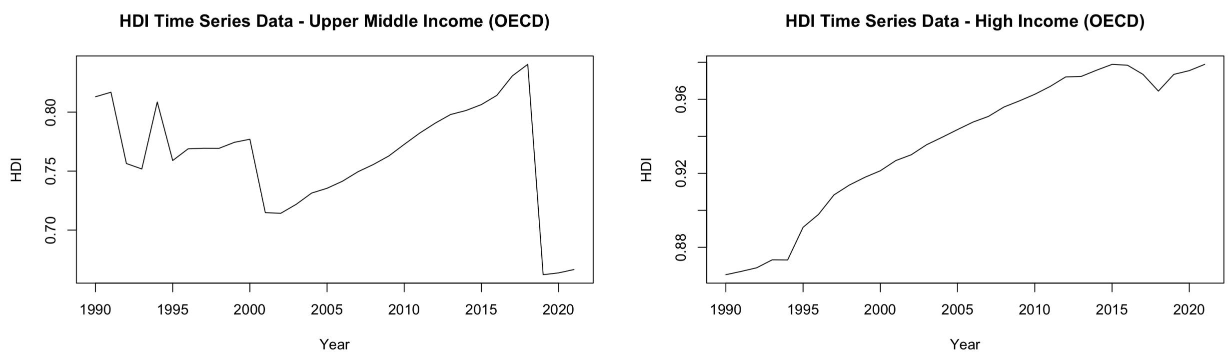
(c) Upper Middle Income

(d) High Income

Figure 7.2: Forecasts of HDI of Non-OECD Countries, by Income Group

Low and high income countries in the non-*OECD* seem to have had a strong, negative impact from the 2008 recession Fig. 7.2a and Fig. 7.2d, although the two middle-income regions were not significantly impacted Fig. 7.2b and Fig. 7.2c. From the graphs, it appears that both high and low income groups did not recover from this drop. The high income group did recover slightly, but it took several years to do. Their drop in HDI was from about 0.92 to 0.8. The drop that the lowest income group faced was from about 0.6 to 0.3, which was much more severe.

Time Series of HDI for OECD Countries



(a) Upper Middle Income (b) High Income

Figure 7.3: Forecasts of HDI of OECD Countries, by Income Group

The OECD countries only have upper middle income and high income groups. The upper middle income group did see a sharp decline in their HDI in the 2010's, which cost them about 0.1 HDI in their development. The high income group was barely affected by this. This could have been related to trade tensions between the USA and China, Brexit negotiations, a migration crisis or other economic trends.

7.2 Forecasts of HDI

For all of our data, a 15-year forecast looks as follows:

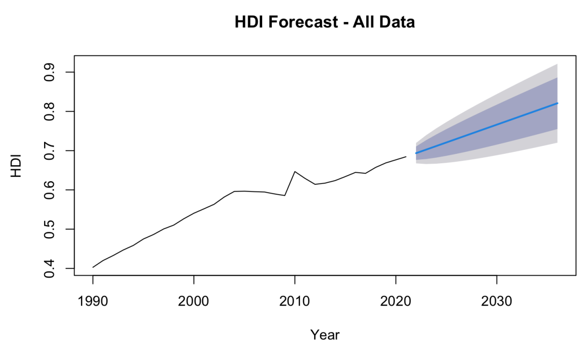
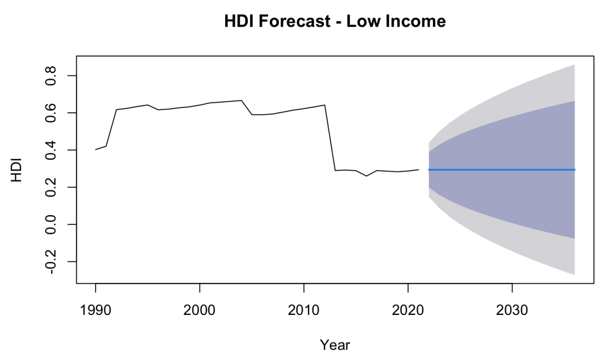


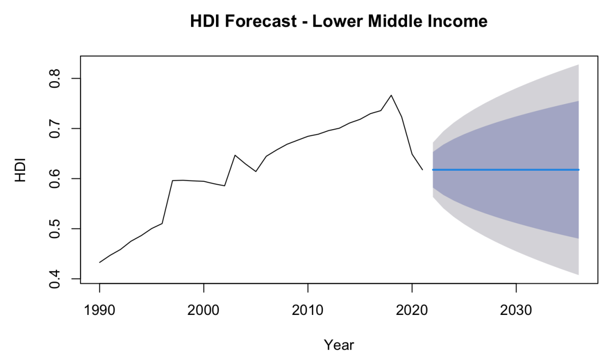
Figure 7.4: Forecast of all data for all income groups

This forecast seems quite positive over the long-run. According to the UNDP (2023), however, the outlook is much more bleak. They point out that 2023 marks a year in which the HDI has decreased for two full years, which is the first time that this has ever happened in the history of their calculation. However, we must remember that our data only runs until the year 2021 and so this could explain the lack of pessimism in some of our results and forecasts.

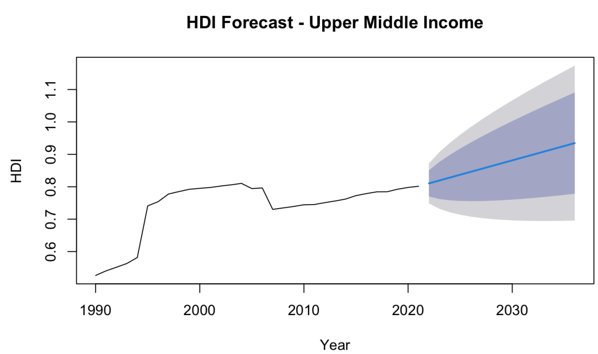
Time Series of HDI for Non-OECD Countries



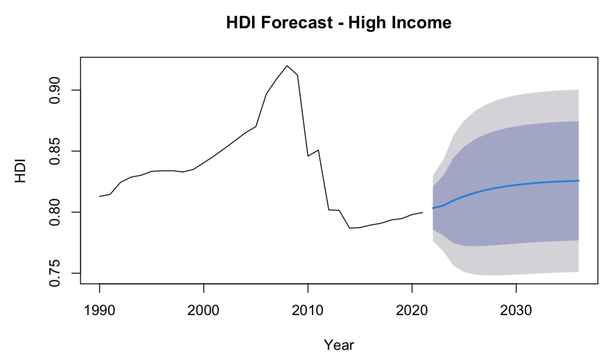
(a) Low Income



(b) Lower Middle Income



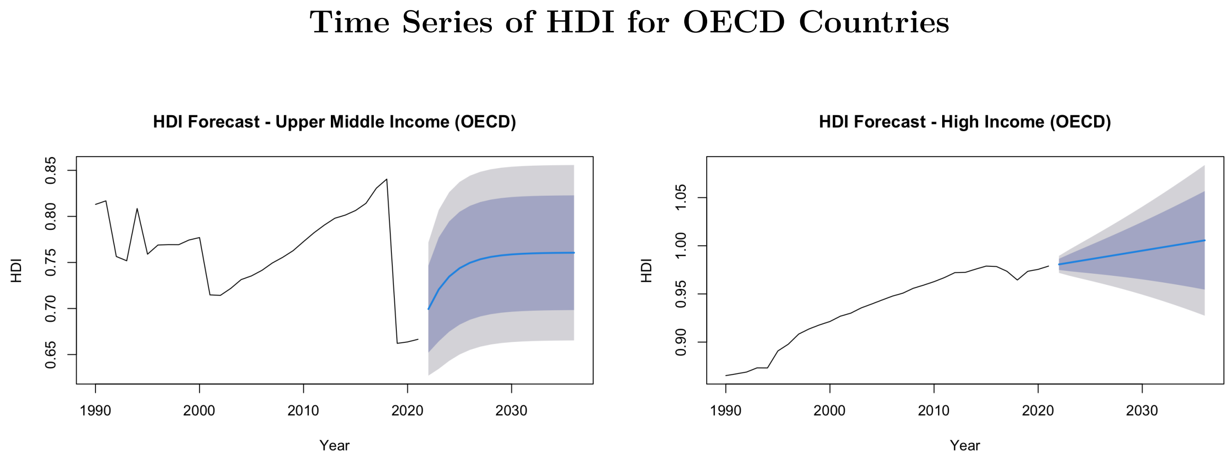
(c) Upper Middle Income



(d) High Income

Figure 7.5: Forecasts of HDI for Non-OECD Countries

According to our forecasts in Fig. 7.5, the two lowest income groups will stay about the same in the next 15 years while the two highest income groups should see an increase in their development.



(a) Upper Middle Income (b) High Income

Figure 7.6: Forecasts of HDI for OECD Countries

According to our forecasts of the two income groups in *OECD* countries in Fig. 7.6, high income countries are forecast to experience a linear increase in their development between 2021 and 2036. Upper middle income countries will experience an increase which increases at a decreasing rate, and will probably flatten out some time before 2036.

7.3 Conclusion

The past few years have looked increasingly grim as the international pandemic has carried on, and as war has returned to Europe. However, based on our forecasts, it seems that there is still optimism for wealthier places in the next decade, although much of this hinges on whether any more global crises emerge.

Chapter 8

Conclusion

In this thesis, we set out to learn about the interaction between trade and development in the globalized world. We explored differences among *OECD* and non-*OECD* countries and between various income groups among these countries. We also sought to replicate the findings of several academic papers on this topic.

Finding 1 was that trade had positive effects on HDI for all income categories. We re-validated this finding with our own GMM regressions.

Additionally, we found that the lowest income group seemed to have the strongest effect of trade on development. According to a 2023 post by the WorldBank (2023), ”From 1990 to 2017, developing countries increased their share of global exports from 16 percent to 30 percent; in the same period, the global poverty rate fell from 36 percent to 9 percent. Not all countries have benefited equally, but overall, trade has generated unprecedented prosperity, helping to lift some 1 billion people out of poverty in recent decades.”

Finding 2 was that trade no longer positively affects human development when the income component is excluded. We were not able to re-verify this result with our data. However, we did see a noticeable decline in the impact of trade on development when income was removed from the HDI calculation.

The ”standard” argument about trade claimed that the impact of trade on development was really felt through income and without it, there would be no significant impact. However, our thesis findings show that the ”globalist” counterargument - that trade impacts non-income HDI (meaning education and life expectancy) - may still have credibility. Over the last 30 years, the poorest regions seem to have been the most significant beneficiaries of trade, as it pertains ot their development, and sadly, it could be that they will be hardest hit by global crises in the coming years, if we do not return to a stable form of international stability.

According to our forecasts, we can predict that HDI for low and lower middle income countries will stay about the same or will decrease in the future. Upper and middle income countries should see an increase, since our data ends at 2021. If we had incorporated the years 2022 and 2023 into our data set as well, we might have been as pessimistic as the *World Bank* and may have seen more of a downturn on the horizon for all income groups. for all income groups.

The *World Bank* attributes the bleak outlook that many institutions share to the following reasons: the war in Ukraine has brought about trade disputes, where some countries believe in sanctions in order to isolate a country, and others see this as a threat to their own economies. Food exports through conflict zones have become an issue that has caused serious concerns globally.

Global supply chain problems and inflationary price increases have also become normal. Trade and HDI are clearly linked and trade can certainly boost the development of nations internationally. For this reason, we must tread carefully so that the Sustainable Development Goals can be reached by 2030, and so that mutual reciprocity can exist between peoples around the world, enriching them further in their global experience.

Bibliography

Ruzita Mohd Amin and Zarinah Hamid. Trade and Human Development in OIC countries: A Panel Data Analysis. *Research Management Centre (RMC), International Islamic University Malaysia*, 2013.

M. Arellano and S. Bond. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58:277–297, 1991.

M. Arellano and O. Bover. Another look at the instrumental variables estimation of error-component models. *Journal of Econometrics*, 68:29–51, 1995.

Christopher F. Baum, Mark E. Schaffer, and Steven Stillman. Instrumental variables and gmm: Estimation and testing. *Boston College Economics Working Paper 545*, 2002. Accessed: 2023-09-01.

Antony Davies and Gary M. Quinlivan. A Panel Data Analysis of the Impact of Trade on Human Development. *Journal of Socio-Economics*, 35(5):868–876, 2006.

W. Easterly and R. Levine. *It's Not Factor Accumulation: Stylized Facts and Growth Models*, volume 15. Oxford University Press, 2001.

William Greene. *Econometric Analysis*. Pearson Publishing, 7 edition, 2011.

Umut Gunduz, Mehtap Hisarciklilar, and Tolga Kaya. The Impact of Trade on Social Development. *World Academy of Science, Engineering and Technology International Journal of Economics and Management Engineering*, 3(6):1231–1234, 2009.

IMF. World Economic Outlook - Real GDP growth Annual percent change. https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD, 2023. Accessed: 2023-09-01.

W. Arthur Lewis. *The Slowing Down of the Engine of Growth*, volume 70. American Economic Association, 1980.

OECD. International trade during the COVID-19 pandemic: Big shifts and uncertainty. https://www.oecd.org/coronavirus/policy-responses/international-trade-during-the-covid-19-pandemic-big-shifts-and-uncertainty-d1131663/, 2020. Accessed: 2022-11-01.

OECD. Member countries. https://www.oecd.org/about/members-and-partners/, 2023. Accessed: 2023-09-01.

OECD. Country codes. https://www.oecd.org/migration/mig/34107835.xls, 2023. Accessed: 2023-09-01.

Robert M. Solow. A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70(1):65–94, 1956.

UN. SDG Report. https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf, 2021. Accessed: 2022-11-01.

UN. SDG Report. https://s3.amazonaws.com/sustainabledevelopment.report//sustainable-development-report-2023.pdf, 2023. Accessed: 2023-09-01.

UNDP. Asia-Pacific Human Development Report 2006. https://www.undp.org/publications/asia-pacific-human-development-report-2006, 2006. Accessed: 2022-11-01.

UNDP. Human Development Report 2018-21. https://www.undp.org/iraq/publications/undp-strategic-plan-2018-2021/, 2017. Accessed: 2022-11-01.

UNDP. Technical notes. https://hdr.undp.org/sites/default/files/2021-22_HDR/hdr2021-22_technical_notes.pdf, 2022. Accessed: 2023-09-01.

UNDP. Human Development Report 2021-22. https://hdr.undp.org/content/human-development-report-2021-22/, 2022. Accessed: 2022-11-01.

UNDP. Towards 2023 HDR. https://hdr.undp.org/towards-2023-human-development-report, 2023. Accessed: 2022-11-01.

Wikipedia. Human Development Index Article. https://en.wikipedia.org/wiki/Human_Development_Index, 2023. Accessed: 2023-09-01.

WorldBank. World Bank Country and Lending Groups. https://datacatalogfiles.worldbank.org/ddh-published/0037712/DR0090754/OGHIST.xlsx. Accessed: 2022-11-01.

WorldBank. Globalization, Growth, and Poverty. 2002.

WorldBank. Trade Has Been a Powerful Driver of Economic Development and Poverty Reduction. https://www.worldbank.org/en/topic/trade/brief/trade-has-been-a-powerful-driver-of-economic-development-and-poverty-reduction, 2023. Accessed: 2023-09-01.

WorldBank. World Development Indicators (WDI). https://databank.worldbank.org/source/world-development-indicators, 2023. Accessed: 2023-09-01.