A Panel Data Analysis of the Effects of Macroeconomic Variables on Income Inequality in Latin American Countries

Scott Poretsky

Abstract:

This paper investigates the relationship between inflation, trade, unemployment, education, and economic growth on income inequality in the South American OECD countries (Chile, Costa Rica, Colombia, Mexico, Argentina, Brazil, and Peru). While Argentina, Brazil, and Peru are not official OECD countries, they have a working relationship with OECD and have taken the first steps toward initiation in OECD. The variable that represents income inequality is the Gini Index World Bank estimator, and the variable that represents economic growth is GDP. This paper uses a panel data set from 2006 to 2020. The results of this study show that trade percentage, the unemployment percentage, and labor education increase income inequality, while inflation and GDP decrease income inequality.

Student, Bryant University, 1150 Douglas Pike, Smithfield, RI02917. Phone: (781) 366-4532.
Email: sporetsky@bryant.edu.

1.0 INTRODUCTION

Income inequality is increasingly becoming talked about more all around the world. It is becoming more prevalent in countries everywhere, including both developing countries and developed, world power countries. The effects of income inequality on the population is severe, hurting much more than people's bank accounts. Literature shows that rising income inequality results in more families being unable to afford good schooling and other forms of human capital investment, creating a devastating poverty trap for the poor (Checchi 2001). On the monetary side, literature also shows that one standard deviation decrease in income inequality can increase income per capita by as much as 0.5% - 0.8% (Checchi 2001). It has been proven that the people in countries with lower income inequality have better health and overall happiness than in countries with high income inequality, making the high income inequality countries spend more on healthcare (Singha and Singh 2020). These examples are just a few of the major effects of income inequality, proving the necessity for finding solutions to decrease inequality.

This study aims to enhance the understanding of the macroeconomic variables that effect income inequality. While many people think that the entrepreneurs, executive bankers, and athletes who have amassed large fortunes in the hundreds of millions and even billions of dollars are the cause of income inequality, the truth is that many macroeconomic variables play a key role. By understanding which macroeconomic variables increase or decrease income inequality, better policy measures can be made to help reduce the current levels of income inequality in a country. On top of this, finding clear trends in the effects of macroeconomic variables in one country may help prevent rising income inequality in a different country in the future.

While income inequality is a global issue, this paper only looks at the Latin American countries that are in and have a working relationship with the OECD. The reason for this is because high income inequality has had a greater effect on developing countries like those in Latin America than in developed countries like the US (Li and Zou 2002). The OECD stands for the Organization for Economic Co-operation and Development and they are an international organization, currently made up of 38 countries, who set standards and find solutions for economic, social, and environmental

challenges. This organization helps these 38 countries set public policies, find solutions for finding jobs, helps increase sustainable economic growth, fights corruption, and much more (Organization for Economic Co-Operation and Development 2022). It is clear that any country in the OECD is trying to increase their economic and social position in hopes to become a developed country, so focusing on these countries is important because they are actively working towards growing their economy. The OECD countries in Latin America specifically are very large and are in a position to transition from a developing country to a developed country in the near future.

The reason Argentina, Brazil, and Peru are included in this study even though they are not officially in the OECD is because they currently have a working relationship with the OECD. These countries actively provide research and other resources to the OECD, and on January 25th, 2022, the OECD officially started discussions with these countries about having them join. Because of this, it made sense to include them in the study, and it adds a significant amount more data for more accurate results. The time period of 2006 to 2020 was chosen because many significant economic events in this time period. The first major one was the global recession in 2008, so starting in 2006 shows two years of economic growth leading to a major collapse. The next major event happened at the end of 2019 with the outbreak of the Covid pandemic. This resulted in another recession as millions of people lost their job which severely disrupted the global supply chain. In between these events, there was a long period of major economic growth for many countries.

The rest of the paper is organized as follows: Section 2 talks about the trends of income inequality in Latin American countries. Section 3 gives a brief literature review. Section 4 outlines the data and empirical model. Finally, section 5 presents and discusses the empirical results. This is followed by a conclusion in section 6.

2.0 TREND OF INCOME INEQUALITY IN LATIN AMERICAN COUNTRIES
Figure 1 shows how the Gini Coefficient has changed in the Latin American countries from 2002 to 2012. A 10 year difference is a lot, and this graph shows that the over trend

in the Latin American countries is that the Gini Coefficient has fallen since 2002. The X axis is 2002, and the Y axis is 2012. Being above the line of best fit means that country's Gini Coefficient has increased (higher income inequality), of which only three countries above the line. Every OECD country and potential OECD country is below the line of best fit, meaning their Gini Coefficient's have decreased (lower income inequality).

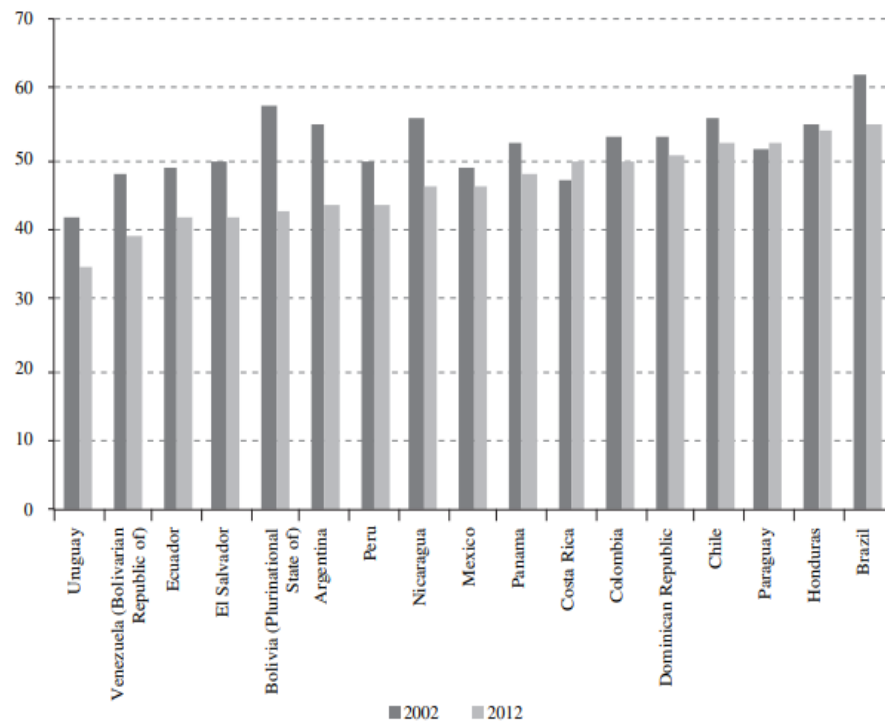**Figure 1: Latin America (18 countries): Gini Coefficient, around 2002 and 2012**
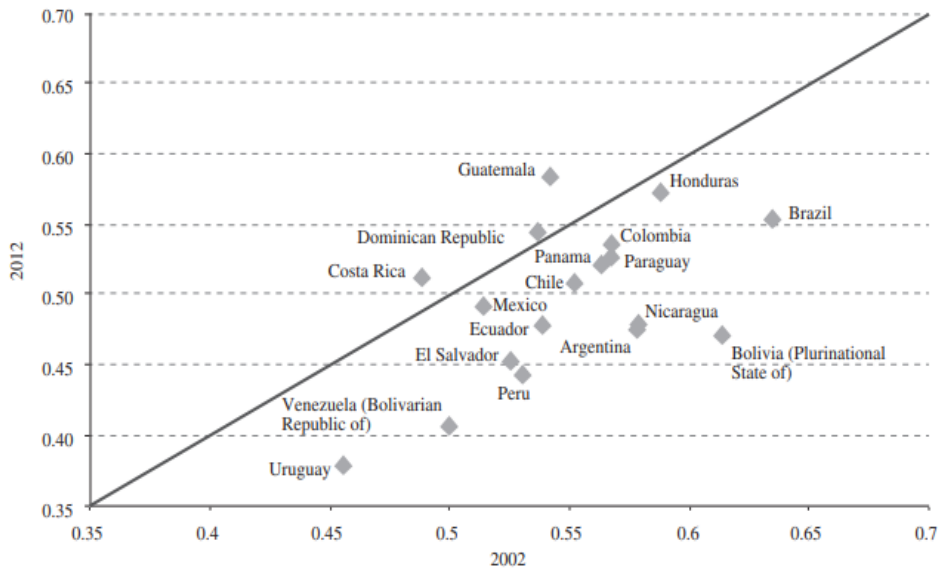
Source: (Amarante et al. 2016)

Figure 2 shows the percentage of wealth held by the top quintile of income earners in the Latin American countries. When the top quintile owns a disproportionately high number compared to the lower quintiles, that shows there is a high level of income inequality. While the percentages in this graph are relatively high, the trend shows that the share of wealth held by the top income earners is falling. The dark grey bar represents 2002, and the light grey bar represents 2012. Only one country has seen an increase in wealth held by the top quintile, which is Costa Rica. Every other country, including the OECD

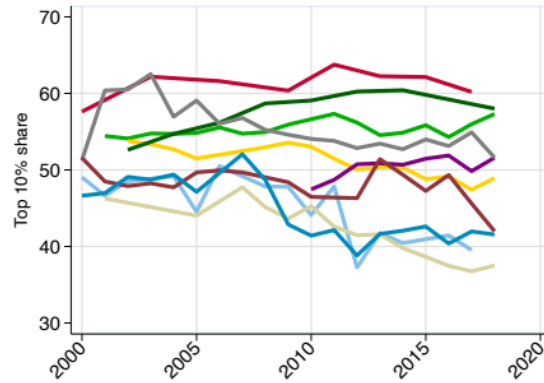countries and potential future OECD countries saw the wealth help by the top quintile fall from 2002 to 2012.

Figure 2: Latin America (17 countries): Total Income Share of the Richest Quintile around 2002 and 2012

Source: (Amarante at al. 2016)

Figure 3 shows the wealth held by the top 10% in Latin America countries. The difference between this graph and Figure 2 is that this graph has data through 2020. This graph shows that income inequality for the most part is not getting better, and in many cases, is getting worse. Chile, Mexico, and Brazil (OECD countries and candidates) are the top three most unequal countries with the top 10% earners holding around 60%, 58%, and 57% respectively.

Figure 3: Income Inequality in Latin America: Top 10% Share

(b) Top 10%

Argentina		Brazil	
Chile		Colombia	
Costa Rica		Ecuador	
Mexico		Peru	
El Salvador		Uruguay	
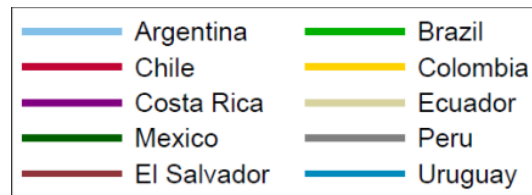
Source: (Rosa et al. 2020)

3.0 LITERATURE REVIEW

Over the past several decades, many European countries went through a massive economic transition from state-owned corporations and agriculture to a more privatized service-based economy (Bucevska 2019). The result of this was an inconsistent, more volatile trend in economic growth and an increase in income inequality. (Bucevska 2019) attempts to find the main factors driving income inequality in three target European countries as this has become a huge global topic. These findings will hopefully provide a road map towards decreasing income equality now and in the future. (Bucevska 2019) finds that the main drivers of income inequality in the selected European countries are the unemployment rate, levels of economic development, and the investment rates. Looking at more demographic factors that have a huge effect are population growth and education. Surprisingly, the results found that the inflation rate and terms of trade were not statistically significant in the selected countries.

An empirical model that has been used in global trade theory for many decades is gravity trade and non-gravity trade. Gravity trade is when two countries with similar economic mass (size) trade with each other, and non-gravity trade is the opposite where two countries with different economic mass (size) trades with each other. (Brueckner et al. 2020) study the relationship of non-gravity, bilateral trade between the U.S. and 154 countries, and their levels of income inequality. The main variable chosen in this study besides trade is education. The findings show that when a country has a small percentage of their population educated, an increase in non-gravity trade significantly increases income inequality. Following this, as the population increases education, the correlation between non-gravity trade and income inequality decreases. Countries who are global leaders in education do not have a statistically significant relationship between non-gravity trade and income inequality.

Tons of literature look at economic growth, mainly GDP, as an indicator towards income inequality. GDP, however, fails to consider the human elements of income inequality such as human well-being and happiness. (Singha and Singh 2020) argue that is time to start recognizing other models besides growth indicators, like GDP as the metrics used to measure income inequality. Results have shown that overall personal health, labor productivity, and general happiness are greater in poor countries with a more equal distribution of wealth than in wealthier counties with a larger distribution of wealth. While GDP is great for showing the final goods and services sold, taking into consideration sociological, philosophical, and psychological factors can produce much higher growth rates and production output in an economy.

While there is a lot of literature focusing on income inequality and the factors that effect it, very few take the aim of trying to predict the graphical the results. (Checchi 2001) set out to do just that, because she feels that from a policy point of view, it is extremely important to know if a policy change will have a low, moderate, or high change in income inequality. (Checchi 2001) looks at how changes in educational attainment effects income inequality. She finds that the relationship between years spent in school and income inequality is negative, and that it graphically makes a U-shape, with a lower turning point of 6.5 years. It is really important to know that educational

attainment is not 1:1 positively linear to consider when making policy changes. Also, (Checchi 2001) finds that income inequality is positively correlated to the capital output ratio and government spending on education, and negatively correlated to per capita income.

(Li and Zou 2002) use a cross-country data set to study how inflation effects income inequality and economic growth in what they consider to be less studied countries (Latin American countries, Asian countries, African countries, etc.). Their results show that inflation worsens income inequality and disproportionately increases the share of wealth for the rich. Surprisingly, they found that while inflation negatively effects the poor and middle class, the results shown were statistically insignificant. Their last result shows that inflation negatively effects economic growth.

Another name for trade percentage of GDP which is used in this paper, is trade openness. (Dorn et al. 2021) study how trade openness affects income inequality in 139 countries from 1970-2014. They use an instrumental variable based on a gravity equation and using a time-varying interaction of geography and impactful natural disasters. The findings are fairly consistent with other research that shows global trade disproportionally helps developing countries and hurts developed countries. In other words, global trade decreases income inequality for developing countries and increases income inequality for developed countries. (Dorn et al. 2021) Note that not every developing country was helped by trade, but overall, the trend is that developing countries are helped more. The developed countries trend of increasing income inequality is a trend of outliers. The type of company that was helped the most (reducing income inequality) were transitioning countries, such as China.

4.0 DATA AND EMPIRICAL METHODOLOGY
4.1 Data

The study uses annual panel data from 2006 to 2020. Data was obtained solely from the World Bank's World Development Indicators (WDI). Summary statistics for the data are provided in Table 1. (Organization for Economic Co-Operation and Development 2022)

Table 1 Summary Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
GINI INDEX	79	48.279	4.341	40.9	55.6
INFLATION	105	8.285	9.604	-.0534	50.921
GDP	105	7.98e+10	6.59e+11	2.27e+10	2.62e+12
UNEMPLOYMENT%	105	7.345	2.909	3.21	17.41
TRADE%	105	2.027	18.063	22.105	89.814
LABOR EDUCATION	97	1.029	9.100	40.84	77.36

4.2 Empirical Model

Following (Bucevska 2019), this study adapted and modified their model by using mostly similar variables and taking out some variables that did not fit with this study. This study similarly uses the Gini index, GDP, inflation, and unemployment. This study drops grratecaptal, debt, and population. Making slight changes, this study replaces terms of trade (TOT), with trade percent, and education with labor force with basic education. The models in this study could be written as follow:

OLS:

Gini Index = $\beta_0 + \beta_1$ Inflation + β_2 GDP + β_3 Unemployment% + β_4 Trade% + β_5 LaborEducation + ε

ε = Distance from predicted value and actual value not explained by model

Fixed Effect:

Gini Index = $\beta_0 + \beta_1$ Inflation + β_2 GDP + β_3 Unemployment% + β_4 Trade% + β_5 LaborEducation $\alpha + \mu$

α = Unobserved effects that are invariant

μ = Distance from predicted value and actual value not explained by model

Random Effect:

Gini Index = $\beta_0 + \beta_1$ Inflation + β_2 GDP + β_3 Unemployment% + β_4 Trade% + β_5 LaborEducation + U + W

U = Country specific deviation

W = Year specific deviation

This study compares the results of three different regression models because the results from each one can be interpreted differently. The basic OLS regression compares the relationship between the dependent variable and the independent variables, while looking at the distance from the predicated values and the actual values that are not explained by the model. The Random Effect model looks at the specific deviations in the countries and year. The Fixed Effect model takes into account the unobserved effects that are invariant in the model, while also looking at the distance from predicated values and the actual values that are not explained by the model.

The Gini Index, also known as the Gini Coefficient or Gini Ratio, is the most well know and common indicator for determining income inequality. It Is calculated from the Lorenz Curve which is a graph that essentially shows the distribution of income from a specific population, with a line of perfect equality and the Lorenz Curve which is below the line of perfect equality. The Gini Index is a ratio between these two lines (Bucevska 2019). The Gini Index definition is commonly shared and accepted, and this paper uses the same consistent definition. Many papers examine the relationship between the Gini

Index and macroeconomic variables as income inequality is so prevalent around the world. Examples of this can be found in the Literature Review section above.

Independent variables consist of five variables obtained from (The World Bank Group 2022). Appendix A provides data source, acronyms, descriptions, and expected signs. First, Inflation represents the relative change in prices on goods and serves from each country as a percent each year. Second, GDP represents the amount of economic activity taking place in each country. A higher GDP means the country is producing and selling more goods and services, and a low GDP means the country is producing and selling less goods and services. Third, unemployment percent is the percentage of the active labor force that is unemployed. Fourth, trade percent is the percentage of GDP that comes from trade. This is calculated by adding the sum of exports and imports for a specified time period and then dividing it by the same time periods GDP. Fifth, Labor Education is the percentage of the labor force with a basic education, which is defined as completed primary education or lower secondary education. All data, variables, and definitions come from (The World Bank Group 2022).

5.0 EMPIRICAL RESULTS

The empirical estimation results are presented in Table 2.   The empirical estimation shows that every variable chosen in this model has a positive correlation to income inequality, except for inflation which is negative. The estimated signs for each variable were predicted as follows: Inflation (+); Trade Percent (+); Unemployment (+); GDP (+); Labor Education (-). The estimated correlations and actual correlations were correct for Trade Percent, Unemployment, GDP, and were incorrect for Inflation and Labor Education.

It should be noted that there were blank data points for the Gini Index and Labor Education for some countries. This was likely due to the difficulty and inconsistency with collecting and reporting this type of data. Due to these blanks, mathematical estimations were applied to the Gini Index variable and the Labor Education variable so the data could be complete and more accurate.

Table 2: Regression results for the OECD Latin American Countries

	Gini Index		
	III (OLS)	II (Random)	I (Fixed)
CONSTANT	27.947***	37.521***	38.846***
	(3.880)	(3.696)	(3.400)
INFLATION	-0.119***	-0.028	0.01573
	(0.032)	(0.296)	(0.027)
TRADE%	0.037*	0.041*	0.050**
	(0.020)	0.022	(0.022)
UNEMPLOYMENT%	0.917***	0.309***	0.237**
	(0.112)	(0.102)	(0.095)
GDP	3.06e-12***	-6.88e-13	-2.31e-12**
	(4.16e-13)	(7.35e13)	(7.81e-13)
LABOR EDUCATION	0.178***	0.116***	0.110**
	(0.038)	(0.044)	(0.042)
R^2	0.6624	0.1733	0.2183
Number of obs.	105	105	105

Note: *** , **, and * denotes significance at the 1%, 5%, and 10% respectively.   Standard errors in parentheses

There are many interpretations that can be made from these results. First, inflation was only significant in the OLS model at 1%, and it is negative which shows that a rise in inflation decreases income inequality. This was surprising because it was assumed that inflation would increase the assets held by the wealthy, and lower the purchasing power of everyone, therefore, increasing income inequality. Second, trade percentage was statistically significant for the fixed effect model at 5%, the random effect model at 10%, and the OLS model at 10%. Trade percentage was assumed to be positive because

theoretically it should disproportionately increase the wealth of those who own the trade production. Third, unemployment was statistically significant for the fixed effect model at 5%, the random effect model at 1%, and the OLS model at 1%. It was assumed that unemployment would have a positive correlation because income for the individual decreases drastically (usually to $0), when they are unemployed, however, those who keep their jobs still earn an income, increasing income inequality. Fourth, GDP was statistically significant for the fixed effect model at 5%, and the OLS model at 1%. It was assumed that an increase in GDP would increase income inequality because those that control the means of production would likely become disproportionately wealthier than the average worker. Nationwide production increase correlates to an increase in GDP. Fifth, labor education was statistically significant for the fixed effect model at 1%, the random effect model at 1%, and the OLS model at 1%. It was assumed that as the general population became more educated, the overall wage rate would increase to match the rising skill level, leading to higher wages. The results show that when the education level for those in the work force rise, income inequality rises too. This might occur because the education gap and skill gap increases since not everyone becomes more educated.

Comparing these results to (Bucevska 2019) which is where this study based its model from, the results are fairly consistent. Both studies conclude a negative sign for inflation, a positive sign for unemployment percent, and a positive sign for GDP. While the fixed effect model in this study for GDP has a negative sign, the basic OLS model is more statistically significant with a positive sign. This is consistent with (Rosa et al. 2020) whose OLS model for GDP also has a positive sign. Similarly, (Dorn et al. 2021) shows a positive sign for trade percentage which is consistent with this papers results. While our definitions for education are slightly different, it is still interesting to see that (Bucevska 2019) resulted in a negative sign, while this study consistently resulted in a positive sign for each model. (Li and Zou 2002) also found a negative relationship between primary education and income inequality, as well as a negative sign for inflation which is consistent across all three studies.

It should be noted that the data for this experiment was imperfect which lead to certain variables for the fixed effect model and the random effect model to be statistically

insignificant. This data was likely imperfect because of the independent variables chosen might not be good indicators to predict income inequality, as well as the blank data points which were estimated. This can also be shown from the low r-squared fixed effect model and random effect model at .2183 and .1733 respectively. Following this study, different variables should be selected so there is a higher correlation between the dependent and independent variables. The amount of years that this study examines should be longer, preferably 20 years minimum.

6.0 CONCLUSION

In summary, there are many different variables that impact income inequality in the OECD Latin American Countries. Knowing the variables that increase or decrease income inequality is extremely important since this has been a growing concern globally. The results show that trade percentage, unemployment percentage, and labor education result in higher income inequality, while inflation and GDP result in lower income inequality. Given that this study uses an odd number of variables, more macroeconomic variables increase income inequality than decreases income inequality. However, if more variables were used, this conclusion may differ.

While income inequality is not a good thing, it can certainly be argued that trade percentage and labor education are generally positive for an economy / society. Trade allows a country to make money on their surplus production and provide the population with products and services that could not be efficiently produced in their borders. A more educated labor force translates to an increase in production, as well as innovation. Therefore, before changing or creating any new policies, every potential outcome must be thought of and analyzed. On the other side, it makes sense that unemployment increases income inequality because not everyone becomes unemployed, so those who keep their jobs earn a significantly higher income than those who lost their jobs. Unemployment percentage also had the highest effect on income inequality at 0.917, so based on these results, it is logical that the first policy recommendation should be towards decreasing unemployment / maximize employment.

Having an understanding about which variables effect income inequality is necessary for effective policy change. The hope of this study is to further examine other variables that have an impact on income inequality and compare and contrast the results to the vast amount of literature on this topic. While this study solely focuses on OECD countries in Latin America, the results can be used for policy changes all around the world. Comparing the results to other studies that looked at different countries, both developed and developing, who also used different time frames, and seeing similar results shows that the effects of these variables apply globally. Ideally, this study will add a new perspective to the other literature that will expand and enhance the current knowledge around global income inequality. With enough knowledge on which variables have the biggest impact around the world, effective policy can be made / changed to reduce the gap on income inequality in every country, regardless of size.

If this study were to be redone, many changes would have to be made. First, the models would need to have many more independent variables than just five. There are so many possible variables that effect income inequality that five is not enough. Also, further investigation will be needed to figure out why inflation was not statistically significant for the fixed effect model or the random effect model. Second, the study should use a longer time-frame than just 15 years. The issue of rising income inequality dates back further than 15 years, so a longer time frame would be needed. Third, it would be helpful to compare these results to other Latin American countries that have no relationship to the OECD to see what effects the OECD has on income inequality. At its core, this study is very basic with lots of room for improvement in later versions.

Appendix A: Variable Description and Data Source

Acronym	Description	Data source	Expected Sign
Gini Index	Represents income inequality. The gap between the Lorenz Curve and the line of perfect equality	World Development Indicators	+
Inflation	The rate in which prices rise and purchasing power declines	World Development Indicators	+
GDP	The final market value of products and services produced within a country's borders	World Development Indicators	+
Unemployment %	The percentage of the active labor force currently unemployed	World Development Indicators	+
Trade %	The sum of exports and imports of goods and services divided by GDP	World Development Indicators	+
Labor Education	The percentage of the active labor force with basic education (primary or lower secondary)	World Development Indicators	-

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