

Homework Assignment 17: Due at the beginning of class 11/20/02

The specific learning goals of this assignment are for you to:

- Realize that the economic growth of a country is affected by many factors, of which income distribution is one.
- Create a function to describe the relationship between the Gini Index and economic growth.
- Determine the Gini Index (and income distribution) that will maximize economic growth.
- Use functions and derivatives to describe the effects of educational reform on the economic growth of a country.

Note: To expedite your work in Questions 2 and 4, a convenient set of coordinate axes is available for download as a separate document.

On the last homework assignment you learned about Lorenz curves and the Gini Index, and how these intellectual tools could be used to describe the distribution of income within an economic system. In this homework assignment, you will determine how equally (or unequally) income needs to be distributed throughout a country in order to maximize economic growth. You will also learn some ways in which the educational policies can be used to influence distribution of income and economic growth.

Many social problems (e.g. corruption of government officials), criminal problems (e.g. the pervasiveness of the illicit drug business) and medical problems (e.g. broadening access to drugs such as nevirapine) can be understood as problems of inequality of incomes. Government officials who are not paid as highly as other workers – but who possess much more power than other workers – sell their influence to the highest bidder. Young people may elect to sell illicit drugs rather than the less financially attractive legitimate work that they are able to find, especially if they are unable to enter higher paying jobs and professions. People living on less than one dollar per day (39% of the total population of sub-Saharan Africa¹) simply do not possess enough money to buy medicine that costs several hundred dollars. According to the World Bank², a high degree of income inequality negatively impacts important factors that contribute to a country's economic growth.

¹ Source: Soubbotina, T. P. and K. Sheram. 2000. *Beyond Economic Growth: Meeting the Challenges of Global Development*. Washington DC: The World Bank Group.

² Soubbotina, T. P. and K. Sheram. 2000. *Beyond Economic Growth: Meeting the Challenges of Global Development*. Washington DC: The World Bank Group.

- High inequality threatens a country's economic and political stability, making armed conflicts and war more likely. Political instability increases the risks of investment, which tends to discourage the most desirable form of foreign capital, *foreign direct investment* (FDI)³.
- High inequality limits the effectiveness of the free market to promote economic efficiency. Changes in price and fines for anti-competitive practices have little potential to affect behavior and practices when the vast majority of the populace have no capital.
- High inequality may discourage basic norms of human behavior, such as trust (at least on a limited basis). When business transactions are only possible with the involvement of complicated legal instruments, the pace of business is slowed and the cost of doing business is increased.

Given all of these observations, it seems reasonable to suggest that the problems we have studied could be solved by a more even redistribution of income⁴. However, too much equality can be bad for the economy as well. In countries that have tried socialist economies, for example, people are deprived of tangible incentives for economic activity. The world's largest experiment in socialist economics (the Soviet Union) failed partly due to poor discipline and low initiative among workers and poor quality of work. As a result, citizens of the USSR had a poorer selection of lower quality goods and services. The USSR tended to make slower technological progress than Western nations, despite the fact that many of the greatest scientists and engineers that they world had ever known lived in Soviet countries. The economy of the USSR grew more slowly than those of Western countries, and receded more drastically, leaving greater levels of poverty among the Soviet citizenry. (Surviving socialist nations, such as Cuba, are often economic examples of the Marxist principle parodied by George Orwell in his novel, *Animal Farm*: "All animals are equal, but some are more equal than others." The per capita GDP of Cuba in 2001⁵ was \$2,300, whereas Fidel Castro's personal fortune is estimated at more than \$1.4 billion⁶.) Too much income equality appears to breed economic stagnation.

The central questions that you will answer in this homework assignment are:

- How much income inequality is needed to maximize economic growth?
- How can education be used as a policy tool to achieve this?

³ See the Optional Background Reading for Homework 1 for information on why FDI is a desirable source of foreign capital for developing nations.

⁴ For example, the per capita GDP of South Africa was \$9400 in 2001. (Source: CIA World Fact Book, 2002.) If every person in South Africa had \$9400, they would easily be able to afford antiretroviral medications (about \$350 dollars per year) and nevirapine (\$80-\$300 per course of treatment).

⁵ Cia World Fact Book, 2002.

⁶ *Forbes Magazine*, July 28, 1997.

- Figure 1⁷ shows a plot of the average⁸ annual growth in a country's GDP versus its Gini Index. (Recall that perfect equality of incomes is reflected by a Gini index of zero, whereas perfect inequality of incomes is reflected by a Gini Index of one.) In a few sentences, describe what Figure 1 suggests about the relationship between economic growth and income distribution. As part of your answer, you should note whether you think that income distribution is the sole determinant of economic growth and refer to specific features of Figure 1 to support your position.

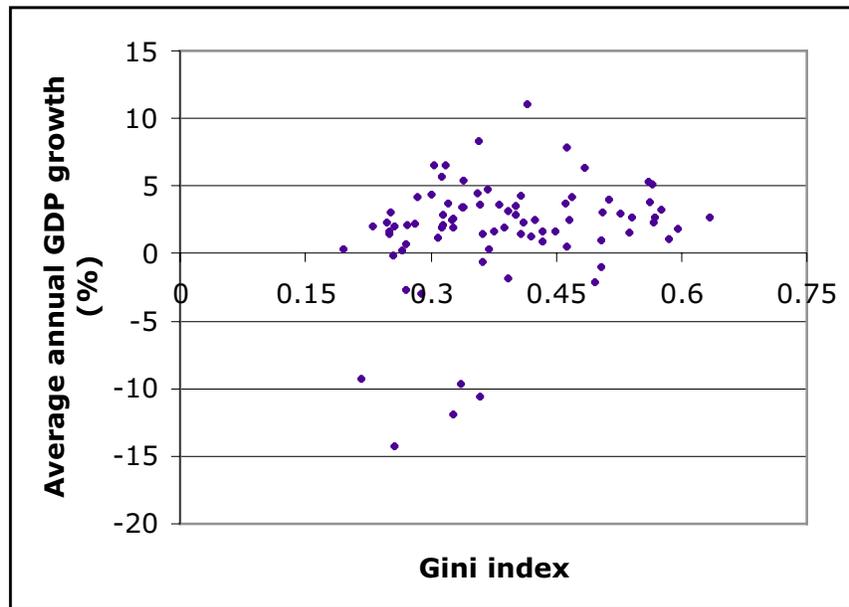


Figure 1: Average annual growth of GDP versus Gini Index.

- When some of the other factors that influence economic growth are controlled for, and the data from Figure 1 averaged to account for regional differences, the Gini Index and corresponding levels of annual GDP growth are related in a much less haphazard fashion. The processed and averaged data is given in Table 1. Use this data to plot a graph showing the Gini Index versus the average annual growth in GDP. What sort of function would do a reasonable job of summarizing the trends in this data?

Gini Index	Annual GDP growth (%)	Gini Index	Annual GDP growth (%)
0.190	-4.465	0.445	+2.769
0.235	+0.783	0.520	+2.378
0.295	+2.028	0.595	+2.083
0.400	+3.640		

Table 1: Averaged results for Gini Index and Annual GDP Growth.

⁷ The data used to create Figure 1 was collected from various sources including the World Bank and the CIA. You will not need to use the data represented by Figure 1 directly in this homework assignment, but if you'd like it you can download a copy separately.

⁸ This is the average for the period between 1980 and 1995.

3. In this problem x will represent the Gini Index. Find a formula for $G(x)$, the annual growth in GDP (in units of %) and a formula for the derivative $G'(x)$. Use your results to determine what value of the Gini Index maximizes the economic growth of a country. Based on your results, if a country was interested in maximizing its economic growth, should its distribution of income resemble that of Sweden ($x = 0.25$), the United States ($x = 0.401$) or Brazil ($x = 0.634$)?
4. Using your answer to Question 3, draw a **Lorenz curve** that shows (roughly) how incomes should be distributed in a country that wants to maximize its economic growth. As part of your answer, you should demonstrate that the Gini Index of your Lorenz plot is approximately equal to the Gini Index that you calculated in Question 3.
5. Below are three statements taken from a study of 87 countries conducted by Icelandic economists Thorvaldur Gylfason and Gylfi Zoega⁹. In each case, express the written statement symbolically using the derivative $G'(x)$.
- When there are considerable inequities of income distribution ($x = 0.5912$) raising public spending on school by 3.5% of the GDP will cause the Gini index to fall by 0.0805 and the annual GDP growth to increase by 1%.
 - When there are considerable inequities of income distribution ($x = 0.6242$) increasing the average length of time that girls spend in school by four years will cause the Gini index to fall by 0.04 and the annual GDP growth to increase by 1%.
 - When there are considerable inequities of income distribution ($x = 0.6094$) raising the percentage of children who enroll in high school by 27% will cause the Gini index to fall by 0.054 and the annual GDP growth to increase by 1%.

⁹ Gylfason, T. and G. Zoega. 2001. Education, social inequality and economic growth: A view of the landscape. *Proceedings of the Third International Conference for Education and Research*. Athens, Greece, 25-26 May, 2001.