The Effects of Some Social and Economic Indicators on the Gap Between the American Income Inequality Level and Its Optimal Level

Tito Belchior Silva Moreira[1], George Henrique de Moura Cunha[2], Luciano Balbino dos Santos[3], Paulo Roberto Pires de Sousa[4] & Michel Constantino[5]

[1] Universidade Católica de Brasília (UCB), Economics Department, Brasilia-DF, Brazil

[2] Programa de Pós-graduação em Desenvolvimento Regional do Centro Universitário Alves Faria, Brazil

[3] Universidade do Estado do Amazonas (UEA), Brazil

[4] Universidade Federal do Amazonas (UFAM), Brazil

[5] Universidade Católica Dom Bosco (UCDB), Programas de Doutorado em Ciências Ambientais e Sustentabilidade Agropecuária e em Desenvolvimento Local, Brazail

Correspondence: Tito Belchior Silva Moreira, Universidade Católica de Brasília (UCB) - Câmpus Taguatinga, QS 07 – Lote 01 – EPCT – Taguatiga – Brasilia, DF, CEP-71966-700, Brazil. E-mail: tito@pos.ucb.br, titoeco@yahoo.com.br

Received: June 19, 2021 Accepted: August 10, 2021 Online Published: March 27, 2022

doi:10.5430/ijba.v13n2p102 URL: https://doi.org/10.5430/ijba.v13n2p102

Abstract

Since the last decades of the twentieth century, there has been a debate on the causes and consequences regarding the rise of inequality in its varied dimensions. Much discussion is dedicated to whether public policies should be aimed at reducing or mitigating the upward trend in inequality. This paper explores empirical evidence regarding the income inequality level that maximizes the per capita consumption of the U.S. economy from 1946 to 2015. Based on the cointegration equations empirical tests, we find a concave nonlinear relation between the log of per capita consumption and the log of the Gini Index. In this context, the optimal level of income inequality is 0.376. In addition, we test whether some determinants of inequality show a nonlinear relationship with the square of the difference between the current Gini index and its optimal level, $(\text{Gini} - \text{Gini}^*)^2$. The relation between $(\text{Gini-Gini}^*)^2$ and education shows an inverted U-shaped curve in which the threshold value wasn't reached yet but, once the threshold value is reached, more education consumption could reduce income inequality, which can result in better equality of opportunity for most of the American population. However, the indicators of economic openness, taxes, and financial assets show U-shaped curves. Considering the analyzed period from 1946 to 2015, openness and, taxes have contributed to the increase in inequality since the mid-1970s. Besides, financial assets also have contributed to inequality since 2008. However, from 1946 to about 2007, these financial assets, which include credit, contributed to generating lower income inequality.

Keywords: economic openness, education, financial assets, optimal level of income inequality, taxes

JEL Classification: I3, O15

1. Introduction

The increasing income inequality in the United States has caught economists' eyes since the last quarter of the 20th century. In fact, as pointed out by Heckman and Krueger (2003), the "natural" level of inequality was lower in the 1950s and 1960s, although it increased in the 1970s due to structural changes in the U.S. and global economies. In this context, Attanasio and Pistaferri (2014) show that in the 1970s, the inequality of consumption and income was stable, but increased strongly after 1980. The authors still highlight that the Great Recession was associated with a decline in consumption inequality.

Considering income inequality, specifically the Gini Index, Stiglitz (2013) points out that a more equal society has a Gini index of 0.3 or below. This is the case of Sweden, Norway, and Germany. Moreover, most unequal societies have a Gini index of 0.5 or higher, such as some countries in Africa and Latin America. The U.S. is approaching the 0.5 limit fast since the income inequality index in 2015 is already at 0.452. In this context, the US is entering the most unequal societies club. Stiglitz also shows some other uncomfortable facts about the U.S. economy. The perception of America as a land of opportunity may be a myth because there is little income mobility. Furthermore, America has more inequality than any other advanced industrialized country.

The income inequality may also be computed considering the inequality among different groups of income. Hence, at the top of a pyramid, a small proportion of the population owns much of the income; and at the base, a large part of the population owns a small part of the income. At intermediate levels of income are the individuals who are part of the middle class. In addition to income inequality, one must consider that inequality has several dimensions. There are inequalities in health and access to education, as well as gender inequalities and deprivations in childhood, among others. Inequalities are interrelated in a way that can eliminate or reduce the most important principle of a civilized society, which is equal opportunities (Stiglitz, 2016). In the same vein, Deaton (2013) distinguishes between the different types of inequality in a historical context, presenting the origins, consequences, and propositions of public policies in order to reduce inequality.

The consumption inequality is another indicator of inequality explored in the literature. Aguiar and Bils (2015) debate to what extent the increase in income inequality was reflected by consumption inequality since 1980. They show consumption inequality tracked income inequality more closely than estimated by direct responses on expenditures. From another point of view, Piketty (2015) evaluates the wealth inequality and also discusses some of the implications for optimal taxation. Additionally, the author analyzes the ratio capital/income and the share of income from capital.

Given that the differences in the level of material life among some countries are very large, and the gaps between the rich and the poor within each nation are equally high, Deaton (2013) makes some inquiries. Do these inequalities tend to intensify as a result of general economic progress? Is everyone benefiting or only the rich who have achieved the Great Escape, leaving the less fortunate behind? This expression, the Great Escape, was inspired by a film, "The Great Escape", that tells the story of a group of men fleeing a prisoner of war camp during World War II. Heckman and Krueger (2003) also point out that there has been a far greater inequality since the 1970s. The authors still stressed that it is far from clear that current levels of inequality are above what would be socially optimal. Besides, the "natural" level of inequality needs not be a stationary variable. In this context, Zingales (2012) highlights that, on one hand, there is a consensus that without some degree of inequality there is no incentive for economic agents to improve their human capital and take investment risks. Without the expectation of a higher reward for good performance, most people will not make much effort to get better. This argument implicitly assumes the idea that meritocracy is essential to the maintenance of an incentive system in a market economy with equality of opportunity. In this sense, one can understand the idea of a "natural" level of inequality.

On the other hand, meritocracy is a difficult principle to sustain in a democracy since the whole system that distributes merit-based rewards will inevitably bring greater rewards to few people. This can provoke envy in most. In this case, there is a tension between meritocracy and democracy due to strong income inequality (Zingales, 2012). Still based on Zingales (2012), strong income inequality implies that few economic agents receive a disproportionate reward, but many receive little or no reward, reducing incentives for risk-averse agents. Hence, political support for meritocracy can become discredited if most people have a perception that they gain little from this system, while an elite group gains disproportionate political power and distorts the meritocratic system for its own benefit.

In the above context, when the government has broad discretionary power to control the market and favors some private agents in relation to others, a phenomenon known as “crony capitalism” occurs. This promiscuous relationship between the government and private companies is due to the lobbies of large companies that obtain political or economic benefits in exchange for their political support. In turn, these same companies are usually characterized as too big to fail (Zingales, 2012 and Greenspan, 2013).

Even if there were a consensus that there is too much inequality, it is far from clear that spending more on public policies in order to equalize incomes across workers would be socially desirable. At first, it would be necessary to know the optimal level of inequality. In this way, policymakers could have a parameter to know until what point the income inequality level should or could be reduced. In other words, whatever the public policy implemented in order to reduce income inequality, it is necessary to know the optimal level of inequality. In this sense, one of the contributions of this article is to show the optimal level of income inequality. It is defined as the income inequality level that maximizes per capita consumption of the American population.

If policymakers do not want to enforce an incentive system, they can opt for an income distribution policy that they believe to be “fairer”, rather than an incentive system that prioritizes merit. In this case, redistribution of income through taxation can be a solution to excessive income inequality. Nevertheless, Zingales (2012) points out that this solution has already been tried in various ways in socialist and social democratic countries. In fact, they weakened the incentives for wealth creation and, consequently, limited the possibilities of prosperity and growth of these economies.

The questions mentioned above have been strongly debated, even though several economists suggest the reduction of inequality through public policies can lead to higher productivity, efficiency and growth, besides preservation of democracy (Stiglitz, 2016). Considering that democracy ought to reflect the will of the majority, why should citizens or voters support an incentive system based on merit, if this system is not very inclusive, rather than defend policies to make income distribution more equitable? Considering this dilemma between the meritocracy-based incentive system and a less unequal income distribution, what would be the optimal level of income inequality that could be used as a parameter for this discussion?

This article aims to identify the level of income inequality that maximizes per capita consumption for the U.S. economy from 1946 to 2015. Furthermore, we test whether some determinants (education, openness, taxes and financial assets) of income inequality also show a nonlinear relationship with the square of the difference between the current Gini index and its optimal level, $(\text{Gini} - \text{Gini}^*)^2$. For example, we evaluate if there is an optimal level of taxes to reduce the income inequality.

2. Methodological Aspect

The data (1946 to 2015) used in this paper is available from the Federal Reserve Bank of St. Louis. We use eleven annual variables: i) Real personal consumption expenditures, billions of chained 2012 Dollars (PCECCA); ii) Population, thousands, (B230RC0A052NBEA), iii) Income Gini Ratio of Families by Race of Householder, All Races, Ratio (GINIALLRF), iv) Real personal consumption expenditures: Education (chain-type quantity index), Index 2009=100 (DEDURA3A086NBEA), v) Gross Domestic Product, Billions of Dollars (GDPA), vi) State and local government current tax receipts, Billions of Dollars (W070RC1A027NBEA), vii) Federal government current tax receipts: Personal current taxes, Billions of Dollars (A074RC1A027NBEA), viii) Gross domestic product (implicit price deflator), Index 2012=100 (A191RD3A086NBEA), ix) Imports of Goods and Services, Billions of Dollars (IMPGSA), x) Exports of Goods and Services, Billions of Dollars (EXPGSA), xi) Federal government; total financial assets, Millions of Dollars (FGTFASA027N). It stands out that the current values of all variables are set up in the same unit of measurement and all of them are transformed into logarithms.

Table 1 shows the descriptive statistics regarding the variables used in the regressions. The Gini Index ranges between 0 to 1, and when this index approaches 1 it means that there is strong income inequality. On the other hand, when it approaches 0 it reveals low income inequality. We multiply the Gini Index by 10 in order to avoid negative values once it is transformed into a logarithm, where L = log. In this case, we have the variable *L_Gini*, whose mean and median are 1.363 and 1.333, respectively. The variable *L_PC_Consumption* is the ratio between real personal consumption expenditures and population in log.

Table 1. Descriptive statistics

	Mean	Median	Maximum	Minimum	Std. Dev.
L_ Gini	1.363	1.333	1.515	1.247	0.089
L_ PC_ Consumption	9.858	9.844	10.541	9.101	0.458
L_ Education	4.153	4.398	4.700	2.838	0.573
L_ Openness	2.751	2.847	3.427	2.079	0.448
L_ Tax	5.364	5.600	7.404	2.608	1.508
L_ Financial_ Assets	8.615	8.645	10.004	7.787	0.565

Source: Elaborated by the authors. Note: L = Log.

The variable *L_ Education* is the log of the real personal consumption expenditures in education. The variable *L_Openness* shows the economic openness degree from the USA regarding the rest of the world. It is calculated by the sum of imports of goods and services and exports of goods and services as a proportion of GDP in percent (%), which in turn is transformed in Log. *L_Tax* is the sum between state and local government current tax receipts and federal government current tax receipts (Personal current taxes) deflated by implicit price deflator from GDP, which in turn is also transformed in Log. Finally, *L_ Financial_ Assets* is a proxy to federal government size, as well as the size of the federal financial sector. It is composed by the sum of all these assets: debt securities and loans; corporate equities; total taxes receivable; U.S. official reserve assets; checkable deposits and currency; total time and savings deposits; trade receivables and total miscellaneous assets. The *Financial_ Assets* variable is deflated by implicit price deflator from GDP, which in turn is also transformed in Log. The Source of this detailed information can be found in "Series analyzer for FL314090005.Q" from FED of St. Louis.

2.1 Empirical Approach

Firstly, we highlight that empirical evidences on the relationship among income inequality and its social-economic determinants are widely studied based on panel-data. However, Risso, Punzo and Carrera (2013) emphasize that time series models based on a specific country can be more attractive and show interesting results. Moreover, they relate that the empirical results suffer fewer problems of endogeneity, heterogeneity and measurement errors that are usually observed in panel-data regressions. In addition, another advantage of using time series instead of panel data is the possibility of detecting approximately the year in which the limit occurs. In this context, this article identifies the respective year in which the limit takes place for each one of the explanatory variables.

Our empirical approach is developed in three steps. The first one shows a nonlinear relationship between per capita consumption and Gini index with the variables in level. The goal is to determine the level of income inequality that maximizes per capita consumption based on equation 1.

$$(L\_ PC\_ Consumption)_t = Bo + B_1{*}(L\_Gini)_t + B_2{*}(L\_Gini^2)_t + u_t \quad (1)$$

where B_i is the regression's parameters and u_t is the error term. It is expected that the estimated parameters B_1 and B_2 are positive and negative respectively, i.e., $B_1 > 0$ and $B_2 < 0$. In this case, a concave curve can be obtained in an inverted U shape. Thus, the optimal level of income inequality (Gini*) that maximizes the per capita consumption can be determined. In this context, the determination of the optimal level of income inequality is the first contribution of this paper.

Considering the analyzed period regarding income inequality, one notices that mainly from the 1970s there is an upward trend, and in this context, one can explain intuitively why to expect a concave curve between the Gini coefficient and per capita consumption. As the consumption of individuals depends on their income, it can be expected that at the beginning of the period, with low rates of inequality, consumption tends to be higher on average and as inequality increases, consumption should increase in a decreasing way until achieving a level of inequality that maximizes per capita consumption. From that point on, the increase in inequality rises the income discrepancy between agents, which should impact a drop in consumption. In this context, it does not make sense to expect that excessive income inequality will have a positive correlation with per capita consumption.

Taking into account that there is a strong positive correlation between consumption and per capita income, one can assess whether there is non-linearity by analyzing the extremes. On one hand, at the beginning of the analyzed period (1946), low rates of inequality and per capita consumption are observed, indicating that individuals have relatively low per capita incomes as well as low income dispersion between them. On the other hand, as per capita consumption increases as well as per capita income, which can be considered a proxy for the productivity of the American economy, an increase in income inequality is expected since sectors of the economy with higher productivity will improve the remuneration economic agents linked to these sectors, while agents from less productive sectors will have lower remunerations. Nevertheless, at the other extreme with high rates of inequality, a large part of the population will not be able to have high consumption per capita because they have low levels of income compared to agents linked to the most productive sectors of the economy. Thus, a combination of high inequality combined with low consumption per capita is expected, which suggests an inverted U-shaped curve.

The second step consists of generating the dependent variable. The literature about the determinants of income inequality generally uses some proxies to income inequality, such as the Gini Index, for example. Instead of using the Gini Index as a dependent variable, we are interested in the gap between the current Gini Index and its optimal level. However, since there are values lower than the optimal Gini Index, in order to avoid negative values, we use the square of the gap $(\text{Gini - Gini*})^2$ as the dependent variable. In other words, any gap from the left or right side of the Gini* is not desirable, because, on one hand, if there is little inequality then the incentive system of economic agents will be reduced, i.e., it will not be worth increasing their effort in order to get low rewards. However, if there is a very high inequality level then the economic agents will not believe in the meritocracy system and, therefore, once more there will not be an incentive to make much more effort. In this context, it may make sense that the deviations of inequality measure from its optimal value are symmetric. Besides, the dependent variable is transformed into Logarithmic. Besides, Finally, the dependent variable is transformed into Logarithmic.

In fact, we are interested in evaluating the effect of the explanatory variables on the square of the gap $(\text{Gini} - \text{Gini}^*)^2$, instead of the Gini index level. The reason is that it is necessary for policymakers to have this parameter, Gini*, so as to know how far the current income inequality level is from its optimal level. This way, they can discuss policies that reduce inequality toward the optimal level, at least, while the marginal benefits generated for such policies are greater than the marginal costs. It does not make sense to reduce income inequality without any criterion or parameter because the costs of affording this "herculean" task could be so high compared to the benefits that it would become socially undesirable. In this sense, this is our second contribution.

The last step consists of testing if there are nonlinear relations among the explanatory variables and the dependent variable, $(\text{Gini} - \text{Gini}^*)^2$. In this case, this empirical strategy allows us to show the points of maximum (concave curve) or minimum (convex curve) of each variable used in the empirical models based on equation 2, as follows

$$(L\_Gini - L\_Gini^*)^2_t = \delta o + \delta_1{*}(L\_Education)_t + \delta_2{*}(L\_Education^2)_t + \delta_3{*}(L\_Openness)_t + \delta_4{*}(L\_Openness^2)_t + \delta_5{*}(L\_Tax)_t + \delta_6{*}(L\_Tax^2)_t + \delta_7{*}(L\_Financial\_Assets)_t + \delta_8{*}(L\_Financial\_Assets^2)_t + z_t \quad (2)$$

where δ_i are the parameters and z_t is the error term. As already mentioned before, assuming an inverted U-shaped hypothesis of the variable L_Education, for example, then the estimated coefficient (δ1) should be positive and its quadratic term (δ2) should be negative. Moreover, both coefficients should be significant. When assessing the effect of education on income inequality, one can intuitively think that there is a non-linear relationship if the issue is initially analyzed in extreme terms. On one side, if a society is at a stage where the majority of the population does not have access to education, then the level of income inequality must be low since the majority of the population has low human capital and therefore also has low income. In other words, most individuals will be paid for low remuneration. On the other side, if most of the population has high educational levels then they will have high-income rates, meaning that at this stage society will also have low-income inequality, i.e., most individuals will have high remunerations. As there is a low level of inequality in both situations, it makes sense to intuit that between the two extremes, inequality begins to increase to a maximum point, and from there, a trajectory to reduce income inequality begins, generating a concave curve.

On the other hand, assuming a U-shaped hypothesis of the variable L_Openness, for example, then the estimated coefficient (δ3) should be negative and significant. Besides, its quadratic term (δ4) should be positive and significant. In these cases, we have nonlinear effects on the variables. Intuitively, it makes sense a convex curve to represent a connection between economic openness and income inequality. Considering the extremes, an economy with low levels of openness can have a high inequality level, since without external competition there is a tendency for the concentration of industries in oligopoly regimes with a consequent concentration of income. Thus, as there is an increase in openness, with more competition via tradable goods, there will be a trend towards reducing the economic concentration with new enterprises, as well as more diversification in the economy. In this sense, greater openness can lead to greater productivity in the economy and, therefore, new opportunities for economic agents obtain better results. In this case, it is expected a decrease in income inequality toward to a minimum point from the curve. However, with openness levels beyond the minimum point, or with exceeding openness, some business activities will not be competitive enough to survive and, moreover, there will be a tendency of reduction in the remuneration related to the sectors more vulnerable to openness. In this case, income inequality will increase.

Regarding the taxes, it is possible to compare the association between taxes and income inequality with the inverted U-shaped Laffer curve, which shows a relationship between tax rate and government revenues. In this sense, this connection among the Laffer curve and inequality as well as government expenditures in public goods and services will generate a U-shaped curve. Considering the Laffer curve, once the aliquots gradually increase toward a maximum point, the revenues also increase as well. The effect on the U-shaped curve is that it is possibly to increase the capacity of the government to attend the needs of the population with provisions of public goods and services due to higher revenues. Therefore, higher revenue propitiates higher public expenditures which can generate conditions for the reduction of income inequality, once most citizens can access the benefits from public goods and services. However, beyond the minimum point, higher taxes rate implies a decrease in government revenues, and consequently, there will be a lower supply of public services, ending up in higher income inequality.

In the same vein, the connection between financial assets and income inequality can show a U-shaped form. Brei, Ferri, and Gambacorta (2018) evaluate the nonlinear effects from the financial assets on income inequality and they found a convex curve. As already mentioned, the financial assets are a proxy to the federal financial sector. Lower financial asset levels imply that the population has little access to credit, mainly poor people, and this situation can lead to higher income inequality. Once higher credit access increases gradually until the minimum point, then income inequality tends to decrease. However, beyond this threshold, as the financial system size increases the liquidity increase as well. In this context, the economic agents are induced in some way to assume more risks, propitiating condition at first for an economic boom and later a bust. As the subprime crisis showed, at some moment will take place a change of expectative that induces to a sharp fall in the actives' prices resulting in income losses, high unemployment rates as well as higher income inequality.

In contrast to the usual empirical models regarding the determinants of income inequality, which mostly use linear models in the variables, we chose to use nonlinear models. One of the advantages of this kind of empirical modeling is that these models can provide better information to policymakers about the use of public resources. For example, if one of the explanatory variables has a concave relation with the dependent variable, it is possible to know that reducing income inequality requires spending public resources beyond the maximum point. On the other hand, if the curve is convex, the policymaker knows that one can increase public spending to combat income inequality only to the minimum point of the curve and, consequently, beyond this point the income inequality will increase. Thus, we show that instead of the monotonic relationships among variables as usual in the literature, we find nonlinear relationships before or after a given threshold in order to evaluate if the income inequality will increase or will decrease up to a point or beyond that point.

Based on equations 1 and 2, we test a nonlinear relation among the dependent variables and their respective explanatory variables. In this context, it is necessary to test the nonstationary and cointegration variables. Tables 1A and 1B show unit root tests based on the augmented Dickey-Fuller and Phillips-Perron test s in supplementary material. Table 1A shows that all variables in level do not reject the null hypothesis, i.e., the time series has a unit root. On the other hand, Table 1B does not accept the null hypothesis with the variables in the first difference. In this case, all variables are I (1). Hence, it is possible to evaluate cointegration tests based on trace and maximum eigenvalue tests taking into account the optimum choice of lags (Johansen, 1988, 1991, 1995). These tests based on tables 1C and 1D in supplementary material are associated with the equation 1 and tables 1E and 1F also in supplementary material are associated with equation 2. The results show that the variables from equations 1 and 2 indicate cointegrating equations.

In the regression analysis, the use of the ordinary least squares (OLS) method would not be the best way to solve problems that contain extreme observations or outliers. Hence, we need a parameter estimation method which is robust where the value of the estimation is not very sensitive to small changes in the data. In this context, the robust least squares (RLS) method refers to a variety of regression methods which is *robust*, or less sensitive to outliers. Empirical results from RLS models are shown in subsection 4.1. There are some methods for RLS to determine a regression model: M-estimation (Huber, 1973), S-estimation (Rousseeuw and Yohai, 1984), and MM-estimation (Yohai 1987). These three methods differ in the following aspects:

i) M-estimation is an extension of the maximum likelihood method and, besides, it is also a robust estimation. This method approaches dependent variable outliers so that the value of the dependent variable is different principally from the regression model norm (large residuals). ii) S-estimation is characterized by being a computationally intensive procedure, which takes into account outliers in the regressor variables (high leverages). iii) MM-estimation is a conjunction of S-estimation and M-estimation. In other words, the procedure starts by performing S-estimation, and then uses the estimates obtained from S-estimation as the starting point for M-estimation. Since MM-estimation is a conjunction of the other two methods, it addresses outliers in both the dependent and independent variables.

In addition, we also use cointegrating regressions since the variables are I (1), in order to make sure they still obtaining more robust results; that is exhibited in subsection 4.2. There are also three efficient estimation methods. The first one is the Fully Modified OLS (FMOLS) based on Phillips and Hansen (1990, 1995). The second one is the Canonical Cointegrating Regression (CCR) based on Park (1992), and finally, the Dynamic OLS (DOLS) based on Saikkonen (992 and Stock and Watson (1993) in which Engle and Granger (1987) and Phillips and Ouliaris (1990) residual-based tests, Hansen’s (1992) instability test, and Park’s (1992) added variables test are described, along with various cointegration testing procedures. These methodologies provide a check for the robustness of results and have the ability to produce reliable estimates in small sample sizes.

Each of the three methods has the following advantages: FMOLS modifies least squares to explicate serial correlation effects and for the endogeneity in the regressors that arise from the existence of a cointegrating relationship. DOLS is an approach to construct an asymptotically efficient estimator that eliminates the feedback in the cointegrating system. Technically speaking, DOLS involves augmenting the cointegrating regression with lags and leads, so that the resulting cointegrating equation error term is orthogonal to the entire history of the stochastic regressors innovations. The CCR estimator is based on a transformation of the variables in the cointegrating regression that removes the second-order bias of the OLS estimator in the general case. CCR asymptotically eliminates the endogeneity caused by the long-run correlation. In this context, one uses several methods in order to check the robustness of the empirical results.

3. Empirical Results

Firstly, this section presents the nonlinear relation between per capita consumption and Gini index in order to show the optimal level of income inequality, which is defined as the level of income inequality that maximizes per capita consumption. After that, subsections 4.1 and 4.2 show empirical evidence of the nonlinear effect from some determinant factors on the (Gini - Gini*)^2 based on two empirical approaches, respectively: Robust Last Square and Cointegration Equations. Figures 1 and 2 display the evolution of per capita consumption and Gini index through time. Figure 1 shows the per capita consumption series from 1946 to 2015.

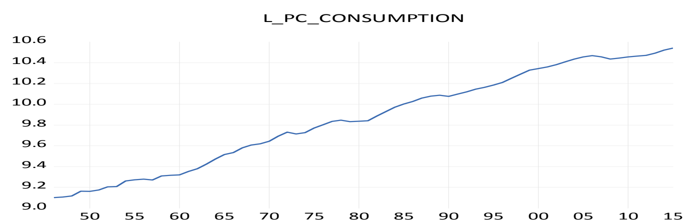

Figure 1. Evolution of per capita consumption

Note: L_PC_Consumption = log(onsumption/population); L= log

In the same way, Figure 2 shows the time series of the Gini index and (Gini index)^2 from 1946 to 2015. Greenspan (2013) reports that in the early postwar years from 1946 to 1970, income inequality was fundamentally stable based on the evolution of income inequality. This is due to a stable relationship between earned wages in jobs that demand repetitive actions at a production line and those employments of cognitive occupation.

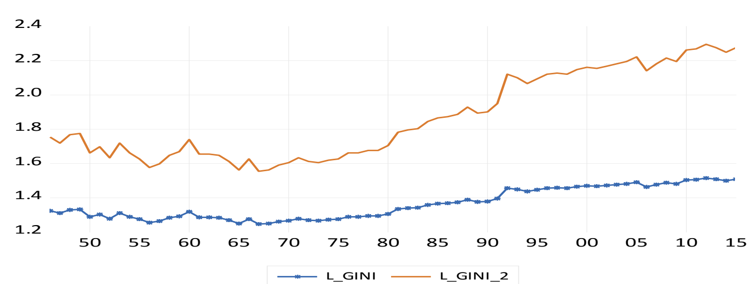

Figure 2. Evolution of L_Gini and (L_Gini)^2

Notes: Gini = Gini Index*10; L = log; L_Gini = Log(Gini); L_Gini_2 = [Log(Gini)]^2

In the 1970s the automation process began, which entailed a gradual substitution of jobs with repetitive work. Competitive foreign products with a lower labor cost, mainly from China and Eastern Asia, increased their market share in detriment of American products. In addition, employees were replaced by increasingly sophisticated robots. In this way, inequality was more visible in the incomes of the American middle class. Consequently, the Gini coefficient began to rise in the 1970s and continued the upward trend in the following years (Greenspan, 2013).

After the initial considerations, the next step is to test a nonlinear relation among per capita consumption, Gini Index, and (Gini Index)^2 with variables in levels. Table 1A and 1B present unit root tests with variables in level and in 1st difference respectively, which show that the time series variables are I(1), i.e., it is integrated of order one. Then, it is necessary to evaluate whether or not there is at least one linear combination of the variables that is integrated of order zero, I (0), and consequently, if there is a stable and non-spurious cointegrated relationship in the long run among L_PC_Consumption, L_Gini and $(L\_Gini)^2$.

The Johansen approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order. The Johansen's maximum likelihood test based on maximal eigenvalue of the stochastic matrix and the trace of the stochastic matrix are shown in tables 1C and 1D. Both tests confirm the existence of a long-run equilibrium relationship among the variables. The optimum choice of lags is 1 based on SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion. The trace and maximum eigenvalue tests (Johansen, 1988, 1991, 1995) indicate one cointegration relation. In this context, the long-run cointegrating equation is given by

$$L\_Consumption\_PC = -70.584 + 107.262*L\_Gini - 40.508*L\_(Gini)^2 \quad (3)$$

$$(26.067) \qquad (38.123) \qquad (13.875)$$

where the values in parentheses are the standard error. Notice that the estimated coefficients for L_Gini and $L\_(Gini)^2$ show positive and negative signs, respectively. In this case, it is a concave curve, and therefore it is possible to estimate the income inequality level maximizing per capita consumption in the long-run. See Figure 3. We have the first order condition

$$d(\text{L\_Consumption\_PC}) / d(\text{L\_Gini}) = 107.262 - 2*40.508*\text{L\_(Gini)} = 0.$$

and hence, L_Gini = 1.324. The antilog is 3.758. The corresponding Gini index is 0.376, a value close to the median (0.380). Taking into account the Dynamic Least Squares (DOLS) Method, the long-run cointegrating equation is given by,

$$L\_Consumption\_PC = 12.43824*L\_Gini - 4.691320*L\_(Gini)^2 + 0.024878*@trend \quad (4)$$

$$(5.337774) \qquad (1.955638) \qquad (0.001098)$$

where the estimated coefficients for L_Gini and $L\_(Gini)^2$ also show positive and negative signs, respectively. In this case, we have the first order condition and hence, L_Gini = 1.326. The antilog is 3.765. The corresponding Gini index is 0.376, a value close to the median (0.379). For purposes of comparison, the Gini index of 2015 is 0.452. Notice that both results based on Johansen approach and DOLS method show that the values of Gini index are practically identical.

Figure 3 shows the value of L_Gini = 1.326, which maximizes the per capita consumption. In this context, considering the time series of the variable L_Gini, it is observed that this value was reached in 1981. Based on the empirical results, we calculate the predicted value of regression 4 in order to display the nonlinear relation between L_Consumption_PC and L_Gini, Figure 3, as follows.

$$Pred\_\ L\_Consumption\_PC = 12.43824*L\_Gini - 4.691320*L\_(Gini)^2 \quad (5)$$

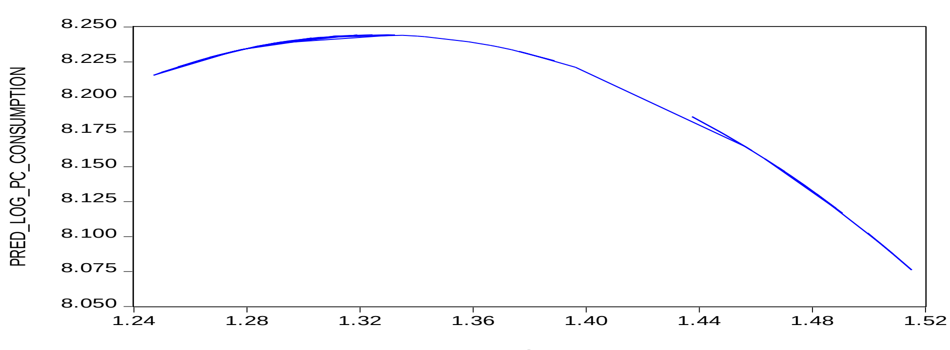

Figure 3. The long-run relationship between Log per capita Consumption and Gini Index

The next step is to show the nonlinear relationships among some determinants of income inequality and the square of the difference between the current Gini index and its optimal index, $(Gini - Gini^*)^2$. Hence, the dependent variable, $(Gini - Gini^*)^2$, is calculated taking into account the difference between the actual Gini index values and its optimal level, in which Gini* = 1.325. After that, we calculate the square of (L_Gini – Gini*). Tables 2 and 3 presented in the next subsections show the nonlinear effects of the exploratory variables, education, openness, taxes, and financial assets, on the dependent variable $(Gini – Gini*)^2$ in the subsections 4.1 and 4.2, respectively, based on equation 2. Table 2 shows regressions via Robust Least Square, while table 3 shows the estimates models based on Cointegrating Regressions.

3.1 Empirical Evidence Based on Robust Least Squares Methods

Table 2 displays three Robust Least Squares models: Model 1 with M-estimation, Model 2 with S-estimation, and Model 3 with MM-Estimation. All the estimated coefficients are statistically significant at the 10% level, except for the constant term from Model 3. Considering the empirical results of the three models, it can be observed that:

On one hand, the variables L_education and $(L\_education)^2$ show the estimated coefficients positive and negative, respectively. It means that there is a nonlinear relation among both variables and $(Gini – Gini*)^2$, which reveals a concave curve. ii) On the other hand, the other variables show the estimated coefficients negative and positive, respectively. In the same vein, there are nonlinear relations among these variables and $(Gini – Gini*)^2$. However, in these cases, there is a convex curve for all of them. iii) At the end of this table, we have the threshold values for every variable based on the respective time series data. Hence, it is possible to know the exact year when the minimum or maximum values took place. For instance, the minimum value of the convex curve (2.660) from L_openness (Model 1) took place in 1973. We also show the mean of the threshold values from Models 1, 2 and 3 (2.668), and its respective year (1973) in which it happened. In other words, from 1946 to 1973, the variable $(Gini - Gini*)^2$ decreased, and after 1973 until 2015 the trajectory of the square of the Gini gap variable increased, i.e., until 1973, the income inequality decreased and after that, it increased due to greater economic openness beyond the threshold. It stands out that the maximum point from L_Education concave curve was not reached yet since the maximum value from its time series is 4.700, while the mean threshold value is 5.787.

Table 2. Empirical results 1: Annual data – 1946-2015

	MODEL 1- Robust Least Squares: (M-estimation)		MODEL 2 – Robust Least Squares: (S-estimation)		MODEL 3 - Robust Least Squares: (MM-estimation)	
Dependent variable: $(L\_Gini – L\_Gini*)^2$	Coefficient (Std.Error)	P-value	Coefficient (Std.Error)	P-value	Coefficient (Std.Error)	P-value
Constant	0.541987** (0.213969)	0.0113	0.711933*** (0.156749)	< 0.00001	0.345582 (0.228576)	0.1306
L_Education	0.103956*** (0.033139)	0.0017	0.075115*** (0.024277)	0.0020	0.124213*** (0.004584)	0.0005
$(L\_Education)^2$	-0.009109** (0.004291)	0.0338	-0.005379* (0.003143)	0.0870	-0.01193*** (0.110937)	0.0092
L_Openness	-0.10142*** (0.026430)	0.0001	-0.09816*** (0.019362)	< 0.00001	-0.08920*** (0.028235)	0.0016
$(L\_Openness)^2$	0.019064*** (0.004784)	0.0001	0.018007*** (0.003505)	< 0.00001	0.017020*** (0.005110)	0.0009
L_Tax	-0.06465*** (0.010462)	< 0.00001	-0.05820*** (0.007664)	< 0.00001	-0.06992*** (0.011176)	< 0.0001
$(L\_Tax)^2$	0.005951*** (0.000912)	< 0.00001	0.005434*** (0.000668)	< 0.00001	0.006433*** (0.000975)	< 0.0001
L_Financial_Assets	-0.10996*** (0.038017)	0.0038	-0.14038*** (0.027850)	< 0.00001	-0.074982* (0.040612)	0.0648
(L_Financial_Assets)2	0.005852*** (0.002083)	0.0050	0.007558*** (0.001526)	< 0.00001	0.003925* (0.002225)	0.0778

Statistics			
Adjusted R-squared	0.414148	0.433352	0.519349
Sum squared resid	0.000566	0.000604	0.000541
Correlation predicted values and observed values	0.967	0.967	0.968
Threshold values and respective years			
L_Education: mean = 5.787	5.176 (beyond 2015)	6.982 (beyond 2015)	5.203 (beyond 2015)
L_Openness: mean = 2.668 in 1973	2.660 in 1973	2.724 in 1973	2.620 in 1973
L_Tax: mean = 5.408 in 1979	5.432 in 1979	5.356 in 1978	5.435 in 1979
L_Finnacial_Assets: mean 9.411 in 2007	9.395 in 2007	9.287 in 2007	9.552 in 2008

Note: *** = p-value < 0,01; ** = 0.01 < p-value < 0.05; * = 0.05 < p-value < 0.10

The next subsection shows a more appropriate empirical approach, considering that all the variables are cointegrated of order one, I (I). Moreover, we show figures which represent a concave or a convex curve according to the nonlinear relation between the square of the Gini index gap, i.e., $(\text{Gini - Gini*})^2$ and every one of the explanatory variables.

3.2 Empirical Evidence Based on Cointegrating Regression Methods

Table 3 shows the estimated models based on Cointegrating Regressions regarding equation 2. The Cointegrating Regressions offer three methods for estimation: Fully Modified OLS (FMOLS), Canonical Cointegrating Regression (CCR), and Dynamic OLS (DOLS). We use all of them to obtain the empirical results of models 4, 5 and 6. All the estimated coefficients are statistically significant at the 10% level. The empirical results of the three models from Table 3 are very similar to Table 2.

Table 3. Empirical results 2: Annual data – 1946-2015

	MODEL 4 – Cointegrating Regression: Fully Modified Least Squares (FMOLS)		MODEL 5 – Cointegrating Regression: Dynamic Least Squares (DOLS)		MODEL 6 - Cointegrating Regression: Canonical Cointegrating Regression (CCR)	
Dependent variable: $(\text{L\_Gini} – \text{L\_Gini*})^2$	Coefficient (Std.Error)	P-value	Coefficient (Std.Error)	P-value	Coefficient (Std.Error)	P-value
Constant	0.874917*** (0.128404)	< 0.00001	0.402705*** (0.123263)	0.0021	0.468894* (0.273478)	0.0916
L_Education	0.078288*** (0.020406)	0.0003	0.141556*** (0.033411)	0.0001	0.121284*** (0.037449)	0.0020
$(\text{L\_Education})^2$	-0.007562*** (0.002621)	0.0054	-0.01422*** (0.004672)	0.0040	-0.011505** (0.004791)	0.0194
L_Openness	-0.107412*** (0.018154)	< 0.00001	-0.11798*** (0.025803)	< 0.00001	-0.076868** (0.036834)	0.0412
$(\text{L\_Openness})^2$	0.018482*** (0.003237)	< 0.00001	0.023417*** (0.005053)	< 0.00001	0.014729** (0.006730)	0.0325
L_Tax	-0.024884***	0.0007	-0.07689***	< 0.00001	-0.07057***	< 0.0001

	(0.006938)		(0.005018)		(0.013401)	
$(L\_Tax)^2$	0.002927*** (0.000600)	< 0.00001	0.006891*** (0.000580)	< 0.00001	0.006552*** (0.001142)	< 0.0001
L_Financial_Assets	-0.189071*** (0.022698)	< 0.00001	-0.07964*** (0.022080)	0.0008	-0.103663** (0.051049)	0.0467
(L_Financial_Assets)2	0.010261*** (0.001244)	< 0.00001	0.004016*** (0.001276)	0.0030	0.005430** (0.002781)	0.0556
Statistics						
Adjusted R-squared	0.867682		0.954835		0.924722	
Sum squared resid	0.000942		0.000217		0.000536	
Correlation predicted values and observed values	0.934 (beyond 2015)		0.929 (beyond 2015)		0.967 (beyond 2015)	
Threshold values and respective years						
L_Education:mean = 5.141	5.176		4.977		5.271	
L_Openness: mean = 2.678 in 1973	2.906 in 1978		2.519 in 1972		2.609 in 1973	
L_Tax: mean = 5.094 in 1975	4.251 in 1967		5.645 in 1982		5.386 in 1978	
L_Financial_Assets: mean = 9.559 in 2008	9.213 in 2007		9.919 in 2014		9.545 in 2008	

Notes: Model 5 - Cointegrating equation deterministics: C @TREND; Model 6 - Cointegrating equation deterministics: C @TREND and Additional regressor deterministics: @TREND^2. *** = p-value < 0,01; ** = 0.01 < p-value < 0.05; * = 0.05 < p-value < 0.10.

Based on the empirical results of table 3 we show the predicted value equation of $(Gini – Gini^*)^2$ in order to display its nonlinear relation with each of the explanatory variables, as follows. We choose the models with the highest correlation between predicted values and observed values.

Based on the predicted value of model 6, it is possible to generate Figure 4 and its maximum point considering a concave-shaped curve, as follows:

$$Pred\_(Gini - Gini^*)^2 = 0.468894 + 0.121284 * L\_education - 0.011505 * L\_education^2 \qquad (6)$$

so that the point of maximum is given by *0.121284*/0.02301 = 5.271, while the mean threshold value is 5.141. Figure 4 shows that the education indicator increases toward the maximum point of the concave curve. However, the empirical result also displays that L_education trajectory did not reach the maximum point yet, and consequently, the increase in real personal consumption expenditures with education is not enough to reduce the square of the Gini index gap, $(Gini – Gini^*)^2$.

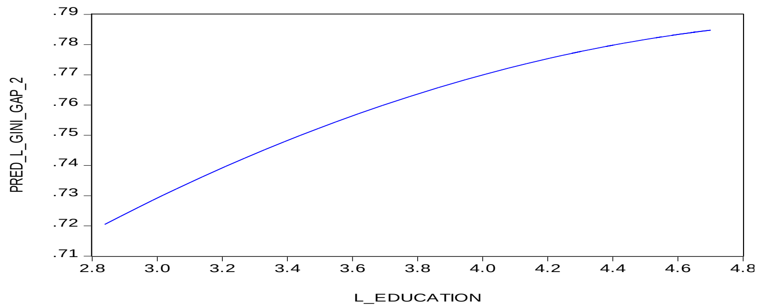

Figure 4. The long-run relationship between $(Gini – Gini^*)^2$ and L_education

Figure 5 shows the trajectory of the real personal consumption expenditures with education and it reveals some interesting aspects. The evolution of the education indicator shows three phases: until the late 1960s, the inclination of the curve is higher than the other phases. There is a lower increment in this education indicator from 1970 to 1990, and from then on, a reduction in the real personal consumption expenditures with education is observed. The behavior of the evolution of this education indicator seems to be explained in figure 4, considering the empirical result in which the US has not yet reached its maximum point.

Coady and Dizion (2017) discuss the relationship between income inequality and education expansion, i.e., the relation between increasing average years of schooling and reducing inequality of schooling. The authors show contradictory empirical evidence based on the positive and negative estimated coefficients between these variables. Based on policy simulations, the authors suggest that education expansion will continue to be inequality reducing. However, this role will diminish as countries develop, but it could be enhanced through a stronger focus on reducing inequality in the quality of education. In this context, this seems to be the case of American income inequality, at least until it reaches the threshold value.

Arshed *et al.* (2018) investigate the idea that education forms a quadratic relationship with income inequality considering for the South Asian Association for Regional Cooperation (SAARC) countries, based on panel data from 1990 to 2015. The empirical results show that initially primary and secondary enrollment increases inequality while tertiary enrollment decreases Hence, it makes inverted U shape for primary and secondary enrollment and U shape for tertiary enrollment.

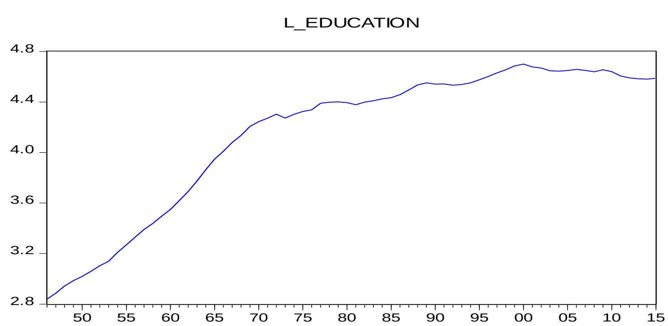

Figure 5. Real personal consumption expenditures evolution with education

In this case, the prescription for public policies should be to invest more on education beyond the maximum point in order to reduce income inequality, i.e., to reduce the square of deviation between L_Gini and Gini*.

Figure 6 shows a convex-shaped curve based on the predicted value of model 6, as follows:

$$Pred\_(Gini - Gini^*)^2 = 0.468894 - 0.076868*L\_openness + 0.014729*L\_openness^2 \quad (7)$$

so that the point of minimum is given by 0.076868 / 0.029458 = 2.609 and its mean threshold value is 2.678, both being reached in 1973. Therefore, until 1973 the income inequality decreased, and it increased after that due to greater economic openness beyond the threshold, as already previously mentioned. Figure 6 shows that if the economic openness increases toward the minimum point of the convex curve, $(Gini - Gini^*)^2$ will decrease, and beyond that point, the income inequality will become higher. Hence, it is necessary to increase these indicators only until the minimum point of the curve to reduce income inequality. Then, an excess of economic openness provides more income inequality.

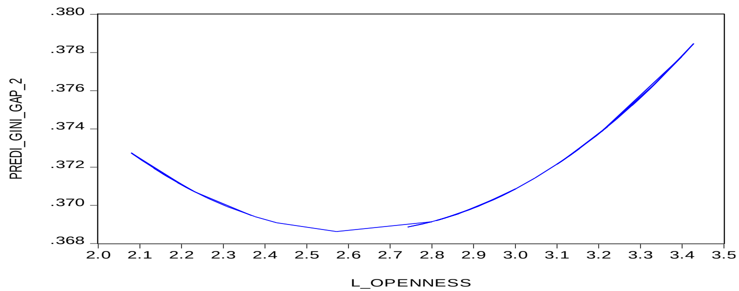

Figure 6. The long-run relationship between $(Gini - Gini^*)^2$ and L_openness

The behavior of the evolution of the economic openness indicator, as shown in figure 7, seems to indicate that there are some phases. The first one appears to be a convex curve, which goes until the 1970s. The second phase also shows a convex curve, albeit not so clear, that goes until the end of the 1990s. From then on, one notices a short increasing trajectory until the 2000s, with a fall in the subprime crisis in 2008, and after 2009 there is a fall in the openness indicator, but it cannot be ensured that it is a tendency.

However, over the entire analyzed period, it can be ensured that there is a growing tendency in the degree of openness of the US economy. Considering that the minimum point from Figure 7 is 2.61 and that it happened between 1972 and 1973, around the oil shock, from then on, the evolution of the economic openness contributes to increasing the America income inequality. Notice that economic openness (L_openness) jumps from 2.609 to 3.28 in 2015, which means an increase of 25.7%.

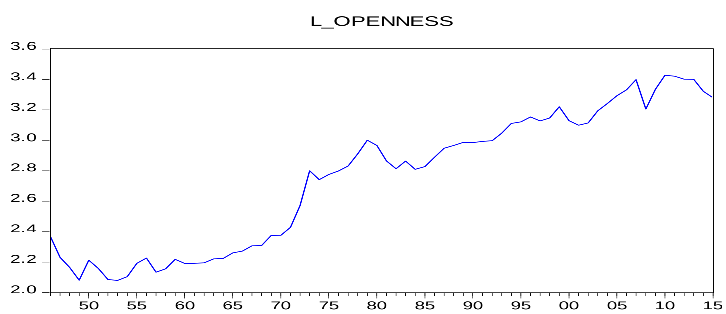

Figure 7. Evolution of economic openness indicator

Kosters 1994 argues that after 1973 and mainly in the 1980s, the US show a pretty low real wage performance for the less skilled workers, mostly due to declining productivity growth associated with increasing wage inequality between skills. It means these factors contributed to the increase in income inequality. In this context, Borjas (1994) highlights the discussion regarding reasons for the inequality starting with the rising inequality which coincided with rising globalization in the form of immigration and trade, noting that the first increased in quantity and declined in quality. Note that based on the empirical results, the threshold value, at which income inequality starts to increase as a result of the higher openness, took place between 1972 and 1973. In this sense, the empirical results are aligned with the literature.

In this context, trade can also play a role in the decline of gross manufacturing job creation by pushing the US economy away from goods production and towards services (Fort, Pierce and Schott, 2018). Moreover, Pierce and Schott (2012) and Asquith, Goswami, Neumark, and Rodriguez-Lopez (2017) show that during the 2000s, industries with relatively greater exposure to trade liberalization with China exhibit both suppressed job creation as well as exaggerated job destruction. On the other hand, part of the migration of industries from the USA to abroad is labor-intensive and, by consequence, increases unemployment of American citizens, so that many workers end up working in less qualified occupations and, therefore, less remunerated. In this sense, all of these facts can contribute to increasing income inequality.

Besides, there is the protection of intellectual property rights (IPRs) problem, which is not respected by China, harming the employment of the American worker. This contributes to depressing the wages of low-skilled labor. Brander, Cui and Vertinsky (2017) stress that China does not meet its international obligations to IPRs, and by consequence, harms the innovation process in China and elsewhere. The authors review the benefits of IPR protection and evaluate the magnitude and cost of China's IPR violations. They argue that as China's IP sector develops, its IPR governance regime might even be used as a strategic tool to further disadvantage foreign IPR holders.

Figure 8 also shows a convex-shaped curve based on the predicted value of model 6, as follows:

$$Pred\_(Gini - Gini^*)^2 = 0.468894 - 0.070574 * L\_Tax + 0.006552 * L\_Tax\_2 \quad (8)$$

so that the point of minimum is given by 0.070574 / 0.013104 = 5.386, which was reached in 1978. If the taxes' indicator increases toward the minimum point of the convex curve, based on Figure 8, the square of the gap of the Gini index from its optimal level will decrease, and beyond that point, the income inequality will become higher.

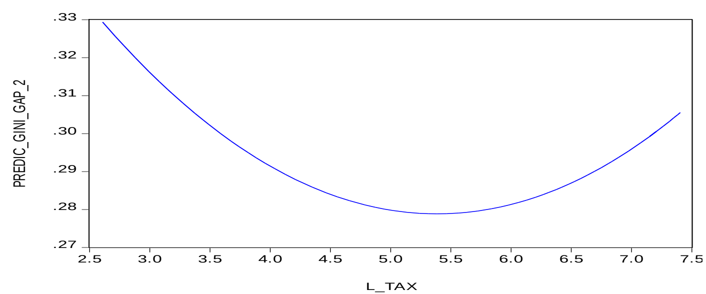

Figure 8. The long-run relationship between $(Gini - Gini^*)^2$ and L_tax

In this case, as expected, in order to reduce inequality, it is necessary to increase the taxes until the minimum point of the curve so as to reduce income inequality. In other words, an excess of tributary burdens generates more income inequality. Notice the taxes' evolution based on Figure 9. It shows that in 2015 the L_Tax value is 7.404. This value is higher than the minimum point of 5.386, which took place in 1978. From then on, the higher the burden tax is, the higher the income inequality will be.

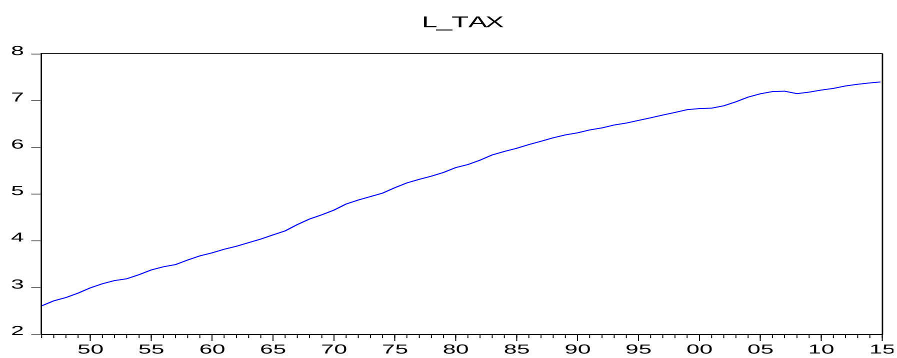

Figure 9. Taxes' evolution

Based on Table 3, we also stress that taking into account that the mean of the threshold value is lower, 5.094; the mean value was reached earlier, in 1975. Therefore, up to 1975, income inequality decreased, and it increased beyond the mean from the threshold value.

One of the main arguments against the existence of a mechanism that reduces inequality as a result of the high taxes due to high governmental expenses is that it significantly affects capital owners, reducing their wealth and current income (Lyubimov, 2017). In this context, in the last decades, many segments of American industries changed toward countries with lower capital costs, also taking into account lower tax burdens, among other factors. This means that the migration of these firms or industries reduces American worker's employment, as well as their remuneration. In other words, higher taxes can imply less wealth and current income for capital owners, but also for less qualified workers. Moreover, by weakening the relation between rewards and performance, a policy that aims to reduce income inequality based on large tax increases can weaken the relation between rewards and performance (accomplishment) and, therefore, reduce motivation to work hard and achieve excellence (Baron, 2017).

In the same way, Figure 10 also shows a convex-shaped curve based on the predicted value of model 6, as follows:

$$Pred\_(Gini–Gini^*)^2=0.468894-0.103663*L\_Financial\_Assets+0.005430*L\_Financial\_Assets2 \qquad (9)$$

so that the point of minimum is given by 0.103663/ 0.01086 = 9.545, whose value was reached in 2008. We can highlight that the average value of 9.559 was also reached in 2008. Once more, the next figure shows that if the financial assets increase toward the minimum point of the convex curve, $(Gini – Gini^*)^2$ will decrease, and beyond that point the income inequality will become higher. In order to reduce inequality, it is necessary to increase these indicators only until the minimum point of the curve so as to reduce income inequality. Therefore, an excess of financial assets leads more income inequality.

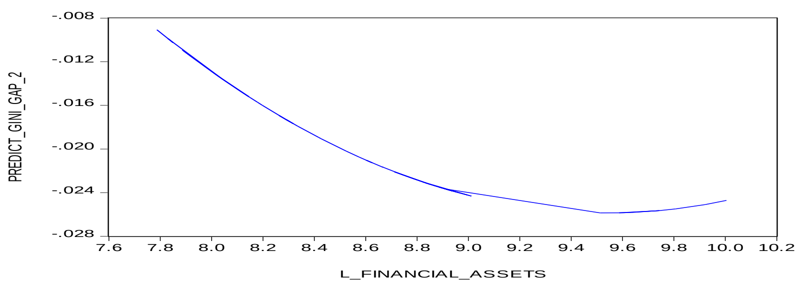

Figure 10. The long-run relationship between $(Gini – Gini^*)^2$ and L_Financial_Assets

At last, Figure 11 displays the evolution of the Financial Assets' indicator. Only in 2008, this indicator reached the threshold value of 9.545 and, from then on, the financial assets increased sharply. This financial indicator reached a value of about 10 in 2015. Hence, the subprime crisis can be responsible for this increase in financial assets.

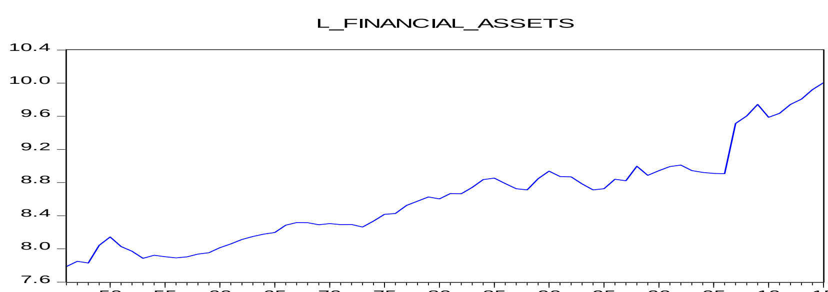

Figure 11. Evolution of L_Financial_Assets

Brei, Ferri, and Gambacorta (2018) evaluate the connection between financial structure and income inequality based on data for a panel of 97 economies from 1989 to 2012. The authors show empirical results, which until a certain point, indicate more finance reduces income inequality. Beyond that point, inequality rises if finance is expanded via market-based financing. This is the case of a concave curve. In this context, our results are compatible with the hypothesis that inequality rises in case finance is expanded via market-based financing, which is a proxy for the expansion of financial assets.

4. Discussion

The main contribution of this paper is to characterize the income inequality level maximizing per capita consumption for the U.S. economy in the period of 1946 to 2015. Based on cointegration analysis, we find a long-run concave nonlinear relation between log per capita consumption and the log Gini Index. The empirical analysis indicates that the optimal level of income inequality is 0.376. In sum, there exists an income inequality level which maximizes the per capita consumption. Facing this issue, we display empirical evidence that there are nonlinear relationships among some determinants of income inequality and the square of the difference between the current Gini index and its optimal index, $(\text{Gini} - \text{Gini}^*)^2$. The results show that: i) if the education indicator increases toward the maximum point of the concave curve, $(\text{Gini} - \text{Gini}^*)^2$ will increase, and beyond that point, the income inequality will reduce. This means that in order to reduce inequality, it is necessary to invest in education beyond the maximum point. Therefore, more education is better; ii) if the indicators of economic openness, taxes and financial assets increase toward the minimum point of the convex curve, then $(\text{Gini} - \text{Gini}^*)^2$ will decrease and, beyond that point, the income inequality will increase.

However, it is important to check which year the threshold value took place in order to know what period each explanatory variable has contributed to the increase or decrease in income inequality. Considering the analyzed period from 1946 to 2015, at first, openness and taxes have contributed to the increase in inequality approximately since the mid-1970s. In this way, one can note that for about 40 years these variables have contributed to increasing income inequality. Second, financial assets also have contributed to inequality since 2008. However, from 1946 to about 2007, these financial assets, which include credit, have contributed to generating lower income inequality. The key question is whether it is possible to reduce or significantly mitigate these three variables via public or economic policies. Although more recently there have been policies from the American government to mitigate, to some extent, the effect of these variables, relevant effects on inequality of income cannot be expected. It seems that the target of such policies has not been to reduce inequality, but to improve the competitive conditions and business environment of the American economy.

Moreover, the empirical results show that investing on education may be the best option to reduce income inequality. The relation between $(\text{Gini-Gini}^*)^2$ and education shows a concave-shape curve in which the threshold value wasn't reached yet. This means that personal consumption of education since 1946 has contributed to increasing inequality, albeit at ever lower rates. However, once the threshold value is reached, more education consumption could reduce income inequality, which can result in better equality of opportunity for most of the American population. In terms of public policies, the increase in education consumption must also be large and comprehensive enough to include most of the American population.

Acknowledgment

I thank Geraldo da Silva e Souza for their relevant comments and contributions to this paper and CNPq, once this study was funded by this institution of research.

References

Aguiar, M., & Bils, M. (2015). Has Consumption Inequality Mirrored Income Inequality?. *American Economic Review*, *105*(9), 2725-2756. https://doi.org/10.1257/aer.20120599

Arshed, N., Anwarn, A., Kousar, N., & Bukhari, S. (2018, November). Education Enrollment Level and Income Inequality: A Case of SAARC Economies. *Social Indicators Research, 140*(4), 1-14. https://doi.org/10.1007/s11205-017-1824-9

Asquith, B. J., Goswami, S., Neumark, D., & Rodriguez-Lopez, A. (2017). U.S. Job Flows and the China Shock. *NBER Working Paper 24080*. https://doi.org/10.3386/w24080

Attanasio, O. P., & Pistaferri, L. (2016). Consumption Inequality. *Journal of Economic Perspectives, 30*(2), 3-28. https://doi.org/10.1257/jep.30.2.3

Attanasio, O., & Pistaferri, L. (2014). Consumption Inequality over the Last Half Century: Some Evidence Using the New PSID Consumption Measure. *American Economic Review, 104*(5), 122-26. https://doi.org/10.1257/aer.104.5.122

Baron, R. (2017). Income inequality: How efforts to reduce it can undermine motivation – and the pursuit of excellence. *Journal of Entrepreneurship and Public Policy, 6*(1), 2-10. https://doi.org/10.1108/JEPP-07-2016-0028

Borjas, G. (1994). The Economics of Immigration. *Journal of Economic Literature, 32*, 1667-717. https://doi.org/10.3386/w4955

Brander, J. A., Cui, V., & Vertinsky, I. (2017). China and intellectual property rights: A challenge to the rule of law. *Journal of International Business Studies, 48*, 908-921. https://doi.org/10.1057/s41267-017-0087-7

Brei, M., Ferri, G., & Gambacorta, L. (2018). Financial structure and income inequality. *BIS Working Papers No 756*, Monetary and Economic Department.

Coady, D., & Dizioli, A. (2017, May). Income Inequality and Education Revisited: Persistence, Endogeneity, and Heterogeneity. *IMF Working paper*, WP/17/126. https://doi.org/10.5089/9781475595741.001

Deaton, A. (2013). *The Great Escape – Health, Wealth, and the origins of Inequality*. Princeton University Press. https://doi.org/10.1515/9781400847969

Engle, R., & Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation and testing. *Econometrica, 55*(2), 251-276. https://doi.org/10.2307/1913236

Fort, T. C., Pierce, J. R., & Schott, P. K. (2018). New Perspectives on the Decline of US Manufacturing Employment. *Journal of Economic Perspectives, 32*(2), Spring, 47-72. https://doi.org/10.1257/jep.32.2.47

Gräbner, C., Heimberger, P., Kapeller, J., & Springholz, F. (2018, December). Measuring Economic Openness: A Review of Existing Measures and Empirical Practices. The Vienna Institute for International Economic Studies. *Working Paper 157*. https://doi.org/10.1007/s10290-020-00391-1

Greenspan, A. (2013). *The Map and the Territory: Risk, Human Nature, and the Future of Forecasting*. Penguin Press.

Hansen, B. E. (1992). Tests for Parameter Instability in Regressions with I (1) Processes. *Journal of Business and Economic Statistics*, *10*, 321-335. https://doi.org/10.1080/07350015.1992.10509908

Heckman, J. J., & Krueger, A. B. (2003). *Inequality in America. What Role for Human Capital Policies?*. The MIT Press, Cambridge, Massachusetts, London, England.

Huber, P. J. (1973). Robust Regression: Asymptotics, Conjectures and Monte Carlo. *The Annals of Statistics*, *1*(5), 799-821. https://doi.org/10.1214/aos/1176342503

Johansen, S. (1991, November). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, *59*(6), 1551-1580. https://doi.org/10.2307/2938278

Johansen, S. (1995). *Likelihood-based Inference in Cointegrated Vector Autoregressive Models*. Oxford: University Press. https://doi.org/10.1093/0198774508.001.0001

Johansen, S. (1988, June-September). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamic and Control, 12*(2-3), 231-254. https://doi.org/10.1016/0165-1889(88)90041-3

Kosters, M. H. (1994). An Overview of Changing Wage Patterns in the Labor Market. In J. Bhagwati, & M. H. Kosters (Eds.), *Trade and Wages: Leveling Wages Down?*. Washington, D.C.: AEI Press.

Lyubimov, I. (2017). Income inequality revisited 60 years later: Piketty vs Kuznets. *Russian Journal of Economics*, (3), 42-53. https://doi.org/10.1016/j.ruje.2017.02.003

Park, J. Y. (1992). Canonical cointegrating regression. *Econometrica, 60*, 119-143. https://doi.org/10.2307/2951679

Phillips, P. C. B., & Hansen, B. E. (1990). Statistical interference in instrumental variable regression with I (Aghion et al., 1999) process. *Rev. Econ. Stud., 57*, 99-125. https://doi.org/10.2307/2297545

Phillips, P. C. B., & Hansen, B. E. (1995). Fully modified least squares and vector autoregression. *Econometrica, 63*(5), 1023-1078. https://doi.org/10.2307/2171721

Phillips, P. C. B., & Ouliaris, S. (1990, Jan.). Asymptotic Properties of Residual Based Tests for Cointegration. *Econometrica*, *58*(1), 165-193. https://doi.org/10.2307/2938339

Pierce, J. R., & Schott, K. P. (2012). The Surprisingly Swift Decline of U.S. Manufacturing Employment. *NBER Working Paper 18655*. https://doi.org/10.3386/w18655

Piketty, T. (2015). About Capital in the Twenty-First Century. *American Economic Review, 105*(5), 48-53. https://doi.org/10.1257/aer.p20151060

Risso, W. A., Punzo, L. F., & Carrera, E. J. S. (2013). Economic growth and income distribution in Mexico: A cointegraion exercise. *Economic Modelling, 35*, 708-714. https://doi.org/10.1016/j.econmod.2013.08.036

Rousseeuw, P. J., & Yohai, V. J. (1984). Robust Regression by Means of S-Estimators. In J. Franke, W. Härdle, & D. Martin (Eds.), *Robust and Nonlinear Time Series*, *Lecture Notes in Statistics No. 26*. Berlin: Springer-Verlag. https://doi.org/10.1007/978-1-4615-7821-5_15

Saikkonen, P. (1992). Estimation and Testing of Cointegrated Systems by an Autoregressive Approximation. *Econometric Theory*, *8*, 1-27. https://doi.org/10.1017/S0266466600010720

Stiglitz, J. E. (2013). *The Price of Inequality*. W. W. Norton & Company Ltd, New York, London. https://doi.org/10.1111/npqu.11358

Stiglitz, J. E. (2016). *The Great Divide – Unequal Societies and What we can do About Them*. W. W. Norton & Company, April 25.

Stock, J. H., & Watson, M. (1993). A simple estimation of cointegrating vectors in higher order integrated system. *Econometrica, 61*, 783-820. https://doi.org/10.2307/2951763

Yohai, V. J. (1987). High Breakdown-Point and High Efficiency Robust Estimates for Regression. *The Annals of Statistics*, *15*(2), 642-656. https://doi.org/10.1214/aos/1176350366

Zingales, L. (2012). *A Capitalism for the People: Recapturing the Lost Genius of American Prosperity*. Basic Books, United States, June 05.