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Income Inequality:

Dynamics and causal factors

Supervisor
Ch. Prof. Antonio Paradiso

Graduand
Andrea De Poi
Matriculation Number 989510

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Contents

1.Introduction

Inequality has always characterized our society but, nowadays, it is a theme more current than ever. Globalization, technological progress, education, overpopulation and resources scarcity are just some of the main topics that are associated with the issue of distribution of income and wealth.

Historically, it has been illustrated in different areas such as cinema and literature and it has involved many researchers from different study areas like sociology, anthropology, economics, philosophy, etc. Statisticians such as Corrado Gini, Henri Theil and Anthony Barnes Atkinson have proposed statistical techniques to study the matter of income distribution in a systematic and methodological way. In the economic literature, David Ricardo with his *Scarcity Principle*, Karl Marx with the '*principle of infinite capital accumulation'* theory, Simon Kuznets theory on the evolution of inequality over time and Robert Solow *neoclassical growth model* are some of the economic theories used to study inequality.

One of the main issues associated with the study of inequality has always been the unavailability of data, especially concerning fiscal data and the lack of a unique regulation about the measurement of individual's economic situation.
In fact, only with a long-term dynamic perspective it is possible to understand a phenomenon in depth. However, there has been some progress in this regard, thanks to the introduction of the World Top Income Database that, at the moment, it is the best available database that provides homogenous series on income inequality for more than 30 countries with a time coverage that started in 1980.

Within the purpose of this thesis, *Section 2* examines the main inequality measures that are present in the literature, highlighting the main advantages and disadvantages and indicating their limits. *Section 3* consists of the time series analysis on income distribution relative to Italy, the USA and other four European countries (France, Spain, Norway, Sweden) with a similar basic social fabric and system organization for the period 1970-2018. Lastly, *Section 4* discusses some of the main decisive factors that impact on inequality. At the end, econometric analysis is used to examine the relationship between the selected drivers of inequality comparing the expected results with the obtain values from the analysis.

2. Inequality measures

Inequality is a complex phenomenon that depends on different factors which cannot be included in a unique structural framework. The concept of inequality is linked to both social and economic aspects and overtones that should be considered together in the analysis as it takes into consideration questions of equity and social justice.

In literature, due to the awkwardness of the subject, some assumptions and principles are slipped in to clarify the limits of the analysis. Thus, the standard of equality can be interpreted in diverse ways and, consequently, it conceived different objectives and outputs. Extensive polysemy means in literature there are many definitions of the concept of inequality.

In general, the term 'inequality' suggests differences in two or more given quantities and measuring this gap is one of the aims of studying this issue. Undoubtedly, equality is directly connected with the idea of equity that is one of the fundamental concepts of welfare economics, but it assumes a wide application in different fields of study.

In economic literature, equity is explained through the concept of distributive justice, namely the fair and equal distribution of goods among the population and it occurs when the resources are allocated.

It is also possible to distinguish between horizontal equity and vertical equity: the former states that 'equals', in the sense of homogenous groups of the society, should be treated equally, whereas, the latter is used in the context of tax law as it justifies the different tax treatment of individuals with different ability to pay.

Many types of inequality exist in the society. They can be conceived in terms of different rights, or considering the unequal access to resources, the unequal treatment of equals, and so on.[1] In this essay inequality will be considered in terms of income distribution as it is more related with the economic aspect.

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[1] Martin Rein and S.M.Miller identified the notion of the various goals of greater income equality and indicating the diversity of views that the concept of inequality suggests. (Rein, M. and Miller, S. M. (1974) '*Standards of Income Redistribution*', Challenge (05775132), 17(3), p. 20. doi: 10.1080/05775132.1974.11470052.)

Moreover, some economists distinguish between the notions of 'equality of opportunity' and 'equality of outputs'. Realization of equal opportunities look at the implementation of an appropriate access system to resources, initial allocations in the society with the aim of providing an equal starting point for everyone and adding value to efforts and merits.

Equality of outputs, instead, is concerned with the redistributional activity that occurs when the society and economy are unable to provide an adequate system of wealth equality. Although they are conceptually different, inequality of outcome directly affects the equality of opportunity for the next generation. (Cf. Atkinson A. 2015)

2.1. Income distribution

First of all, a fundamental aspect to consider is the interpretation associated with the concept of income and the difficulties inherently incorporated in the analysis.

One general definition of income inequality is that the wealth is unequally distributed among the participants in the economy.

More precisely, in economic literature there is a substantial difference between economic wealth and income. Although both can be considered as individual utility levels, the former represents the individual property in terms of assets that is measured at one specific time whereas the latter is the individual wealth produced over an interval of time. In other words, wealth is a *stock* variable and it may be accumulated over time, while in contrast, income is a *flow* variable measured per unit of time.

Therefore, inequality can be measured both in terms of wealth and incomes or, in some circumstances, it is possible to considered them together as in the case of the Italian Household Economic Situation Indicator ('Indicatore della Situazione Economica' *ISE*) that is obtain with:

$$ISE = annual\ Income + 20\%\ total\ assets \qquad (1)$$

Furthermore, when it defines the concept of "income distribution" the economic literature distinguishes between "*primary distribution*" and "*secondary distribution*": the former concerns the classical economic theory about the output allocation among the three basic factors of production (natural resource, labour and capital stock) while the latter regards the distribution of income (defined as a flow) and wealth (stock) within the basic social unit (individuals, nuclear families or extended families of the society). [2]

In other terms, the '*primary distribution'* or '*functional distribution of income*' analyses the distribution of wealth among the three major divisions created by the social stratification of the classical view of an economic system (upper class, middle class, and lower class) with the corresponding type of income of factor payments (profit, rent, interests and wages).

On the other hand, the theory of '*secondary distribution*' or '*personal distribution*' reflects the significant change in the social structure, from homogeneous to heterogeneous society and labour market, that brought researchers to focus more on individuals and other forms of aggregation of income among the individuals in a given population (families and cohabitants). (Cf. Baldini e Toso 2004)

In addition, economists usually distinguish between '*pure redistribution'* and '*efficient redistribution*'. Pure redistribution is a sort of redistribution mechanism from the better-off to the worse-off (purely for social justice), which occurs when the market equilibrium is already Pareto efficient; i.e. when it is impossible to alter allocation of resources and output in such a way that everyone gains. On the other hand, "efficient redistribution" happens when resources in the economy are not distributed in an efficient way (inefficient allocation) and a direct intervention in the production process through income redistribution serves to improve both equality and efficiency. (Cf. Piketty 2003)

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[2] Classical economists such as Adam Smith, Thomas Malthus and David Ricardo focus attention on the primary distribution.

2.2. Different approaches

Research in the field of measuring income inequality has evolved over time starting with a statistical approach, through a social welfare approach and up to an axiomatic (or structural) approach.

The statistical approach is based on objective measures that can also be applied in the study of other variables (such as measuring concentration of weights and heights in a population) and because they are mainly based on statistical concepts.

The social welfare approach introduced an explicit connection between the inequality measures and the social welfare functions.[3]

Lastly, the axiomatic approach established some properties ("axioms") that an inequality measure should satisfy to be suitable for the purpose for which it is processed. (Cf. Baldini e Toso, 2004)

Those characteristics are:

- *Symmetry (*or *anonymity):* given a vector of incomes *v*, any permutation of *v* does not change the index value.

- *Income scale independence:* the inequality index does not change if every income is multiplied by the same constant[4]. This implies that if there is a change in the total amount of wealth that does not alter the distribution of income, this will not modify the inequality index.

- *Principle of population:* if the incomes in a distribution are replicated *k* times, the inequality index does not change as the inequality distribution is the same.

- *Decomposability:* the inequality index is decomposable into subgroups if it can be expressed as a function of inequality within the constituent subgroups and

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[3] This method makes inequality judgements and derives inequality measures from social welfare functions that rank all the possible states of society in the order of preference (Frank A. Cowell, 2011, "Measuring Inequality").

[4] This axiom implies that inequality is based on the relative difference between rich and poor and it does not depend on the absolute difference.

inequality between the subgroups.[5] This principle implies that if there is a decrease in the value of one subgroup inequality it will also diminish the aggregate index value.

- *Weak Principle of transfer (Pigou-Dalton)* states that every transfer of wealth from a rich to a poor individual that does not change the individual ordering will decrease the inequality index value.[6]

- *Strong principle of transfers* is an improvement of the previous Pigou-Dalton axiom because it makes the inequality measures more sensitive to transfers to the lower part of the distribution. In other words, according to this property, the lower is the income recipient of the transfer, the higher will be the reduction of the inequality measure.

All these characteristics are taken into consideration in order to establish the reliability and effectiveness, as well as the advantages and disadvantages, of each inequality index.

The following inequality measures discussed come from the direct application of the previous approaches or, in some cases, from a mix of them.

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[5] The inequality index is decomposable into G subgroups if it can be expressed as the weighted sum of the values of inequality within subgroups (I_g) plus inequality between subgroups (I_B): $I = \sum_{g=1}^{G} \alpha_g I_g + I_B$. (Baldini e Toso, 2004)

[6] More precisely, given two individuals (A and B), with respective incomes y_A and y_B where $y_A = y_B + \delta, \delta > 0$, a positive transfer of income $\Delta y < \frac{\delta}{2}$ from y_A to y_B will decrease the inequality index.

2.3. Synthetic indexes

In statistics, a synthetic index of inequality is a function $I: D^N \rightarrow R^1$ that associates every distribution of income to a number that measures the level of concentration: it is possible to determine if the distributions have the same level of inequality or which is the least unequal. Thus, the index permits to have a comprehensive system to order all the possible distribution of incomes.

In addition, according to the statistical literature, the essential statistical techniques and methods to study the inequality phenomenon can be divided in two methodologies; those who study the distribution of incomes in terms of variability and those who analyse data concentration. These concepts are closely related but not precisely coincident.

2.3.1. Variability indexes

Variability measures the dispersion of values among their mean or median value, and it indicates if there is heterogeneity or homogeneity in the distribution of the data.

Conventional inequality measures based on the concept of variability are the following index:

- Variance:

$$\sigma^2 = \frac{\sum(y_i - \mu)^2}{N} \tag{2}$$

It is defined as the average of the squared differences from the mean and, in this analysis, it measures the distribution of the individual's income y_i around the mean income μ.

According to the axioms mentioned above, this index respects all the properties apart from the *Income scale independence*. In order to get around this problem, there are the following methods in literature. [7]

- Coefficient of variation

$$c = \frac{\sigma}{\mu} \tag{3}$$

Through the standardization of the variance, we obtain the coefficient of variation that is a pure number and consequently independent on the scale.

Nevertheless, this index does not satisfy the *strong principle of transfers* and it is very sensitive to the presence of extreme values of incomes.

- Logarithmic variance (v) and variance of the logarithms of incomes (v_1)

$$v = \frac{1}{N}\sum\left[\log\left(\frac{y_i}{\mu}\right)\right]^2 \tag{4.1}$$

$$v_1 = \frac{1}{N}\sum\left[\log\left(\frac{y_i}{y^*}\right)\right]^2 \tag{4.2}$$

Logarithmic variance (v) is obtained with the logarithm of mean income μ, whereas variance of the logarithms of income (v_1) is defined as the mean of the logarithm of income y^*.

In addition to the other axioms, these two logarithmic transformations permit to satisfy, the strong principle of transfers but, on the other hand, they do not respect the Pigou-Dalton principle since high income values can alter the transfer effect. They cannot also be decomposed into component subgroups.

[7] If you multiply the incomes for a constant k, the new variance is multiplied by k^2. This is due to one of the fundamental properties of the variance: $\sigma^2(kx) = k^2\sigma^2(x)$.

It is possible to use the *mean logarithmic deviation (L)* to obtain an index that satisfy all the required axioms except for the population independence[8]. This is:

$$L = -\frac{1}{N}\sum_{i=1}^{N}\frac{\ln y_i}{\mu} \tag{4.3}$$

2.3.2. Concentration index

Concentration can be defined as follows: given a population of N individuals and a set of income values x_i with additive and transferability characteristics, that are ordered in ascending way $x_1 \leq x_2 \leq x_3 \leq \cdots \leq x_N$, concentration of N values $x_1, x_2, \ldots, x_N$ is the way the summation $T = \sum x_i$ is distributed among the N individuals. (Cf. Vajani 1974)

The Lorenz Curve is mainly based on the concept of the concentration ratio and it is fundamental to introduce the most famous Gini index most used in inequality analysis.

Lorenz curve and Gini coefficient

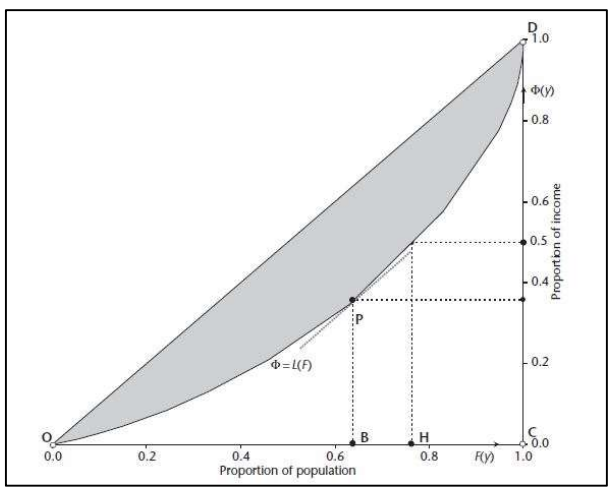

Figure 1.1
Source: "Measuring Inequality", Frank A. Cowell, 2011.

[8] This index is obtained using the generalized entropy index: $E_\alpha = \frac{1}{\alpha^2-\alpha}[\frac{1}{N}\sum_{i=1}^{N}(\frac{y_i}{\mu})^\alpha - 1]$ with $\alpha = 0$ (Baldini e Toso, 2004).

The Lorenz curve is not a synthetic index of inequality but is a relative measure that is often used to represent graphically the distribution of incomes within a population and the corresponding concentration level.

It identifies the proportion of income *φ(y)* with the corresponding proportion of population *F(y),* where the population is arranged in ascending order of income (*Figure 1).*

In other terms, if the total amount of wealth available in a society is represented as a cake, the Lorenz curve indicates each portion of the cake assigned to a segment of the population.

In the case of perfect equality, the Lorenz curve is represented with the bisector of the first quadrant angle (*OD*) as, in this situation, *k* % of the population receives *k* % of the cake. The opposite situation of perfect inequality occurs when only one individual of the society holds all the wealth, that is when the curve lays along the right angle between the segment *OC* on the horizontal axis and the segment *CD* on the vertical side.

Apart from these two borderline cases, in general, the Lorenz curve lies below the line of equality with a positive and increasing slope and a convexity structure.

In *Figure 1*, point P represents the coordinate where the slope is parallel to the segment OD and the proportion of the population that has the mean income or less, whereas, at point H half of the wealth has been distributed.

Furthermore, when we compare two different types of distribution, curve A and B, we state that A dominates B if, whatever proportion of people *F(y)* is chosen, this group gets a larger proportion of incomes *φ(y)* in A than in B.

In addition, the concept of "dominance" derives from the social welfare approach based on the social welfare function (*SWF*). SWF ranks all the possible states of society in the order of preference and affirms that, given two different social states,

A and B, with the associated welfare levels W_A and W_B, the social states A dominates B if $W_A > W_B$.[9]

As a result, if the two social states A and B have the same total wealth but with a different distribution of incomes $\varphi(y_A)$ and $\varphi(y_B)$, the Lorenz curve of A dominates B if and only if $W_A > W_B$.

In general, the Lorenz curves intersect and hence, from the diagram, it is not possible to determine which is the more equal situation.

Gini index comes to help when Lorenz criterion is unable to establish which distribution is more equal.

This index is the geometric interpretation of the Lorenz curve and it corresponds to the concentration ratio, that is the ratio of the area between the line of perfect equality and the Lorenz Curve ('*concentration area'* of the shaded area in *Figure 1*) to the area of the right triangle *OCD.*

$$G = \frac{concentration\ area}{OCD\ triangle\ area} \tag{5}$$

In the literature there are different versions of the formula to compute the value of Gini Index.

In the case of discrete distribution, one version is the following:

$$G = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}|y_i - y_j|}{2N^2\mu} \tag{6}$$

Where N is the population size, $\Delta = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N}|y_i - y_j|}{N^2}$ is the mean absolute difference between all the individual incomes and μ is the average income value. In this case, G varies from 0 (in the case of perfect equality) to the maximum value $\frac{N-1}{N}$ (maximum concentration).

[9] The theory of welfare specifies also all the properties that a SWF should satisfy. (Frank A. Cowell, 2011, "*Measuring Inequality*").

Gini index satisfies the properties of *Symmetry, Income scale independence, the principle of population* and *the Pigou-Dalton axiom.*

Conversely, it does not respect the *strong principle of transfers;* given a transfer between two individuals, what influences the Gini Index is not the income differences but the distance between the respective positions of individuals on the ordinal scale of income. In addition, transfers near the modal value of the distribution will have greater impact on the index.

In addition, the Gini index can be exactly decomposed into *within* and *between* components only if the groups subdivisions do not present overlapping in the distribution.[10] In fact, G can be decomposed as $G = G_W + G_B + R$, where G_W is the *within* component, G_B is the *between* component and R is the residual that occurs if there is overlapping. The Gini index is not subgroup consistent and so it does not respect the decomposability principle.

Another point worth noting is that Gini and all the variability measures that have been considered up to now, provide values to which a unique distribution of incomes do not correspond.

In fact, Gini is obtained through the measure of Lorenz diagram areas and, as a result, many different situations could exist that give the same value.

2.3.3. Theil's entropy index

This index was introduced by Henri Theil, but it comes from the implementation of the Claude Shannon information theory in the field of statistics as it incorporates the concepts of entropy and probability distribution to provide a new inequality measurement.

Basically, given the information value of a message $h(p_i)$, about the occurrence of one uncertain event ω_i to which is associated a probability p_i, with $0 < p_i < 1$, we can measure the average information content of the system, namely entropy, if we

[10] Overlapping occurs when the groups are sorted by average income and the richest individual of the poorest group has greater income than the poorest of the next group.

add up all the information values of messages concerning independent events and weighting in relation to the respective probability.

The assumption is that the lower the probability that the uncertain event will occur, the greater the information value of the event itself and, as a result, $h(p_i)$ is a decreasing function of p_i.

In the inequality study, this is meant as: if there exists perfect equality in the income distribution, it is easy to forecast the individual income level that is randomly picked in a population.

Thus, we have:

$$entropy = H = \sum_{i=1}^{N} p_i h(p_i) \tag{7}$$

This is the weighted sum of all the information values for the various events ω_i.

In addition, the events must be statistically independent so that the probability that one event occurring does not depend on the occurrence of another event.

Hence, we have $h(p_1 p_2) = h(p_1) + h(p_2)$ only if $h = -\log(p)$ and so:

$$H = -\sum_{i=1}^{N} p_i \log(p_i) \tag{8}$$

Theil reinterpreted the entropy concept and obtained the inequality index as the difference between the maximum possible value of entropy and the actual entropy. He considered N possible events as the number of populations, the probability p_i as the ratio of individual income i to total income, namely $s_i = \frac{y_i}{N\mu}$, with $\sum_{i=1}^{N} s_i = 1$ and $s_i = \frac{1}{N}$ in the case of maximum entropy value.[11]

So, we have:

[11] The case of maximum entropy corresponds to perfect equality in the distribution of incomes as $y_i = \mu$ and so $H_{max} = \sum_{i=1}^{N} \frac{1}{N} h(\frac{1}{N})$.

$$T = \sum_{i=1}^{N} \frac{1}{N} h\left(\frac{1}{N}\right) - \sum_{i=1}^{N} s_i h(s_i) \tag{9}$$

After the substitution of $h = -\log(p)$, we obtain:

$$T = \frac{1}{N} \sum_{i=1}^{N} \frac{y_i}{\mu} \log\left(\frac{y_i}{\mu}\right) \tag{10}$$

Consequently, the Theil index will be close to *0* (low level of inequality) if the actual entropy of the income distribution is close to the maximum value of entropy H_{max} whereas it will be higher (high level of inequality) with low actual entropy values.

In general, all the entropy measures satisfy all the required axioms and, in particular, the perfect decomposability property allow to measure the inequality *within* and *between* subgroups (T_W *and* T_B) without any residuals ($R = 0$) and to explain their weight on the total index.

$$T = T_W + T_B \tag{11}$$

Therefore, this index is recommended in the study of the evolution of inequality over time or when comparing homogenous groups such as social classes, geographic areas, etc.

2.3.4. Atkinson index

This index has an explicit connection with the social welfare approach as it takes into consideration the fundamental welfare principles.

Firstly, let us reconsider the social welfare function (*SWF*) mentioned above:

$$W = \sum_{i=1}^{N} U(y_i) = U_1(y_1) + U_2(y_2) + \cdots + U_N(y_N) \tag{12}$$

In this way, social welfare is represented as an additive function of the social utility $U(y_i)$ of individual i that increases with y_i. In other words, $U(y_i)$ represents the valuation given by society of an individual income (*social utility function*).

Secondly, every modification in the distribution of incomes will cause a change in the social welfare. In fact, this will be equal to the summation of all the individual income variations multiplied by the respective *welfare weights* $U'(y_i) = \frac{dU(y_i)}{dy_i}$ (also called *social marginal utility*). Thus, variation of *SWF* caused by a change in the distribution is:

$$dW = U'(y_1)\Delta y_1 + U'(y_2)\Delta y_2 + \cdots + U'(y_N)\Delta y_N \tag{13}$$

In addition, the welfare weights $U'(y_i)$ always decreases as y_i and, as a result, the *SWF* is strictly concave.[12]

Another assumption of the *SWF* is the *constant relative inequality aversion:*

$$U(y_i) = \frac{y_i^{1-\varepsilon} - 1}{1 - \varepsilon} \tag{14}$$

Where $\varepsilon > 0$ is a constant parameter which determines the degree of *inequality aversion* as it indicates the percentage reduction of the welfare weight $U'(y_i) = \frac{1}{y_i^{\varepsilon}}$, after a proportional increase in the individual income y_i (*constant elasticity* of the social marginal utility to income). The higher the value of ε, the faster will be the social utility reduction associated to high incomes. Moreover, if $\varepsilon = 0$ society has no inequality aversion and *SWF* is simply the sum of all the individual incomes: $W = \sum_i y_i$.

Atkinson suggests choosing values included in the interval $0 < \varepsilon < 2.5$, and built an inequality measure introducing the '*equally distributed equivalent income*' y_e, which is the theoretical amount of income received by everyone, producing the same overall level of social welfare compared to the actual distribution.

In other words:

$$W = \sum_{i=1}^{N} U(y_i) = NU(y_e) \tag{15}$$

[12] This implies that society has a social preference for the equal distribution: the higher the individual income y_i, the lower the respective welfare weight $U'(y_i)$.

Where $U(y_e) = \overline{U}$ is the average social utility, N is the number of individuals and y_e is obtained with:

$$y_e = \left[\frac{1}{N}\sum_{i=1}^{N} y_i^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{16}$$

Hence, the Atkinson index compares the average actual income μ with y_e and it obtains:

$$A_\varepsilon = \frac{\mu - y_e}{\mu} = 1 - \frac{y_e}{\mu} \tag{17}$$

A_ε indicates the share of total wealth that the society is willing to give up, improving the equality distribution but maintaining the same overall social welfare level. When $A_\varepsilon = 0$ there is perfect equality distribution as $\mu = y_e$ whereas with $A_\varepsilon = 1$ we have the maximum inequality distribution. In other words, the greater the distance between μ and y_e, the higher the inequality level.

The Atkinson index satisfies all the axioms apart from the *strong principle of transfers.*

2.3.5. Other measures

Apart from the inequality indexes mentioned above, in the literature, there are other useful methods used to measure inequality.

One of these is the $P_{90}/P_{10}\ ratio$ based on the concept of percentiles (or quantiles) of income in which the society is divided. P_{10} represents the upper limit of income below which we find the poorest 10% of the population whereas P_{90} is the lower limit of income above which we find 10% of the richest people for a given country.

$P_{90}/P_{10}\ ratio$ is widely used although some authors suggest P_{90}/P_{50}, P_{50}/P_{10} ratios where P_{50} is the median income. *Palma ratio* (2011) is also another measure of inequality that computes the ratio of the richest *10%* of the population's shares of gross national income (*GNI*) divided by the poorest *40%'s* share.

It is also possible to use a set of quantiles to compare income distribution over time using the proportionate movements of the quantiles of the frequency distribution of wages in a given country.

The quantile ratios usually use specific points on the income scale, estimating the income distance in terms of ratios. In this way, they are not sensitive to outlier values of income (extremely high/low values). However, it is also possible to use the ratio between the average value of the first decile *D1* and the average value of the last decile *D10* but, conversely, this method will depend on high/low values of income.

Furthermore, the quantile ratios method does not take the other parts of the distribution into consideration, so, it does not satisfy the transfer principle.

Another approach is based on the study of poverty using a *poverty line* which is the minimum level of income below which we find the extreme poverty bracket or, alternatively, comparing the average income of the poor with the average income of the general population. However, studying the extent of poverty is technically distant from the concept of inequality. In fact, it is possible to have a low level of poverty with high values of inequality.

On the other hand, '*Top-income*' methodologies focus on the evolution over time of the richest brackets of population (*top* 1% indicates the *P100* last percentile, and *top* 10% is the last *D10* decile) and they do not examine the rest of the income distribution.

3. Income inequality over time

In general, the presence of a variety of indexes to measure inequality suggests that, theoretically, the results of the analysis could be ambiguous or inconsistent when the values are contrasting or even when they are neither cardinal nor equivalent. (Cf. Frank A. Cowell, 2011)

The issue occurs because, as previously mentioned, the researchers incorporated different methodologies and criteria of social justice into the construction of the indexes that making them not always comparable and hard to be aggregated.

In addition, data about income and wealth distribution involves difficulties of homogeneity and consistency due to the diversity and complexity of tax systems between countries and the lack of a unique regulation about the measurement of individual's economic situation.

What is more, differences in the definitions applied to different countries affect the comparability of estimates.[1] (Cf. A.B. Atkinson and A. Brandolini 2009)

According to the theory, different notions and methods can potentially generate various types of inequality series creating conflicts of interpretations.[2]

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[1] Atkinson and Brandolini identify all the factors that affects the comparability of income inequality statistics: differences in the nature of source, in quality and in the way data are processed, etc.

[2] T. Blanchet, L. Chancel and A. Gethin identified fifteen potential types of inequality series ("*How Unequal is Europe? Evidence from Distributional National Accounts, 1980-2017*", WID.world working paper n° 2019/06)

3.1. WID methodology

World Wealth and Income Database (WID.world, http://WID.world) provides homogenous series on income inequality for more than 30 countries including trends starting from 1980. It follows methods and concepts consistent with the macroeconomic national accounts using homogenous units of observation and harmonized definition of income.

The benchmark unit of observation is the adult individual aged 20 and over and the 'equal-split' method is used when only incomes data on household and/or couple are available. Their method is based on the notion of 'net national income' (NNI) that is equal to the Gross domestic product (GDP) net of capital depreciation, plus net foreign income received from abroad. Net national income is preferred to Gross domestic product as it takes into consideration net foreign incomes and it cancels the distortive effect on GDP caused by foreign and international companies and problems regarding residence for tax purposes and localization of production. In the same way, net national income can be obtained with the summation of primary incomes of each institutional sector.[3] Therefore, the main data sources are national accounts, income tax data and household income and wealth surveys allowing to make comparisons between countries and regions. The advantage of this methodology is this universal definition of income, which is valid for all countries and over time and its objective of making it independent from the fiscal legislation of the country and year considered. In the Distributional National Accounts Guidelines (DINA) they also distinguish between 'pre-tax national income' and 'post-tax national': the former is the sum of all personal income flows, before taking into account the operation of the tax and transfer system, but after taking into account the operation of the pension system, whereas, the latter is the pre-tax income net all taxes plus all forms of government transfers.[4]

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[3]"*2008 UN System of National Account*" (SNA) international guidelines on macroeconomic national account definition.

[4] In the DINA Guidelines the authors identified two other concepts of income: "pre-tax factor income" (different treatment of pensions compared to the pre-national income) and "post-tax disposable income" (excluding in-kind transfers compared to post-tax national income).

3.2. Reducing inequality

One of the seventeen global goals established in 2015 and included in the 2030 Agenda by the United Nations is reducing inequality between and among countries by 2030. More precisely, the goal 10 within the Sustainable Development Goals (SDGs) establishes ten intermediate objectives among which the so-called 'shared prosperity' target states that ≪by 2030, all countries must progressively achieve and sustain income growth of the bottom 40 percent of the population at a rate higher than the national average≫.

Inequality reduction objective is also explicitly contained into the European Union agenda through the Lisbon Treaty where 'they promote economic, social and territorial cohesion and solidarity among Member States'.[5] In addition, the Treaty on the Functioning of European Union (TFEU) establishes ≪the aim of reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions[6]≫.

According to the theory, the study of inequality can compare standards of living between countries or income distribution within countries. Although they are conceptually different, they provide a wider overview of the evolution of income inequality in the given countries.

Similarly, the investigation on the economic growth of a country should be combined with the analysis about the extent to which the different social groups benefit from growth. Unlike people think, inequality studies reveal the real standard of living with respect to other common standard macroeconomic measures such as per capita GDP.[7] Following this logic, this analysis discusses both the evolution of inequality between and within given countries. In other terms, the '*intra-country inequality*' is measured between inhabitants of the same country whereas '*inter-country inequality'* compares different average national income across countries.

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[5] Article 3 of the Lisbon Treaty.

[6] Article 174 of the TFUE.

[7] "*How Unequal is Europe? Evidence from Distributional National Accounts, 1980-2017*", WID.world working paper n° 2019/06.

The study makes a comparison between Italy and other four European countries (France, Spain, Norway, Sweden) with a similar basic social fabric and system organization. In particular, Italy and Spain are structurally similar as they are located in Southern Europe and their social structure and political system are closely interconnected. Even though, from an economical point of view, Italy presents a higher level of industrialization with a slightly low level of per adult national income compared to Spain.

Secondly, as earlier mentioned, limited amount and/or insufficient overall quality of data on income inequality have forced to take into consideration only countries that provide enough time coverage.

Eventually, available data on USA and Europe are considered as benchmarks and used to describe the actual overall picture of inequality.

3.3. Inequality between certain countries

In order to make a comparison of standards of living between Italy and the other European countries, *Figure 3.1* shows the evolution of per adult national income from 1950 to 2018 in five different European countries (Italy, Spain, France, Norway and Sweden) and the USA.

All countries show an upward trend over the period, but the most marked increase was in per adult national incomes of northern European countries and the USA. In fact, in 2018 the average amount of per adult national income in Norway is more than 63.000 €, about 47.000 € in Sweden and over 54.000 € in the USA.

In particular, Norway and the USA have always recorded higher income levels, but they both improved their performance during the 1990-2007 period, and it starts a period of stability after the 2008 crisis. Sweden, Italy and France have followed approximately the same pattern until the mid-1990s, since they start to perform different trajectories: Sweden has overcome them whilst France plateaued around 36.000 € and Italy started to decline slightly reaching the same level as Spain around 30.000 €.

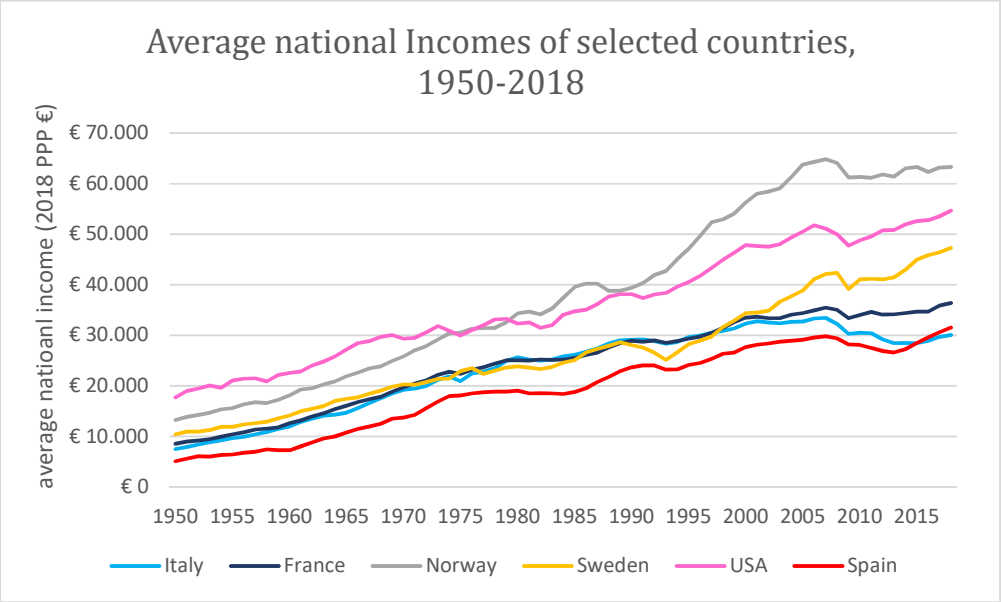


Figure 3.1
Source: Own depiction based on data of World inequality database (WID.world)

In terms of national growth trajectories, *Figure 3.2* represents the evolution of national income growth compared to the European average during the period 1950-2017. The USA, Norway, Sweden and France have always experienced upper levels of average income even if Italy has placed below the European average since 2011. Conversely, Spanish levels of income were always below the European average, although it almost reached the European average during the 1991-2003 period.

On the one hand, it appears clear a substantial increase in the level of wealth measured in terms of average per adult income across the considered countries, but, on the other hand, there is no significant evidence of convergence in the standards of living. Undoubtedly, the 2007-2008 financial and debt crisis contributed to diminish income levels for all countries, but, apparently, Italy and Spain have been the most affected within the selected groups of countries. The impact of financial crisis on the distribution of income will be discussed in the next section.

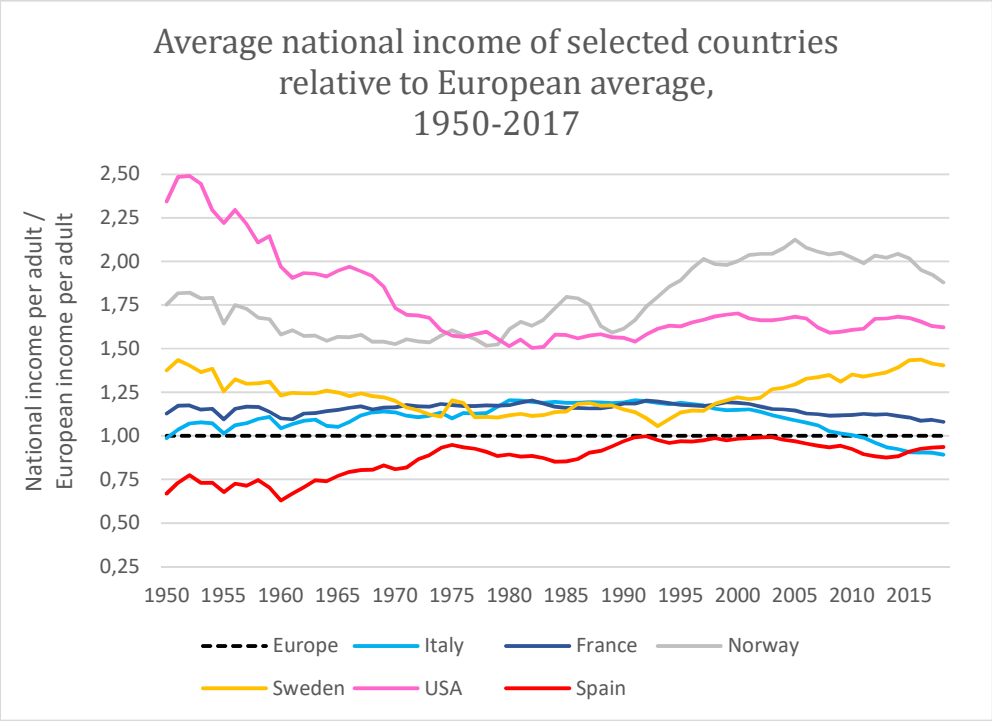


Figure 3.2
Source: Own depiction based on data of World inequality database (WID.world)

3.4. Inequality within certain countries

After having described the main differences in average incomes between selected countries, the analysis will focus on the distribution of income. In other terms, we are going to examine the level of inequality within each country that indicates the differences between inhabitants.

Thus, the discussion will consider data on the distribution of shares of national income across income groups, Gini concentration index and, finally, Theil entropy index to compare Europe with the USA. Unfortunately, the data on shares of national income considered starts from 1980 for most countries, with the exception for France and USA which have a wider time coverage.

3.4.1. 1981 versus 2014

The two graphs (*Figure 3.3* and *Figure 3.4*) give a first general overview of the income inequality dynamics comparing top 10% and bottom 50% shares of national incomes in 1981 and 2014.

In particular, *Figure 3.3* indicates an increase in top 10% shares between the 1981-2014 period since all points lie to the left of the bisector, but the most significant change is in the USA. By contrast, looking at *Figure 3.4,* we note a dip in the bottom 50% shares with the exception of Spain which shows a moderate growth.

It is clear that income disparity in the USA has increased much more than the other European countries, but, in general, this can be applied to all the selected countries, except for Spain that remained unchanged.

Nevertheless, to understand the main differences in the distribution of income for each country, it is necessary to take into consideration further details on income groups of the entire population and the way they capture the share of national incomes.

As a matter of facts, this indicator focuses only on two parts of the distribution (top 10% and bottom 50%) and it does not show what has happened during the period.

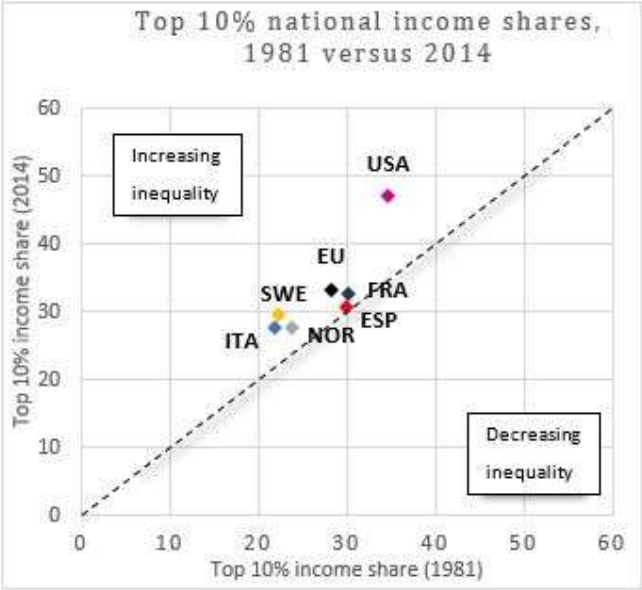


Figure 3.3
Source: Own depiction based on data of World inequality database (WID.world)

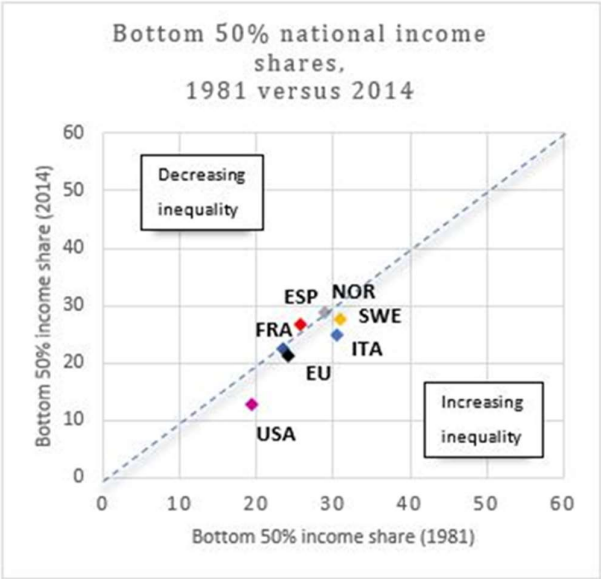


Figure 3.4
Source: Own depiction based on data of World inequality database (WID.world)

3.4.2. Gini Index, income shares distribution and Theil index

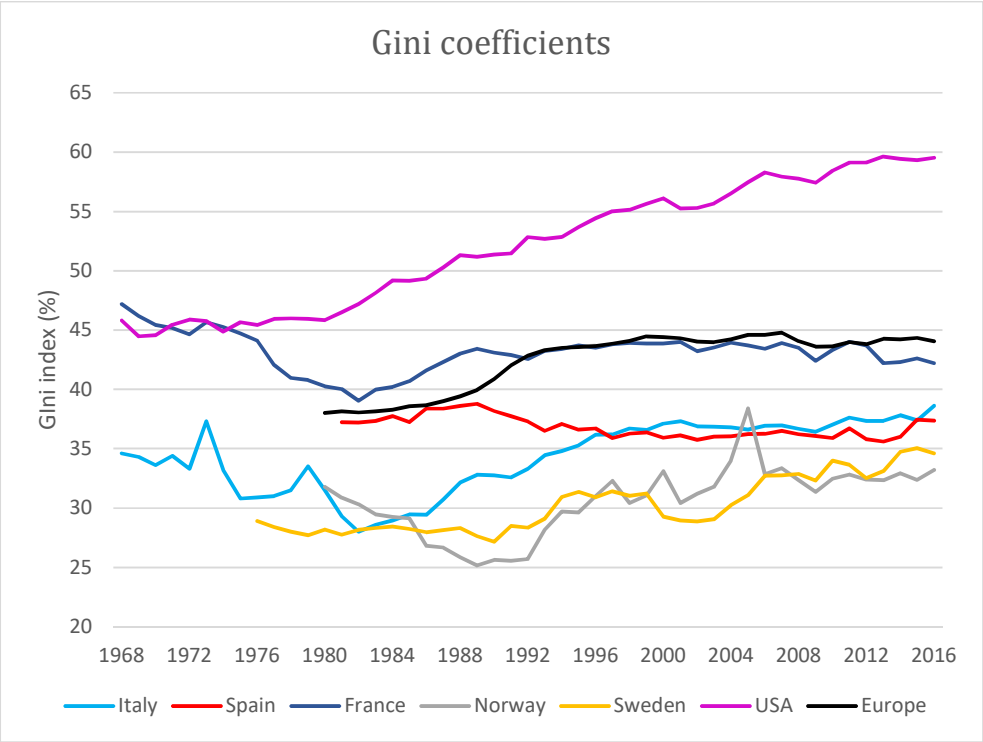


Figure 3.5
Source: Own depiction based on data of the World Inequality Database (WID.world) and Bank of Italy Database

Empirical results on Gini index are presented in *Figure 3.5* and they illustrate the basic trend of inequality within the selected countries.

U.S. and France provide data covering the 1968-2016 period whereas Europe, Spain, Sweden and Norway have more limited amount of data. Gini index trend of Italy has been estimated combining WID values for the 1980-2016 period with data given by Bank of Italy for the 1968-2016 period.[8]

Firstly, it appears clear that US have experienced a dramatic growth of inequality compared to the other European countries as it started with a value around 0,45 in 1981 and it registered a value close to 0,60 at the end of the period. France exhibits

[8] The resulting series are estimates based on the "rule of thumb" principle and, consequently, they should be considered approximations with a specific margin of error.

high Gini index values, but, after the downward trend between 1968 and 1982, they levelled off around 0,43 during the last 1990-2016 period. What is more, it seems that Italy, in general, has followed the same French trend, but with lower levels of inequality around 0,37. Inequality in the two Scandinavian countries has slightly risen from approximately 0,30 to 0,34 whereas Spain reached a plateau around 0,37.

Finally, comparing the European with the U.S. trend, there is evidence that in U.S. inequality has increased more than Europe, in terms of Gini index measure, and that continues to grow. Although the selected countries are positioned on different inequality levels, the general pattern is roughly the same.

In addition, the graph does not provide evidence that the 2007-2008 financial and debt crisis influences the evolution of inequality in the mid-term period since we do not observe neither impressive nor abrupt changes in the mid-term period. As a matter of fact, many researchers and empirical evidences have demonstrated that the impact of economic contraction on the inequality measures is ambiguous. Basically, there are multiple effects on the income distribution such as the increase in unemployment, the fall of wage incomes or capital incomes, public redistribution and household social change. Hence, the overall effect on inequality depends on the combination of all those multiple factors and how they are shared among the income distribution.[9]

In order to understand better which part of the income distribution has been more affected by inequality, we are going to examine the evolution on income shares at the top 10% of the distribution relative to the bottom 50% for each selected country. (*Figure 3.6*)

First of all, let us consider the two Southern European countries (*Figure 3.6a* and 3.*6b*). The upward trend of the Italian Gini index during the period between 1980 and 2016 is explained by the steady increase of the top 10% income shares together with the slight fall of the bottom 50% income shares. Italian bottom 50% was larger than that of top 10% earners until 1994, from that moment on the situation has been

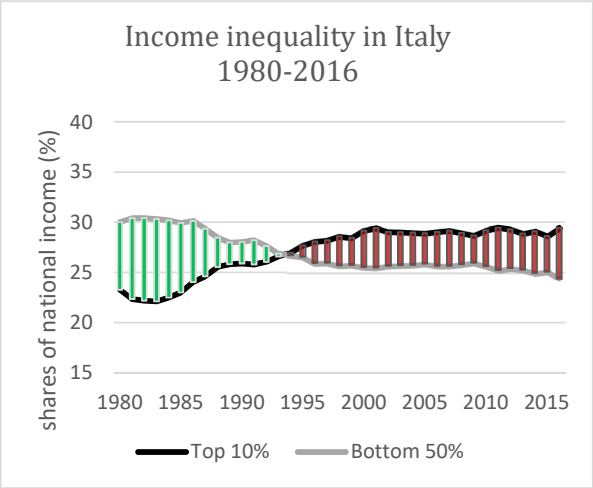
[9] Brandolini A. (Bank of Italy), Roberto Franceschi Foundation, *conference on the Great Recession and the household incomes distribution*. Bocconi University, 25/12/2011. More info at https://www.fondfranceschi.it/atti-dei-convegni/andrea-brandolini-banca-ditalia-la-grande-recessione-e-la-distribuzione-dei-redditi-familiari/22049/

reversed. The stability of the Spanish Gini index is due to the fact that top 10% and bottom 50% income shares have not unchanged. At the end of the considered period, Italy and Spain presents similar income share distribution between top 10% earners and bottom 50%.

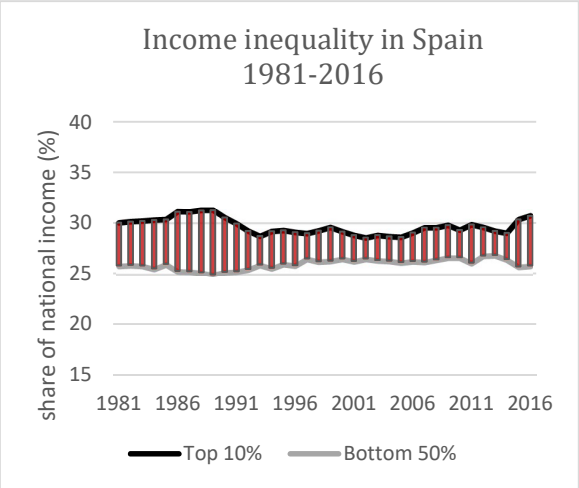
In Norway and Sweden (*Figure 3.6c* and 3.*6d*) bottom 50% and top 10% shares and their evolution over time have been very similar. Their Gini index low level is caused by the fact that bottom 50% shares have been larger than that of top 10% earners, even though the distance has been narrowed over the period.

France shows high levels of Gini index because top 10% has always captured a large share of national income than that of bottom 50% but this distance stayed constant during the last 1995-2014 period. (*Figure 3.6e*)

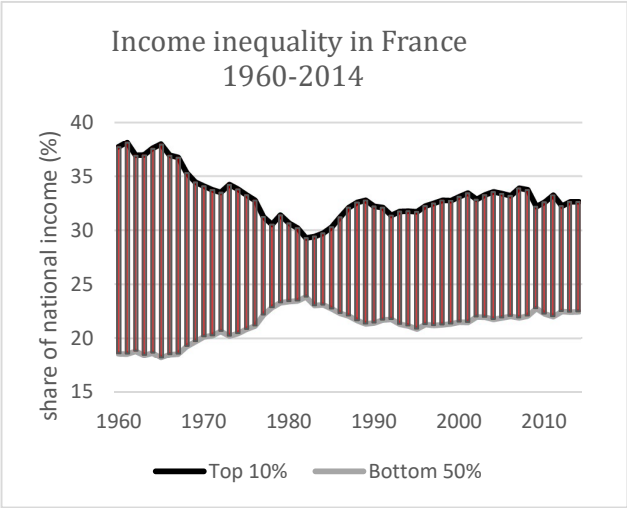
Lastly, the comparison between Europe and the USA (*Figure 3.6f* and *3.6g*) demonstrates that income inequality is clearly higher in the latter than in the former, once again. In 2014 the top 10% earns much more than three times than the bottom 50%, while in Europe this ratio is less than two times. In general, the trend is much sharper in US than Europe, apart from 1980 when the gap was mildly tighter.



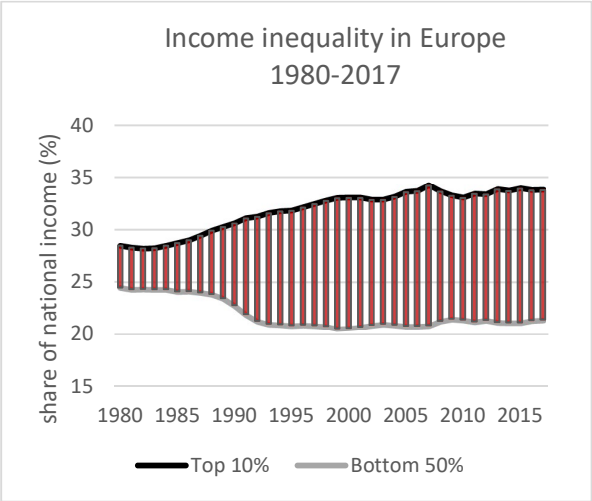
(a)



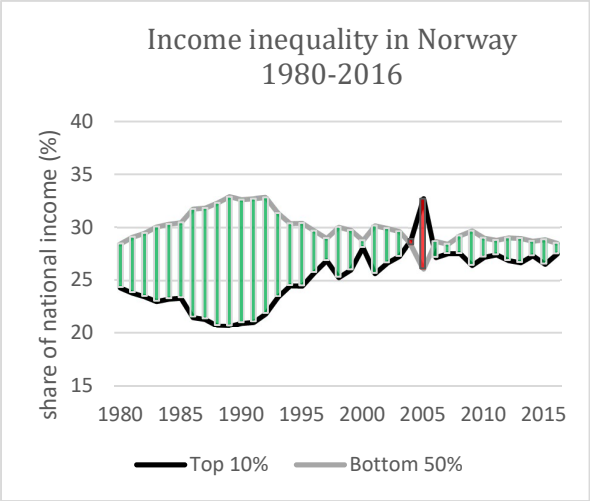
(b)


Income inequality in France
1960-2014
share of national income (%)
40
35
30
25
20
15
1960
1970
1980
1990
2000
2010
Top 10%
Bottom 50%

(c)


Income inequality in Europe
1980-2017
share of national income (%)
40
35
30
25
20
15
1980
1985
1990
1995
2000
2005
2010
2015
Top 10%
Bottom 50%

(d)


Income inequality in Norway
1980-2016
share of national income (%)
40
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30
25
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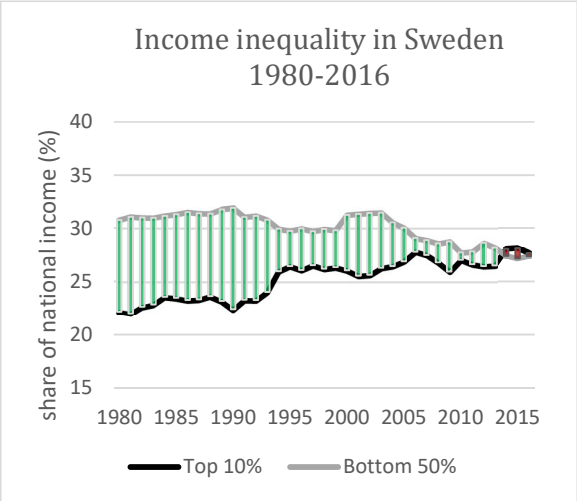
1980
1985
1990
1995
2000
2005
2010
2015
Top 10%
Bottom 50%

(e)


Income inequality in Sweden
1980-2016
share of national income (%)
40
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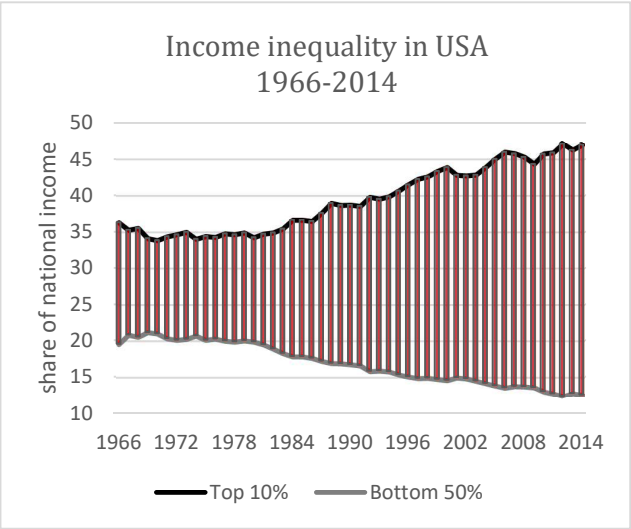
30
25
20
15
1980
1985
1990
1995
2000
2005
2010
2015
Top 10%
Bottom 50%

(f)



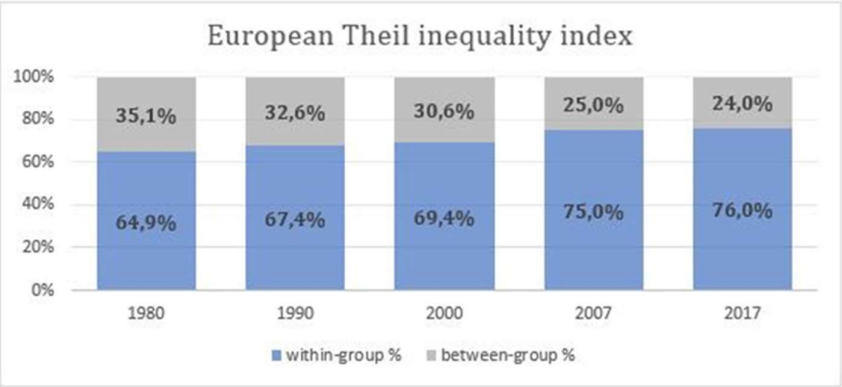
(g)

Figure 3.6
Source: Own depiction based on data of the World Inequality Database (WID.world)

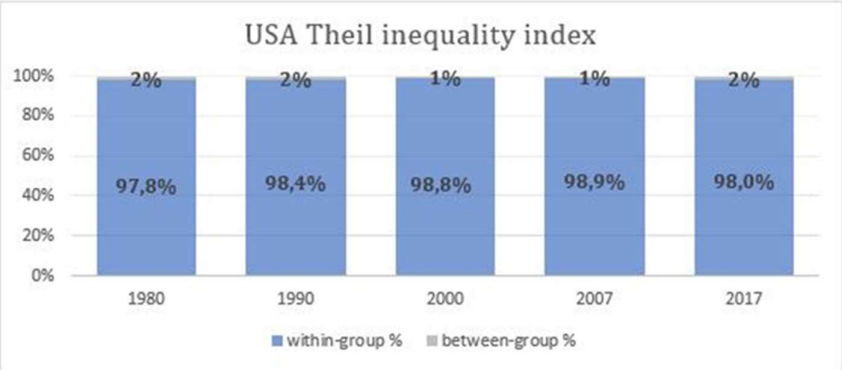
As mentioned in the first chapter, one of the main advantages of the Theil index of inequality is the fact that it can be decomposed into different subgroups to indagate if the observed level of inequality is mainly caused by the so-called between-inequality or the within-inequality.

Theil index estimates obtained for five certain years provide different results between Europe and US. (*Figure 3.7a* and 3.7*b*)

According to the results, European inequality is largely explained by differences between household or inhabitants and it has continued to assume major importance from 1980 to 2017. US inequality is mainly caused by differences in standards of living since between-inequality has been considered irrelevant and unchanged over the 1980-2017. From the percentage bar chart, we can conclude that in Europe there is much more spatial inequalities than in the USA, but the overall level of inequality is lower.



(a)



(b)

Figure 3.7
Source: Own depiction based on data of the World Inequality Database (WID.world)

4. Causal factors

Time series analysis of Section 2 have pointed out that there is no significant evidence of convergence in standards of livings due to the high-income differences across countries, the dramatic increase and the significant stabilization in the level of inequality within the US and Europe, respectively.
This picture suggests that, in general, governments and regional institutions have not managed to do enough to limit inequality and to promote an inclusive growth as it is required by the 2030 Agenda and the European programme.
Gini index, Theil index, and Top income measures give an overview on the country inequality level, but they do not provide any information about the causes that have determined this scenario.

In this Section we are going to examine some of the main factors associated with inequality that have been debated by researchers.
Firstly, we are going to discuss some of Piketty theories and the results of his study on inequality.
Secondly, we will consider the role of technological innovation, education, government policies and globalization process in the context of inequality.
Lastly, the econometric analysis will be used to investigate if there is an empirical evidence of the relationship between the evolution of inequality and the selected factors.

4.1. Piketty theory

The substantial work of the French economist T. Piketty (Cf. "*Le Capital au xxie siècle*", T. Piketty 2013) has brought back attention to the inequality issue and opened up a debate.

He started from the previous fundamental works and theories of Marx and Kuznets to develop a further study on the dynamics of income and wealth inequality, based on time series data, especially for US and France.

According to Marx '*principle of infinite capital accumulation*', the share of industrial capital on national income is inevitably destined to grow, resulting in a high wealth concentration and, consequently, in a high level of inequality. [1]

By contrast, Kuznets introduced in 1955 the '*Kuznets bell curve'* theory that identifies two fundamental inequality stages over the industrialization and the economic development process of a country considering the evolution of inequality compared to per capita income.

During the first industrialization phase country registers a natural increase in the inequality level as few income groups of the population are able to capture benefits of the growth whereas the next advanced stage of industrialization observes a more equal income distribution. Kuznets theory was based on the study of income distribution of the USA over the 1913-1948 period, during which there was a significant decline in the inequality level that, in his opinion, was the result of the current industrialization process. (Cf. "*Share of upper income groups in income and savings*", S. Kuznets 1950)

As regards Marx theory, Piketty observed that the role of technical progress (or technological progress) and productivity can act as balancing mechanisms in the capital accumulation process and, thus, they should be considered in the analysis. However, he agrees with Marx theory about the importance of capital in explaining the dynamics of wealth inequality and inheritance transmission.

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[1] Marx refers to the industrial capital (defined as industrial profits, equipment and other fixed assets used in the production process) instead of land capital (land rent) as it can be infinitely accumulated over time.

As a matter of facts, he compares the annual rate of private capital returns r to the annual national growth rate g.[2] Thus, he explains that when $r > g$, inheritances capitalize faster than income and, consequently, the system produces disequilibrium in the wealth distribution.

In addition, Piketty reviewed Kuznets model stating that the inequality reduction observed in the USA over the 1913 -1945 period can be explained through the occurrence of the two world wars and the financial crisis of 1929 and the resulting political and economical instability situations that impacted on capitalists' wealth.

In fact, he suggests that the study on evolution of inequality should be examined not only from an economic perspective but also from an historical perspective, taking into consideration political changes and other exceptional events such as wars and economic crisis.

Furthermore, Piketty suggests that the rise of high wage incomes (especially for executives' salaries) in the US during the 1980-2010 period is one of the possible causes of the inequality increase.[3]

Finally, he introduces the '*forces of convergence*' as opposed to '*forces of divergence*' to explain the main factors that are able to hinder and curb inequality. What is more, he believes that there is no natural and spontaneous process that permits to reach the perfect equilibrium, as conceived by Kuznets.

In his opinion, knowledge and technological diffusion and the related government policies and expenditures on education permit to increase the level of productivity and therefore to rise national income.

Likewise, he suggests that the increase of personal skills ('*human capital*') allows to diminish the gap between capital incomes and wage incomes and to create more 'meritocratic' inequality.

Conversely, the '*forces of divergences'* concern the increase of the high salaries of top earners, the occurrence of disequilibrium in the capital accumulation process and wealth concentration combined with slow growth and low levels of productivity.

---

[2] According to Piketty definition, the private capital/wealth is obtained with the sum of all net financial and not financial assets owned by private residents of a country. The rate of private capital returns r is the annual average return of capital in terms of profits, dividend, interests, rents and other capital incomes.

[3] In fact, Piketty distinguishes "inequality within capital/wage incomes" from "factorial distribution" that is inequality which occurs between wage and capital incomes.

4.2. The role of technology and education

Researchers have found that technological sophistication and production efficiency play an important role in the economic development of a country and the geographical distribution among countries of these factors determine, eventually, regional income differences. (Cf. Beugelsdijk S. et al., 2018)

This is also supported by P. Krugman theory, which affirms that productivity, in the long-run period, contributes to improve country's standards of living through the raise of output per worker.

Nevertheless, there are contrasting opinion around this topic. For instance, Schumpeter states that there is no direct relationship between technological change and the functioning of socio-economic system. He considers technology as a '*disruptive'* force that shapes markets and produces disequilibrium effects.

(Cf. J. Hagedoorn, S. Shane and S. Venkataraman)

Hence, he believes that this process can generate multiple forms of inequality in the society such as monopolies, geographical technological concentration and unequal distribution of knowledge across workers.

In the economic literature, productivity (or technological progress) has, by definition, a positive effect on the overall economy because it is conceived as a multiplier that allows to produce more output with the same inputs. In fact, technological innovation and production efficiency is measured with country productivity level, that is the total output GDP divided by capital and labour inputs. This comes from the economic Cobb-Douglas aggregate production function:

$$Y_{it} = A_{it} K_{it}^{\alpha} (hc_{it} L_{it})^{1-\alpha} \tag{1}$$

Where Y_{it} is the output produced by country i at time t; K_{it} is the respective stock capital; L_{it} is the employed labour force; hc_{it} is the average level of human capital of each worker. The A_{it} is the level of total factor productivity (*TFP*) that reflects the efficiency with which capital and labour inputs are used in the production process. α is the output elasticity of capital which has constant returns to scale with the assumption of perfect competition in factors and goods markets. In particular, the human capital index can be expressed as:

$$hc_{it} = e^{\varphi(s_{it})} \tag{3}$$

Where $\varphi(s_{it})$ is a function that assumes different values based on s_{it} years of education. (Cf. Psacharopoulos, 1994)

$$\varphi(s_{it}) = \begin{cases} 0.134 \cdot s_{it} & if\ s \leq 4 \\ 0.134 \cdot 4 + 0.101(s_{it} - 4) & if\ 4 \leq s \leq 8 \\ 0.134 \cdot 4 + 0.101 \cdot 4 + 0.068(s_{it} - 8) & if s \geq 8 \end{cases}$$

Looking at the present, we are experiencing a specific period of time where computers and other digital advances play a fundamental role in the labour competition. Some authors refer to this as the "*second machine age*" because the impact of technological transformation has brought to an inflection point on the human social development trend that is the same as what occurred with the introduction of the steam engine during the First Industrial Revolution. Unlike the First Industrialization, where machines had only '*physical power'*, new technologies of the second machine age have, in addition, the so-called '*mental power*', defined as ≪ the ability to use our brains to understand and shape environments ≫. In addition, entrepreneurs are also more willing to use automatization in the production process considering the economic advantages of the machines with respect to human workers. As a result, the replacement of labour with physical capital can change the overall distribution of national income between the two basic inputs of production. (Cf. E. Brynjolfsson and A. McAfee, 2014)

Furthermore, it is expected that technological progress will require more and more specialized workers and it will reduce the demand of less skilled labour and, as a consequence, there will also be a reallocation of income between them.
As a matter of facts, researchers have documented the spread increase of wages in the U.S. labour market during the 1980s and this phenomenon is usually referred to the *skill-biased technical change* (SBTC). (Cf. D. Autor, L. Katz et al.)

In other terms, researchers assert that technology is transforming the wage structure based on the different amount of human capital among workers.
As a matter of facts, from economical point of view, education is considered as an investment and, consequently, economists are interested in evaluating the convenience by estimating its return. In essence, returns on education are measured with the income received and there is a positive relationship between these two factors.

According to Barro and Lee, the individual relationship between income and return on education can be expressed with the Mincer earnings function that is:

$$lnY_i = lnY_0 + \rho s + \beta_1 x + \beta_2 x^2 + \varepsilon_i \qquad (2)$$

Where lnY_i represents the natural logarithm of the individual earning Y_i; Y_0 indicates the individual with neither education nor experience; s are the years of schooling, x is the level of work experience and ε_i is the error term. The long-linear function model allows to interpret ρ coefficient as the percentage change in earnings caused by an additional year of schooling whereas β_1,β_2 parameters are the return on work experience. (Cf. R. J. Barro, Jong-Wha Lee, 2015)

In essence, the human capital theory considers labour as a heterogeneous entity, meaning that each individual is characterized by a different level of human capital, that is the differential capacity to contribute to the production process that, at the end, determine the wage distribution. On the one hand, this theory is useful to explain the evolution of inequality between heterogeneous individual groups in the long period as it implies that, eventually, the supply and demand law determine wage inequality.
On the other hand, it does not explain the inequality occurrence within homogeneous groups of workers, i.e. with the same human capital levels. Furthermore, researchers have found that income differentials diverge from to country to country. (Franzini e Raitano, 2012)

As a result, the overall impact of human capital on inequality is expected to be positive but this can change depending on the geographical area and on the different factors involved.

4.3. The role of government

The share of public spending on the total output is one of the measures used to monitor the government commitment to reduce the gap between rich and poor. Clearly, it does not provide a whole description of the government action as it does not consider other factors of relevance for inequality such as fiscal system, labour policies and social transfers. However, in the literature there is evidence of the positive impact of government spending on income distribution. (Cf. J.Martinez-Vazquez and B.Moreno-Dodson, 2014)

From a theoretical point of view, public spending action is linked with the concept of '*equality of outputs*' as it considers the redistributional activity rather than the realization of equal opportunities in the society (i.e. '*equality of opportunities'*). Furthermore, according to the Wagner's law, the progressive increase of public spending is a direct consequence of the country income growth. This is explained by the fact that economic industrialization is associated with the transformation of the society which requires improvement in social services, administrative and protective actions as the economy grows.

In general, government spending includes all goods and services purchased by government or public institutions. In particular, social expenditure is a share of government spending that considers public services on education, health and social protection. Some researchers sustain that this element has a positive impact on income distribution as it contributes to diminish inequality. (Cf. N. Lustig, 2015)
In essence, public services (especially health and education) mitigate the impact of skewed income distribution and redistribute an actual or 'virtual' income in everyone's pocket. (E. Seery, 2014)
In addition, they also sustain that current levels of inequality are the results of policy choices made by government during these years.

Even so, in order to reduce inequality, social spending should benefit more poorest individuals than top earners. In fact, the limit of the public spending share measure is that it does not take into account how those benefits are distributed within the population. In addition, since it is an aggregate measure, it does not explain the quality of government investments and how they are distributed across different sectors. The evidence of the positive effect of public expenditures on reducing inequality is not always valid. For example, USA government has always experienced

very high levels of investments on health but also very large Gini index value. The reason can be explained by the presence of a complex private system and high cost of healthcare. Hence, this highlights the weakness of the public expenditure measure.

4.4. The role of globalization

Globalization is usually interpreted as the increasing integration and interdependence of the economies around the world with a large movement of goods, services and capital across borders. This phenomenon has been extensively studied by economists to explain the current transformation of the society and economy. Historically, the globalization process has been characterized by three 'waves' of globalization. The first wave began in the 19th century and ended with the First World War, the second wave went through the 1945-1980 period and the third wave is the actual experienced globalization which started around 1980.
Basically, global economy has introduced some channel effects in the business and consumer behaviour such as changes in the organization of the production process with the introduction of multinational corporation or the basket widening of consumer goods. As a result, this has had an impact on the market labour with the entrance of new careers opportunities combined with a rise of market competition.

In the context of income inequality, researchers state that global competition has led to the so-called *factor price equalization*. In other terms, intense low-cost competition and international trade have caused the price equalization of the factors of production (labour and capital) across countries.

In addition, globalization has led to the reallocation of resources across countries also in terms of labour and, as a consequence, this can have generated skewness in the income distribution. Besides, the sociologist L. Gallino also explains that large multinational corporations have captured high economic benefits from globalization, and this has also grown their decision-making power, weakening the role of government. (Gallino, 2009)

Even so, globalization has also contributed to the knowledge and technical progress diffusion across countries that leads economic growth and better standards of living. Similarly, the economist A. Sen argues that globalization, defined as the simple process of commerce liberalization and the increase in the level of interactions between countries, has, ultimately, brought benefits to the society. Hence, he suggests that, in order to curb inequality, country should perform a process of redistribution of the obtained benefits rather than prevent the globalization process.

Moreover, researchers suggest that the gains from the trade liberalization can vary both across and within countries depending on the current level of the globalization process. In particular, according to the analysis, in the early and medium stage of globalization countries can capture large benefits whereas in the advanced stage they obtain decreasing marginal returns. (Cf. Lang and Tavares 2018)

In the literature, there are many different measures to estimate the level of country of globalization. (Cf. Franke-Li, Alcala-Ciccone, Squalli and Wilson, et al.)
The classical trade intensity function is proposed by Rodrick (2009) and it indicates the trade dependency of one economy:

$$TI = \frac{X + M}{GDP} \tag{4}$$

This index is the most common used, but it can be distorted by the 'size-bias' as it can underestimate the degree of openness of large economies compared to small economies.

4.5 Econometric Application

The econometric analysis is used to examine the relationship between Gini index and all the factors discussed above (human capital, trade intensity, government commitment and total factor productivity (*TFP*)). In particular, regarding 'government commitment' measure, it has been considered only the share of country public spending on GDP because of data constraints about limited time coverage and unavailability of disaggregated variables. All data have been collected from the National Account data of *Penn World Table* database. [4]

The countries that will be investigated are Italy and Sweden for the 1976-2014 period.
This choice has been made considering the substantial differences on the inequality levels between the selected countries. Although even Sweden has registered an increase in the *gini index* and *top income shares* during the 1980-2014 period, it is considered one of the most equal country in Europe with high levels of incomes. According to the Oxfam's research, Sweden in 2015 positioned itself in the first place of the *Commitment to Reducing Inequality* (CRI) Index ranking, that measures governments' efforts to reduce the gap between rich and poor based on three policy areas: social spending, progressive taxation and labour market policies (in terms of wages and rights).[5] This is due to the high progressive spending and good labour policies, combined with an efficient welfare system. Italy, conversely, positions in the sixteenth place in this ranking (specifically seventeenth for social expenditure, fourteenth for progressive taxation and twenty-ninth for labour policy).

Here, the *Engle-Granger 2-step method* is applied because it allows to perform inferences in the regression when the data are non-stationary and cointegrated. Usual econometric procedures cannot be applied to non-stationary data because the standard assumptions for asymptotic analysis are not valid and the analysis could also generate spurious regressions with inaccurate results.
Additionally, non-stationary series, in contrast to stationary series, are influenced by

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[4] https://www.rug.nl/ggdc/productivity/pwt/

[5] "THE COMMITMENT TO REDUCING INEQUALITY INDEX. A new global ranking of governments based on what they are doing to tackle the gap between rich and poor.", July 2018, Oxfam.

shocks occurrence which persist over the entire period. (Cfr. Chris Brook, 2007)
R. Engle and C. Granger have developed a modelling strategy to deal with non-stationary data. Firstly, all individual variables are checked for non-stationarity using unit root test, known as augmented Dickey-Fuller (ADF) test. Secondly, it starts the first-stage cointegrating regression using OLS to estimate the parameter values and to check the stationarity of the residuals with the ADF test. If the residuals are stationary the *error correction model* (ECM) is used to start a second-stage regression using OLS to perform inferences.
This approach refers specifically to the Engle-Granger representation theorem that, basically, implies that systems with cointegrated I(1) variables have three equivalent representation: common trend, moving average and equilibrium correction model (ECM). More precisely, it affirms that if two series are cointegrated they always admit at least one representation with ECM.

Clearly, this analysis is limited, and it does not take into consideration all the potential factors that could impact on inequality and, so, it does not have the aim to explain with absolute certainty the inequality phenomenon.

In addition, the Engle-Granger approach presents some issues such as the lack of power in the unit root and cointegration tests, simultaneous equation bias and it can't be performed any hypothesis tests about the estimated cointegrated relationship of the first stage. (Cf. C. Brooks, 2008)

4.5.1. Augmented Dickey-Fuller test (ADF)

In general, a time series is a realization of a stochastic process that is a set of random variables that depends on the event ω in the sample space Ω and on time t in a parametric space T, that is:

$$\{X_t(\omega): t \in T \ and \ \omega \in \Omega\}$$

Basically, a stochastic process is said to be stationary if it has constant mean, constant variance and constant autocovariance for each given lag and, consequently, they cannot depend on the time period in which they are observed.[6]

The *random walk with drift* is a common non-stationary model $y_t = \beta + y_{t-1} + u_t$ where β is the constant term (drift) and u_t is a white noise process $u_t \sim WN\ (0, \sigma_u^2)$ whereas the *trend stationary process* $y_t = \alpha + \lambda t + u_t$ is stationary around a linear trend t.

In general, an autoregressive process of order 1 AR(1) given by:

$$y_t = \phi y_{t-1} + u_t \qquad \text{where } u_t \sim WN\ (0, \sigma_u^2)$$

is stationary if $\phi < 1$ and, conversely, it is non-stationary if $\phi = 1$.

The case of non-stationarity is known as unit root case as the root of the characteristic equation is the unity.

The equation can also be written as $\Delta y_t = \rho y_{t-1} + u_t$, where $\Delta y_t = y_t - y_{t-1}$ and $\rho = \phi - 1$.

To ensure that u_t is a white noise process the model has to be integrated with more lags of the dependent variable obtaining:

$$\Delta y_t = \rho y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + u_t \qquad (5)$$

where p are the number of lags.

[6] This definition relates to the concept of *weak stationarity* which implies that all the random variables of the stochastic process have the same probability function.

Critical values for different significance levels
(Dickey-Fuller Tables)

Sample size T	**0.01** *	**0.025**	**0.05** **	**0.10** ***
	$\boldsymbol{\tau}$			
25	-2.66	-2.26	-1.95	-1.60
50	-2.62	-2.25	-1.95	-1.61
	$\boldsymbol{\tau_\mu}$			
25	-3.75	-3.33	-3.00	2.63
50	-3.58	-3.22	-2.93	-2.60
	$\boldsymbol{\tau_\tau}$			
25	-4.38	-3.95	-3.60	-3.24
50	-4.15	-3.80	-3.50	-3.18

*Table 4.1 Source: Own depiction based on "Introductory Econometrics for Finance", C. Brooks, 2008. Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively; τ, τ_μ and τ_τ denote models without constant, with constant, and with constant and trend, respectively.*

The augmented Dickey-Fuller (ADF) test examine the null hypothesis that $\rho = 0$ ($\phi = 1$) in the above model. In other terms, the hypotheses of interest are

$$\begin{cases} H_0: \rho = 0 \\ H_1: \rho < 0 \end{cases}$$

And it can be also conducted on models with intercept $\Delta y_t = \beta + \rho y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + u_t$, or with intercept and deterministic trend as $\Delta y_t = \beta + \lambda t + \rho y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + u_t$.

Besides, I(0) and I(1) are used to indicate stationary and non-stationary series, respectively. In general, a non-stationary y_t is said to be integrated of order *d* I(d) if it must be differenced *d* times before it becomes stationary.

The test statistic for the ADF test do not follow the usual *t*-distribution under the null hypothesis and they must be compared with the set of Dickey-Fuller critical values given in *Table 4.1. C*ritical values depend on the sample size and on the type of regression test considered (without intercept, with intercept, with intercept and deterministic trend).

Here, Gini, human capital and TFP variables are normalized with a natural logarithmic transformation (logarithm to the base of the mathematical constant *e*) to compare data and to reduce volatility without altering the main pattern.
Trade openness (TO) and government expenditures (GOV) variables do not require

transformation as they are percentage shares. Hence, *gini*, *hc* and *tfp* denotes the normalized variables.

The maximum number of lags of the dependent variable is obtained with

$$p_{max} = int[4\,(T+1)^{0.25}/100] \tag{6}$$

for small sample with $N < 100$, proposed by Schwert (1989).
In this case $p_{max} = 3$ and the lag length selection method used is the *Bayesian information criterion* (BIC) that automatically reduces the number of lags until the t-ratio on the longest remaining is significant at the 10 percent level.

The test regressions have been performed using the more appropriate model of those described above for the unit root test in levels and in differences, respectively. The results of the unit root test are presented in *Table 4.2*.

In the case of Italy, all the selected variables *gini*, *hc*, TO, GOV and *tfp* failed to reject the null hypothesis of a unit root on the level test. The first-difference unit root tests reject the null hypothesis with a significance level of 1% for the *gini*, TO, GOV and *tfp* variables and of 10% for *hc* variable. Thus, all the selected variables are non-stationary and integrated of order 1 I(1).
As regards Sweden, none of the test statistics of the time series is rejecting the null hypothesis of non-stationarity on the level test at the significance level of 10%, except for the GOV variable which fails to reject the null hypothesis at significance level of 5%. So, all the variables are integrated of order 1 I(1), i.e. non-stationary.

At this point, we are now able to continue the analysis in the next section by checking for cointegration between the selected countries using Ordinary Least Squares (OLS).

ADF test results

Country	Statistics	*Gini*	*Hc*	*TO*	*GOV*	*tfp*
Italy	Level	-2.552 $\boldsymbol{\tau_\tau}$	-0.886 $\boldsymbol{\tau_\tau}$	-0.957 $\boldsymbol{\tau_\mu}$	-2.546 $\boldsymbol{\tau_\mu}$	-1.244 $\boldsymbol{\tau_\tau}$
	First difference	-4.422 *** $\boldsymbol{\tau_\mu}$	-1.624 * $\boldsymbol{\tau}$	-6.498 *** $\boldsymbol{\tau_\mu}$	-5.073 *** $\boldsymbol{\tau_\mu}$	-4.580 *** $\boldsymbol{\tau_\mu}$
Sweden	Level	-2.400 $\boldsymbol{\tau_\tau}$	0.162 $\boldsymbol{\tau_\mu}$	-1.023 $\boldsymbol{\tau_\mu}$	-2.927* $\boldsymbol{\tau_\mu}$	-1.708 $\boldsymbol{\tau_\tau}$
	First difference	-5.231 *** $\boldsymbol{\tau_\mu}$	-3.682 ** $\boldsymbol{\tau_\mu}$	-5.672 *** $\boldsymbol{\tau_\mu}$	-5.522 *** $\boldsymbol{\tau_\mu}$	-5.099 *** $\boldsymbol{\tau_\mu}$

Table 4.2
Source: Own elaboration based on data collected from different sources.
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively; τ, τ_μ and τ_τ denote models without constant, with constant, and with constant and trend, respectively.*

4.5.2. First-stage cointegrating regression using OLS

After having ascertained which series are stationary in their differences (i.e. I(1)), we are going to test if they are *cointegrated*.

In general, a set of variables I(1) is defined as cointegrated if the linear combination is stationary, i.e. I(0).
In other terms, given y_t and x_{1t} and x_{2t} time series, all integrated of order one, are said to be cointegrated if $y_t - \beta_1 x_{1t} + \beta_2 x_{2t} = z_t$ where $z_t \sim I(0)$.

Another fundamental property that must be satisfied is that coefficients estimates $\hat{\beta}_i$ obtained from OLS must be consistent in order to have cointegration.

Cointegrated variables are characterized by long-term relationship that make them move together over time and establish an equilibrium level in the long-run period. In other terms, specific shocks on one variable can alter the short-term but, if the variables are cointegrated, in the long-term, they return to the equilibrium level. (Cf. Jozef Barunik, 2009)

The cointegrating regression involves current values of integrated variables by ordinary least squares (OLS) to obtain estimates of long-run parameters.

In this context, we are interested to see the relationship between gini index and the selected variables. So, we are going to regress *gini* variable on *hc*, *TO*, *GOV* and *tfp* using least squares.

After checking the significance of the estimated parameters using OLS, the residual estimates obtained are tested for stationarity through the ADF test to ensure they are I(0). The basic approach that has been used in the analysis is to test all different model combinations to see which is the most suitable, based on the cointegration properties.

In this first-stage, the investigation considers only factors that regards cointegration as the observed relationship between the selected variables could be purely spurious.

The ADF test on residuals is performed on

$$\Delta\hat{z}_t = \delta\hat{z}_{t-1} + \varepsilon_t, \text{ where } \varepsilon_t \text{ is iid error term}$$

The *t*-ratio is compared with the critical values provided in *Table 4.1*.

If the null hypothesis of non-stationarity on residuals is rejected, the series are cointegrated and, then, the system of equations can be modified introducing the *vector error correction* (VEC) model to analyse the short-term period.

The maximum lag is again established with Schwert method and the lag length is selected using the SIC.

Italy

In the case of Italy, many tests have been performed to find the most suitable.
The first estimated model (*model 1*) that has been considered is:

$$gini_t = \hat{\beta}_0 c + \alpha t + \hat{\beta}_1 hc_t + \hat{\beta}_2 TO_t + \hat{\beta}_3 GOV_t + \hat{\beta}_4 tfp_t + \hat{z}_t \qquad (7)$$

Where it is included a constant term c, time trend regressor t and all the selected variables *hc*, *TO*, *GOV*, *tfp*. The obtained estimates by the OLS are provided in *Table 4.3*.

Cointegrating regression (Italy) (*model 1*)

```
Model 1: OLS, using observations 1976-2014 (T = 39)
Dependent variable: lnGini
HAC standard errors, bandwidth 2 (Bartlett kernel)

             coefficient   std. error   t-ratio   p-value
  -------------------------------------------------------
  const       8.70688      1.85114       4.704    4.41e-05 ***
  time        0.0713701    0.0229414     3.111    0.0038   ***
  lnhc       -6.32729      2.44452      -2.588    0.0142   **
  TO         -0.692566     0.213602     -3.242    0.0027   ***
  GOV        -1.57850      0.886393     -1.781    0.0842   *
  lnTFP       1.71410      0.468543      3.658    0.0009   ***

Mean dependent var   3.527011   S.D. dependent var   0.094265
Sum squared resid    0.022706   S.E. of regression   0.026231
R-squared            0.932756   Adjusted R-squared   0.922567
F(5, 33)             70.29453   P-value(F)           1.26e-16
Log-likelihood       89.91084   Akaike criterion    -167.8217
Schwarz criterion   -157.8403   Hannan-Quinn        -164.2405
rho                  0.575254   Durbin-Watson        0.835601
```

Table 4.3
Source: Own elaboration based on data collected from different sources
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively*

All the coefficients on the selected variables are significant. *TO* and *tfp* coefficients are consistent whereas *GOV* and *hc* are significant with a significance level of 1% and 5%, respectively. In addition, the estimated parameters of *hc*, *TO* and *GOV* regressors have negative values whereas *tfp* coefficient assumes positive value.

These results can be interpreted stating that there is a negative relationship between *gini* index and *human capital*, *trade openness* and *government expenses* while an increase in *TFP* should be associated with a rise of inequality.

The residual estimates $\hat{z}_t$ obtained with the ADF test are:

$$\Delta\hat{z}_t = -0.424746\ \hat{z}_{t-1}$$
$$(0.141394)$$
(standard errors in parentheses)

The *t*-ratio is $-0.4247/0.1414 = -3.004$ which lies in the rejection region for this test.

Therefore, we can conclude that the null hypothesis of no cointegration is rejected but additional test is required.

In the second estimated model (*model 2*) the *GOV* regressor is removed as it is the least significant relative to the other variables. The OLS results on *model 2* is given in *Table 4.4*.

If we exclude *GOV* variable from *model 1* all the other variables are significant with 10% significance level.

The new residual estimates $\hat{z}_t$ obtained with the ADF test are:

$$\Delta\hat{z}_t = -0.364774\ \hat{z}_{t-1}$$
$$(0.132305)$$

The *t*-ratio is -0.3648/0.1323=-2.757 which still lies in the rejection region for this test.

Those results lead to the conclusion that, in the case of Italy, the series *gini*, *hc*, *TO*, and *tfp* are cointegrated.

In other terms, this means that these variables share a common trend and tend to move together in the long-run period.

Cointegrating regression (Italy) (*model 2*)

```
Test on Model 3:

  Null hypothesis: the regression parameter is zero for GOV
  Test statistic: Robust F(1, 33) = 3.17128, p-value 0.084152
  Omitting variables improved 1 of 3 information criteria.

Model 5: OLS, using observations 1976-2014 (T = 39)
Dependent variable: lnGini
HAC standard errors, bandwidth 2 (Bartlett kernel)

             coefficient   std. error   t-ratio   p-value
  -------------------------------------------------------
  const       9.96136      1.73884       5.729    1.94e-06 ***
  time        0.0888488    0.0206291     4.307    0.0001   ***
  lnhc       -8.32347      2.14497      -3.880    0.0005   ***
  TO         -0.682827     0.238256     -2.866    0.0071   ***
  lnTFP       2.17436      0.341161      6.373    2.83e-07 ***

Mean dependent var   3.527011   S.D. dependent var   0.094265
Sum squared resid    0.024628   S.E. of regression   0.026914
R-squared            0.927063   Adjusted R-squared   0.918482
F(4, 34)             55.41530   P-value(F)           2.00e-14
Log-likelihood       88.32624   Akaike criterion    -166.6525
Schwarz criterion   -158.3347   Hannan-Quinn        -163.6681
rho                  0.635226   Durbin-Watson        0.694448
```

Table 4.3
Source: Own elaboration based on data collected from different sources
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively.*

Sweden

As regards Sweden, the first cointegrated regression model (*model 1*) considered is:

$$gini_t = \hat{\beta}_0 c + \alpha t + \hat{\beta}_1 hc_t + \hat{\beta}_2 TO_t + \hat{\beta}_3 GOV_t + \hat{\beta}_4 tfp_t + \hat{z}_t \qquad (8)$$

Firstly, *TO*, *GOV* and *tfp* parameters are not significant as they do not reject the null hypothesis with 10% level of significance whereas *hc* parameter is significant with 5% level. This indicates that *model 1* is not the most appropriate to estimate the relationship between the selected variables. (*Table 4.5*)

Different tests have been performed considering the consistency of the parameters and here it is presented the most suitable that has been found. (*Table 4.6*)

$$gini_t = \hat{\beta}_0 c + \alpha t + \hat{\beta}_1 hc_t + \hat{\beta}_2 TO_t + \hat{z}_t \qquad (9)$$

Here, *GOV* and *tfp* have been excluded because their parameter estimates are not significant whilst *hc* and *TO* are significant with 5% and 10% significance level, respectively. The relationship of *gini* dependent variable is negative with *hc* and positive with *TO*.

The new residual estimates $\hat{z}_t$ obtained with the ADF test are:

$$\Delta\hat{z}_t = -0.252081\ \hat{z}_{t-1}$$
$$(0.118862)$$

The *t*-ratio is -0.2521/0.1189= -2.121 which lies in the rejection region for this test with a level of significance of 5%. These results suggest the presence of possible cointegration between the selected variable.

Cointegrating regression (Sweden) (*model 1*)

```
Model 1: OLS, using observations 1976-2014 (T = 39)
Dependent variable: lnGini
HAC standard errors, bandwidth 2 (Bartlett kernel)

             coefficient   std. error   t-ratio   p-value
  -----------------------------------------------------
  const      13.8278       5.16501       2.677    0.0115  **
  time        0.0116483    0.00369113    3.156    0.0034  ***
  lnhc       -2.24062      1.05923      -2.115    0.0420  **
  TO          0.260178     0.171952      1.513    0.1398
  GOV         0.561490     0.495225      1.134    0.2650
  lnTFP      -0.0687762    0.270438     -0.2543   0.8008

Mean dependent var   3.399114   S.D. dependent var   0.069778
Sum squared resid    0.041110   S.E. of regression   0.035295
R-squared            0.777804   Adjusted R-squared   0.744138
F(5, 33)             18.76812   P-value(F)           8.29e-09
Log-likelihood       78.33500   Akaike criterion    -144.6700
Schwarz criterion   -134.6886   Hannan-Quinn        -141.0888
rho                  0.687867   Durbin-Watson        0.604611

Excluding the constant, p-value was highest for variable 5 (lnTFP)
```

Table 4.4
Source: Own elaboration based on data collected from different sources
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively.*

Cointegrating regression (Sweden) (*model 2*)

```
Model 3: OLS, using observations 1976-2014 (T = 39)
Dependent variable: lnGini
HAC standard errors, bandwidth 2 (Bartlett kernel)

             coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const      13.7498       4.93183       2.788    0.0085   ***
  time        0.0114450    0.00348070    3.288    0.0023   ***
  lnhc       -2.18368      1.02595      -2.128    0.0404   **
  TO          0.196586     0.0981967     2.002    0.0531   *

Mean dependent var   3.399114   S.D. dependent var   0.069778
Sum squared resid    0.042441   S.E. of regression   0.034822
R-squared            0.770614   Adjusted R-squared   0.750953
F(3, 35)             26.92463   P-value(F)           3.30e-09
Log-likelihood       77.71401   Akaike criterion    -147.4280
Schwarz criterion   -140.7738   Hannan-Quinn        -145.0405
rho                  0.747919   Durbin-Watson        0.529569
```

Table 4.5
Source: Own elaboration based on data collected from different sources
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively.*

4.5.3. Second-stage error correction model (ECM)

After checking if there is cointegration between the variables, we are going to examine the short-run relationship among them.

In other terms, we are going to consider a dynamic relationship between I(0) variables including a cointegrating relationship known as the *short-run error correction*.

In general, if there are more than two variables the error correction model will be:

$$\Delta y_t = \alpha \cdot \hat{z}_{t-1} + \beta_0 \Delta y_{t-1} + \beta_1 \Delta x_{1_{t-1}} + \beta_2 \Delta x_{2_{t-1}} + \cdots + \beta_i \Delta x_{i_{t-1}} + \varepsilon_t \quad (10)$$

Where $\hat{z}_{t-1}$ is the first lagged of the linear combination of the random variables $y_t - \widehat{\beta_1} x_{1t} + \widehat{\beta_2} x_{2t} + \widehat{\beta_\iota} x_{it} = \hat{z}_t$, $\widehat{z}_t \sim I(0)$ that is obtained in the first-stage cointegration regression and α is the so-called *speed-of-adjustment* (or *factor loading*) coefficient that is a parameter that describes the speed of the

adjustment mechanism that corrects the previous period disequilibrium. It is negative and included between 0 and -1. If it is significant it is confirmed the long-run relationship between the selected variables.

Italy

The first error correction model (*model 1*) tested is:

$$\Delta gini_t = \alpha \cdot \hat{z}_{t-1} + \beta_0 \Delta gini_{t-1} + \beta_1 \Delta tfp_{1_{t-1}} + \beta_2 \Delta TO_{2_{t-1}} + \beta_3 \Delta hc_{3_{t-1}} + \varepsilon_t \quad (11)$$

The parameter α is -0.4373 significant with 10% level of significance and it indicates a relative slowness in the adjustment process to return to the equilibrium level when it occurs shocks. (*Table 4.7*) However, the non-significance estimates of the *tfp*, *TO* and *hc* parameters suggests that variation of them do not impact on *gini* variable in the short period.

ECM regression Italy

```
Model 43: OLS, using observations 1978-2014 (T = 37)
Dependent variable: d_lnGini
HAC standard errors, bandwidth 2 (Bartlett kernel)

               coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------
  d_lnGini_1    0.603243      0.267462     2.255     0.0311   **
  uhat_1       -0.437292      0.256209    -1.707     0.0976   *
  d_lnTFP_1    -0.371700      0.554040    -0.6709    0.5071
  d_TO_1       -0.00647140    0.171752    -0.03768   0.9702
  d_lnhc_1      0.148040      0.689472     0.2147    0.8314

Mean dependent var   0.005371   S.D. dependent var   0.025477
Sum squared resid    0.017062   S.E. of regression   0.023091
R-squared            0.301680   Adjusted R-squared   0.214390
F(5, 32)             10.52092   P-value(F)           4.89e-06
Log-likelihood       89.61246   Akaike criterion    -169.2249
Schwarz criterion   -161.1703   Hannan-Quinn        -166.3853
rho                  0.071327   Durbin-Watson        1.824600

P-value was highest for variable 3 (d_TO_1)
```

Table 4.6
Source: Own elaboration based on data collected from different sources
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively.*

Sweden

The estimated ECM is:

$$\Delta gini_t = \alpha \cdot \hat{z}_{t-1} + \beta_0 \Delta gini_{t-1} + \beta_1 \Delta TO_{1_{t-1}} + \beta_2 \Delta hc_{2_{t-1}} + \varepsilon_t \qquad (12)$$

The results provided in *Table 4.8* indicates that the *speed-of-adjustment* coefficient α is -0.2681 and significant at 5% level. This means that the process of adjustment towards equilibrium is very slow and the selected variables do not influence inequality in the short period.

ECM regression Sweden

```
Model 1: OLS, using observations 1978-2014 (T = 37)
Dependent variable: d_lnGini
HAC standard errors, bandwidth 2 (Bartlett kernel)

               coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const         0.0113760    0.00974332    1.168    0.2516
  uhat_1       -0.268126     0.122720     -2.185    0.0363   **
  d_lnGini_1    0.245408     0.127611      1.923    0.0634   *
  d_lnhc_1     -1.58827      2.10293      -0.7553   0.4556
  d_TO_1       -0.105456     0.146426     -0.7202   0.4766

Mean dependent var   0.005441   S.D. dependent var   0.026218
Sum squared resid    0.021322   S.E. of regression   0.025813
R-squared            0.138352   Adjusted R-squared   0.030646
F(4, 32)             3.006751   P-value(F)           0.032578
Log-likelihood       85.48958   Akaike criterion    -160.9792
Schwarz criterion   -152.9246   Hannan-Quinn        -158.1395
rho                 -0.033359   Durbin's h          -0.321856

Excluding the constant, p-value was highest for variable 3 (d_TO_1)
```

Table 4.7
Source: Own elaboration based on data collected from different sources
*Notes: *, **, *** indicates that the null hypothesis of non-stationarity is rejected at 10%, 5% and 1% significance levels, respectively.*

5. Conclusions

The study of inequality measures has underlined that synthetic indexes, by definition, are based on different principles and theories regarding equity and social justice. As a matter of facts, the social welfare approach uses the social welfare functions that rank all the possible states of society in order of preference. Similarly, Gini index is obtained through the measures of Lorenz diagram areas and, consequently, different income distribution could generate the same value.
In addition, Theil index is based on the entropy concept which refers to the data dispersion rather than data concentration and Atkinson index is explicitly built on the individual social utility. Therefore, as far as objective the study of income distribution can be, it refers to various approaches that, at the end, determine different perception of the society.

After having examined pros and cons of the inequality synthetic indexes we have analysed the inequality evolution over time in terms of income distribution for the selected European countries and the USA. The analysis has pointed out the controversy that exists between income growth and inequality. In brief, data suggests that all selected countries have experienced an increase in the average level of income in the 1950-2018 period, but the benefits of this growth have not been equally distributed. As a matter of facts, all the European countries have shown, approximately, the same pattern of the Gini index values, characterized by an upward trend during the 1980-1995 period and a stabilization of the values in the 1995-2018 period. Differently, the USA have shown a constant dramatic rise of income inequality since the 1980s. Hence, Theil index has highlighted the differences in the structure of inequality between Europe and the USA. Inequality in USA is largely explained by the within-inequality whereas inequality between European countries partially contributes to the overall inequality in Europe.

Thereafter, the focus has been shifted to the main factors that, according to the theory, have contribute to influence the evolution of inequality over time. Different theories explain the positive influence of globalization and technological progress on the economic growth, but, conversely, their impact on inequality is widely debated. Nevertheless, one of the most common theories suggested states that technology and globalization have contributed to the *skill-biased technical change* and *the factor*

price equalization, respectively. As a result, both phenomena have led to a wages structure transformation that could have driven to inequality over time. Furthermore, different researchers suggest that investment on human capital and public expenditures (especially on health and education) are 'forces of convergences', i.e. factors that hinder and curb inequality.

Lastly, the econometric study of Italy and Sweden over the 1976-2014 period has been performed on the basis of this theoretical framework. The selected variables were Gini index, human capital, trade openness, the share of public expenditures and total factor productivity (*TFP*). The *Engle-Granger 2-step method* has been applied since it allows to make inferences in the regression when the time series data are non-stationary and cointegrated. After having checked the non-stationarity of data with the augmented Dickey-Fuller test, we have verified whether time series were cointegrated.
In the case of Italy, we obtained that Gini index, human capital, trade openness and TFP are cointegrated, i.e. the variables tend to move together. In particular, human capital, government expenditures and trade openness can have a negative effect on Gini index whereas, by contrast, *TFP* can increase inequality. Regards Sweden, it turned out that the role of government and *TFP* are not statistically significant whilst Gini index is cointegrated with human capital and trade intensity. The influence of human capital and trade openness on Gini index is positive and negative, respectively. In addition, the second-stage error correction allowed to examine the dynamic relationship between the variables in the short-period. According to the results, the speed-of adjustment coefficient is, for both countries, negative, significant and close to zero. This suggests that the adjustment mechanism in the case of potential shocks is slow.

To sum up, both results agree with the theory of human capital which suggest that, as the number of educated people increases, in the long period, it diminishes the level of inequality thanks to the process of adjustment between the supply and demand in the labour market.
The results on the impact of trade openness are controversial between the two countries instead. This can be explained by the fact that globalization can have different effects depending on the country considered. As a matter of facts, researchers have found that the gains from trade liberalization can vary across and within countries. (Cf. Lang and Tavares 2018)

Finally, the role of government and technical progress seem to have influenced the Gini index trend only in Italy. Public spending appears to be effective on reducing inequality whereas technical progress can have influenced the wage structure of the Italian society.

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Appendix

A. Time series plot

Figure A.1 Time series plot (levels) Italy

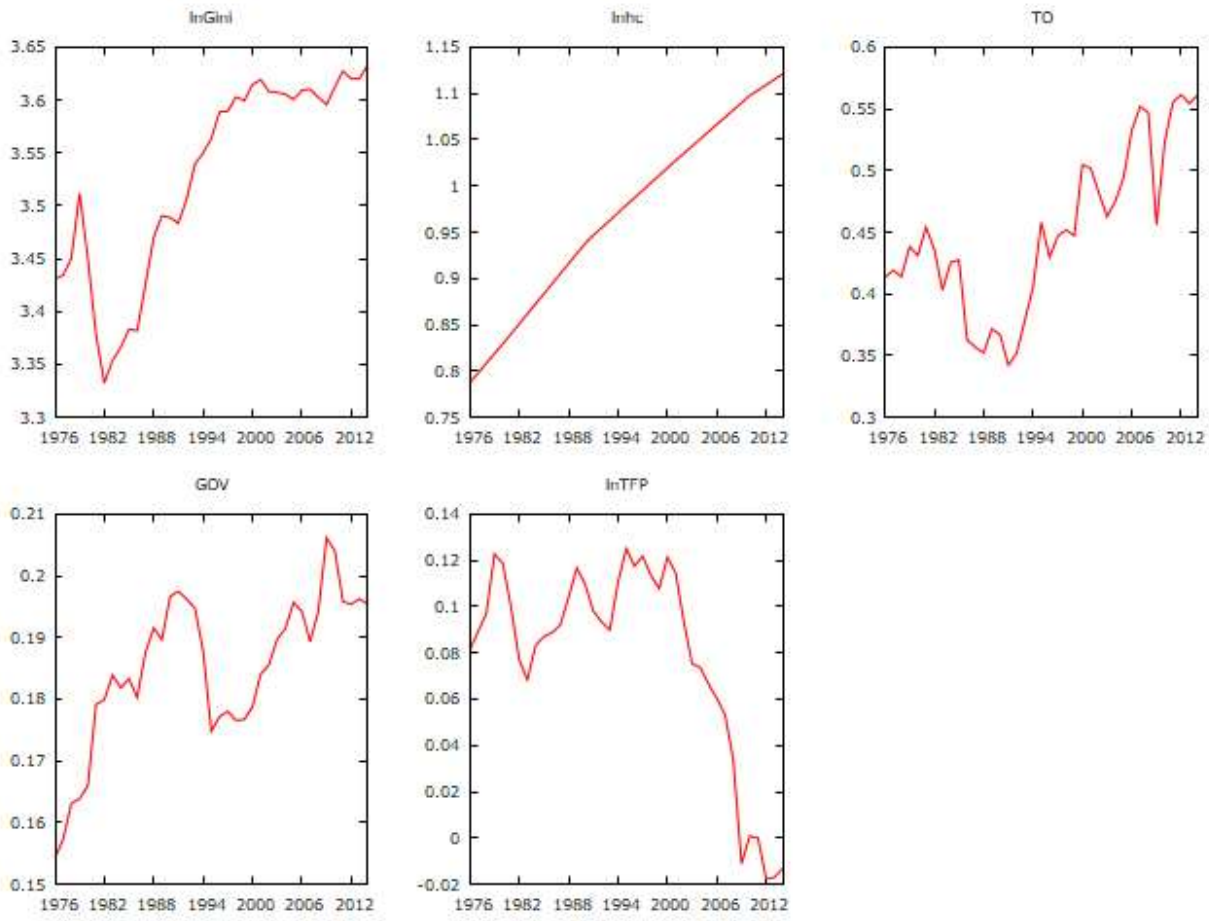


Figure A.2 Time series plot (1st differences) Italy

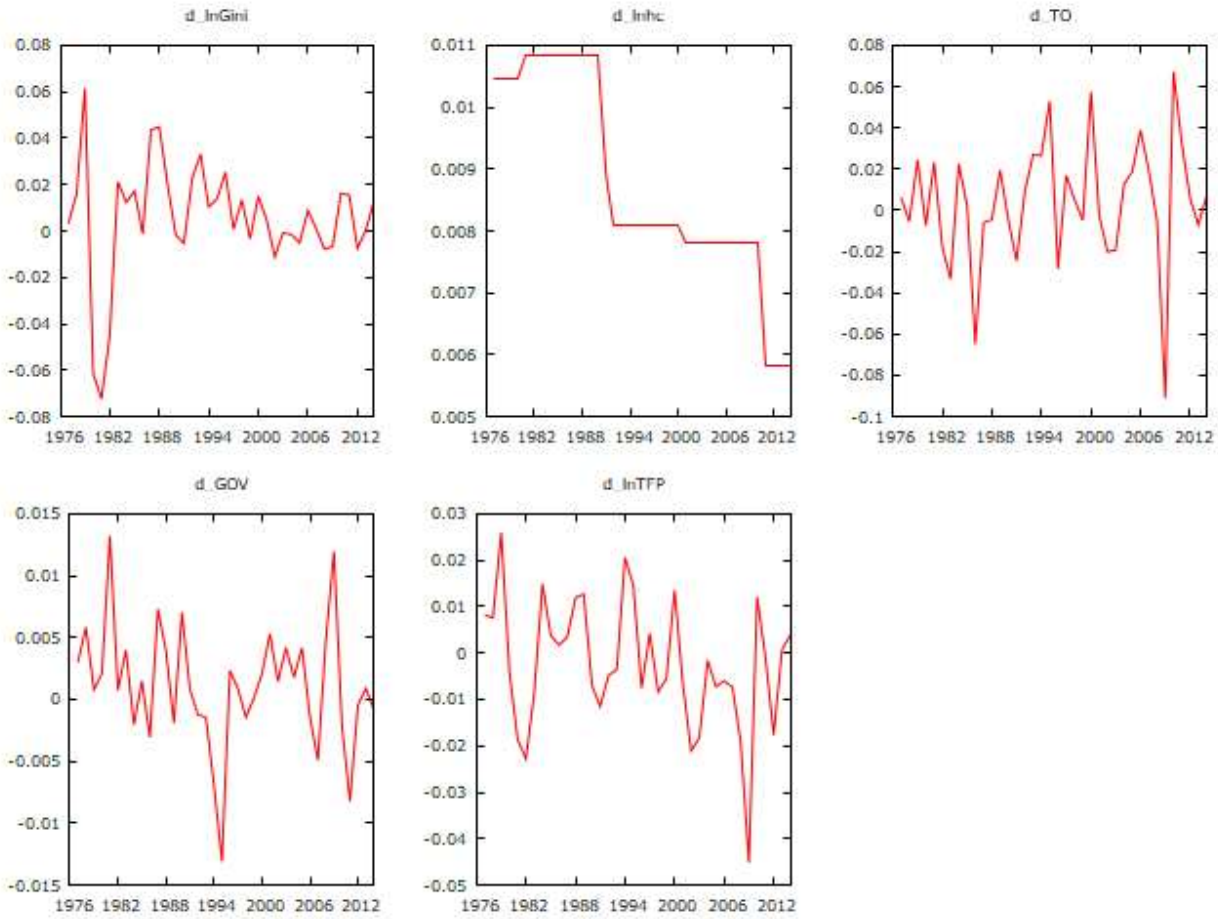


Figure A.3 Time series plot (levels) Sweden

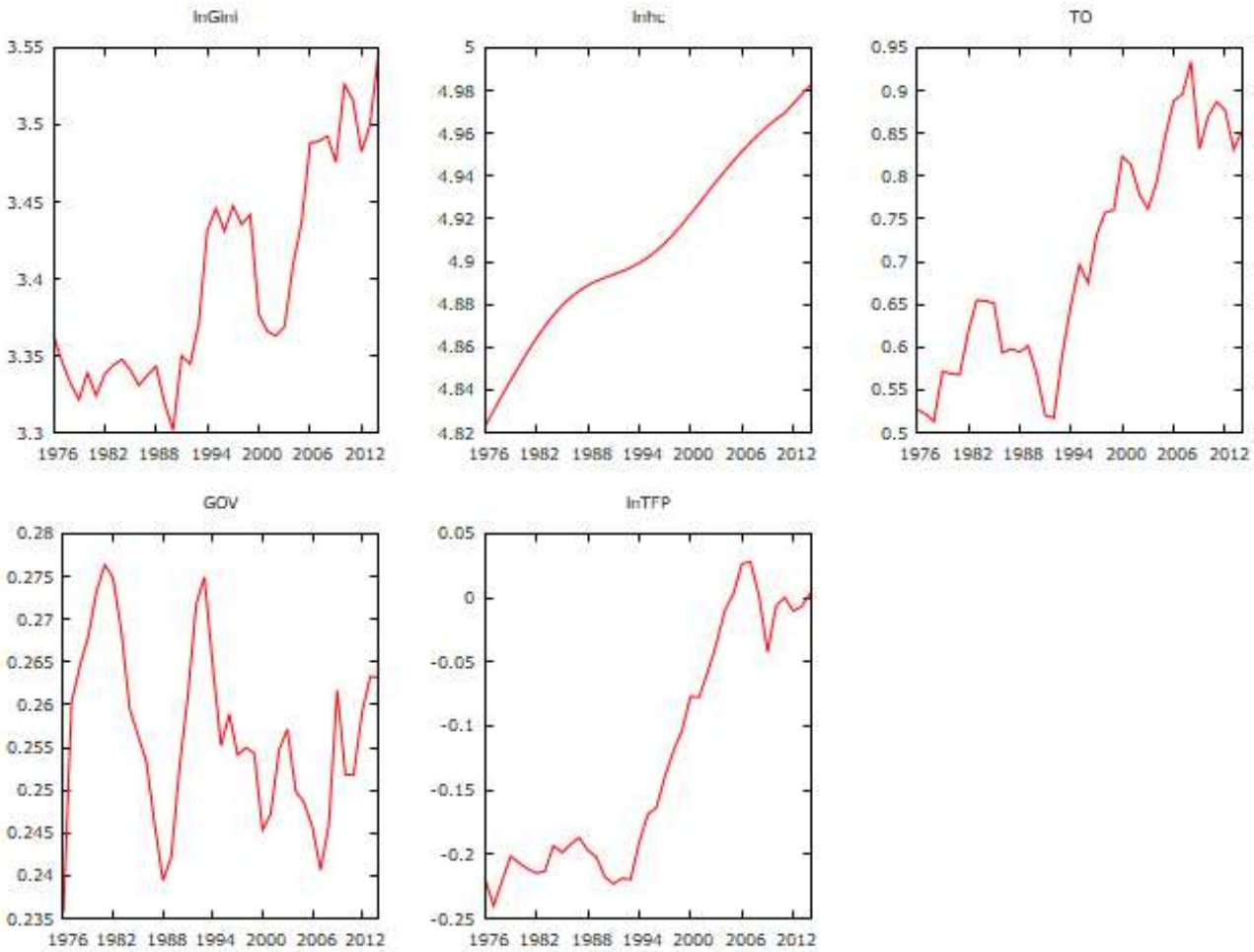
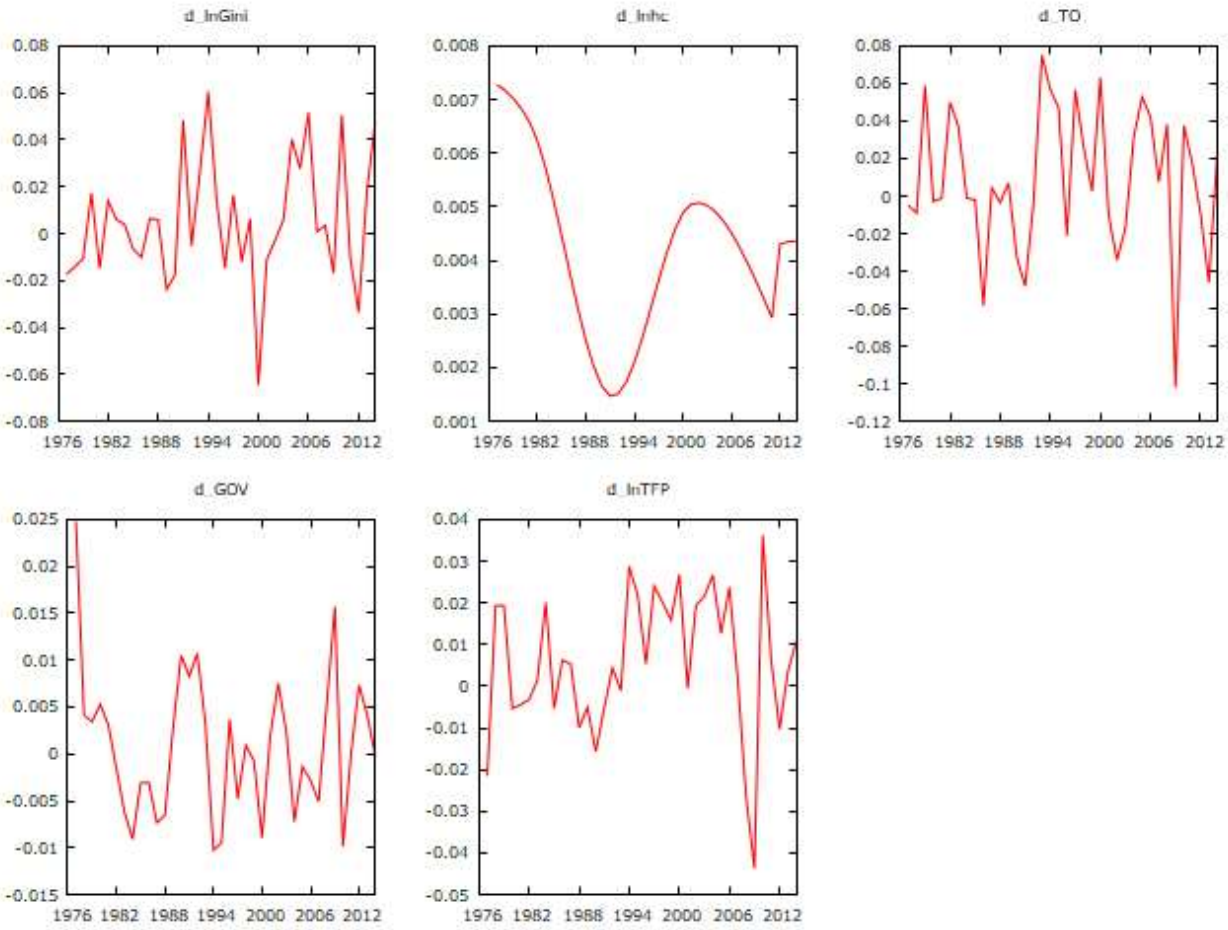


Figure A.4 Time series plot (1st differences) Sweden



B. Residuals plot obtained by OLS first-cointegrating regression

Table B.1 Residuals plot (Italy) *(model 1)*

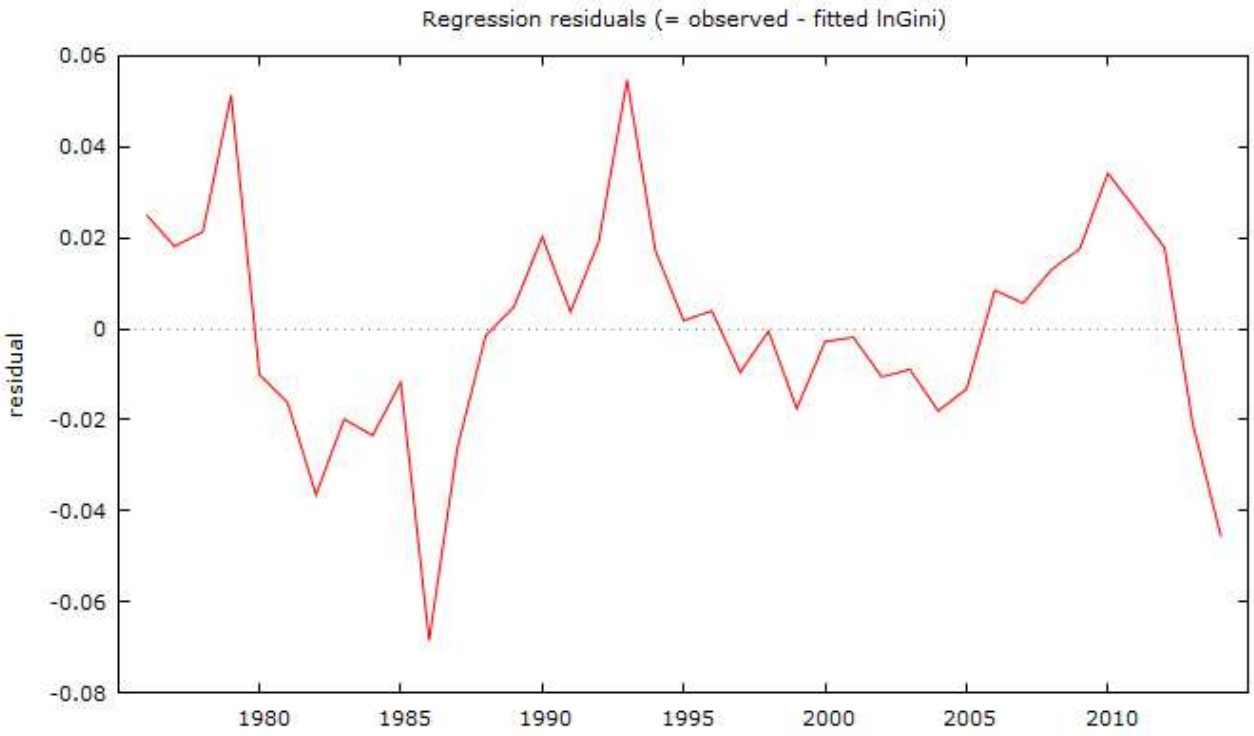


Table B.2 Residuals plot (Italy) *(model 2)*

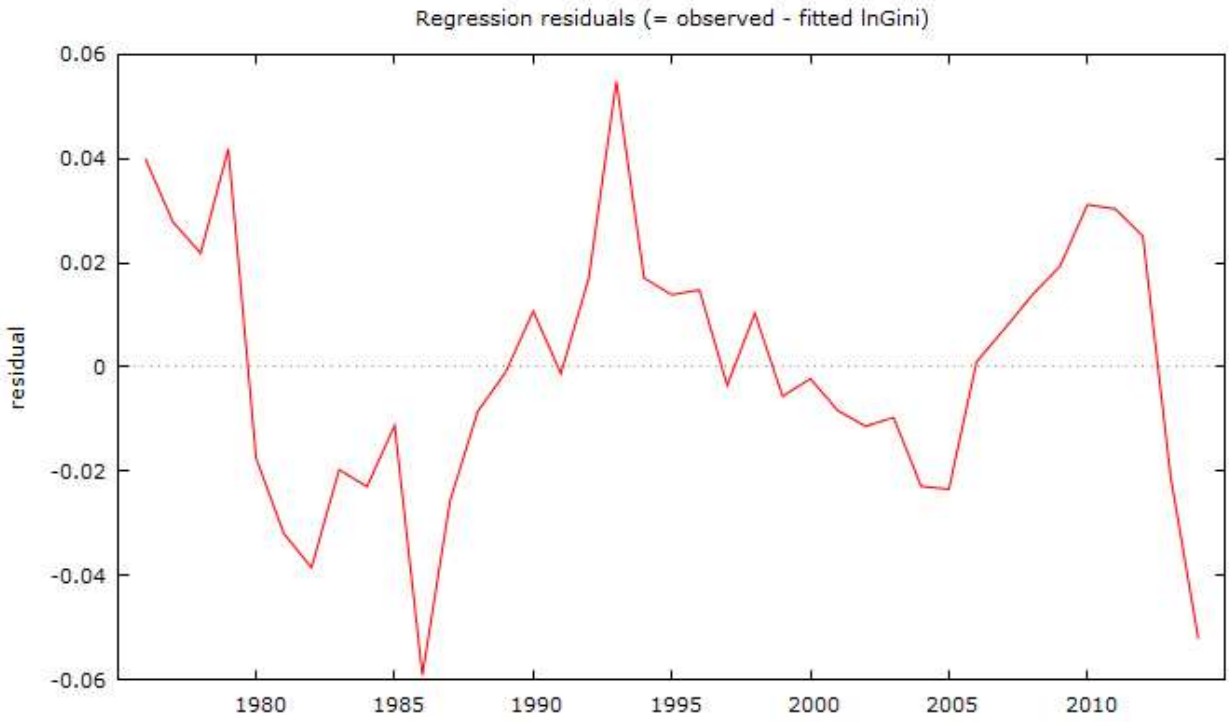


Table B.3 Residuals plot (Sweden) *(model 1)*

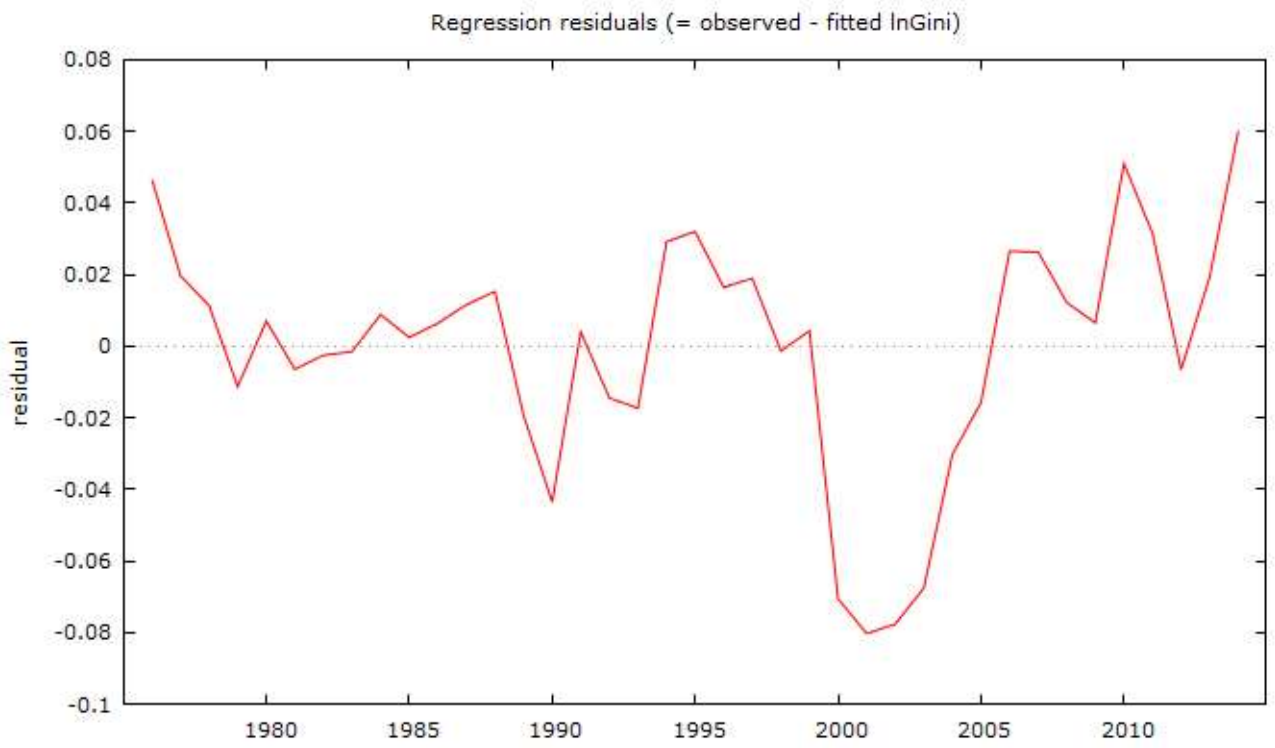


Table B.2 Residuals plot (Sweden) *(model 2)*