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Abstract: Existing economic literature provides contradictory or insufficient explanations of relation between income inequality and economic growth. I propose that the reason is that the authors fail to consider fundamental forces which have given occasion to the variables and historical background of the issue. My analysis is focused on studying causes of the earliest income inequality and economic growth accompanied by inequality. I find that external power exercised by slave owners is force which has given occasion to inequality and growth. This finding provides fundamentally different understanding of the issue.

1. Introduction

Available statistics imply that relation between income distribution and economic growth is complex. Arguments put forward in a documentary *Home* claim that 2% of the richest income groups possess 50% of the world's resources and the top 20% of income brackets receive 80% of income. Income inequality is lower in developed countries than in developing ones (UNU-WIDER). Yet average level of income inequality has increased in OECD countries for the last 20 years (OECD, 2011). Facing income inequality problem, some of countries face no economic growth and others suffer from the negative effects of business cycles. It is conventional truth that many African countries have not experienced economic growth for the last century. It is also known that economic growth is subject to business cycles. Due to the ups and downs of business cycles, both the developing and the developed economies suffer negative economic growth at certain periods. The statistics demonstrate that correlations between growth and inequality should be deeply studied.

Conventional economic literature uniformly holds that to attain higher rates of economic growth, an economy usually has to give up equal distribution of income. More thorough study claims that, in a span of economic growth, income inequality may increase or decrease depending on the economic conditions of a country (Kuznets, 1955). It is commonly believed that unequal income distribution widens on the first stages of economic growth and shrinks after economic growth exceeds a certain point. The hypothesis has been tested by later studies, and contradictory results have been achieved (García-Peňalosa and Turnovsky, 2006; Kuştepeli, 2006; and Panizza 2002). The ambiguity implies that the existing theory is not capable to elucidate relation between growth and inequality.

The current study contributes to understanding of the above relation. The paper suggests that the most important step to solve the contradictions is to reconsider the fundamental causes of the earliest income inequality and economic growth and historical backgrounds of the topic. In order to attain the ends, the paper shall accomplish analysis according to the suggestion. To efficiently conduct analysis, it is imperative to analyze individual behavior at times when the market relations among individuals have started taking place. The analysis serves as a development of three studies: one by Smith (1776), another by Marx (1867), and the other by Tolstoy (1886). Unlike the above authors, my analysis is based on simple, yet strong, game theory model.

The paper continues as follows. The next section provides background information on the models which will be applied. Section 3 states results deducted from the models. The following section delivers explanation of the results. And the final section provides concluding remarks.

2. Background of the Model

The relation of growth and inequality can be approached from different perspectives. One the popular approach is a traditional one proposed by Kuznets (1955) and widely studied by his followers (Alba Ramirez and Collado, 1999; Banerjee and Duflo, 2003; Barro, 2000; Fishman and Simhon, 2002; García-Peňalosa and Turnovsky, 2006; Kuştepeli, 2006; Lee and Roemer, 1998; Milanovic, 2006; OECD, 2011; Panizza 2002; and Willen et al., 2008). This method allows identifying all possible forces which may affect income inequality on a span of economic growth. The disadvantage of this method is that, like Newton's study of properties of gravitational force rather than its causes, it focuses on analysis of forces which may *affect* growth and inequality rather than those which *give occurrence* to them.

Another approach to the issue is general equilibrium model offered by Sraffa (1963). The method avoids strong assumptions and analyzes the issue from general perspective. It demonstrates that all prices, including wage rate and rent, cannot be determined by market forces. The study implies that inequality is a consequence of something else than market forces. Although sound, the method does not give hint on how the prices are set, or what causes inequality and growth.

Also the topic can be considered through Smith's perspective (1776). The author has pioneered in an attempt to explain the fundamental causes of income inequality and economic growth by analyzing historical background of the market relations. The author distinguishes inequalities within three production factors—land, capital, and labor. Unlike Sraffa, Smith has found that inequality can be a consequence of market forces (the author defines them as "natural causes of income inequality") as well as external forces. Also the author asserts that the reason of the earliest substantial economic growth has been division of labor. He elucidates that, due to specialization, market forces which has caused income inequality has occured. However, the author has imposed certain presumption on his analysis. Two of them needs to be emphasized: that division of labor is a consequence of trade, and that any production requires the above three factors—land, capital, and labor. The weakness of this approach is that the assumptions restrain consideration of other possible scenarios.

The issue can also be approached from Marx's standpoint (1867). Marx finds that capitalism is a cause of income inequality. The author argues that capitalists possess power to control laborers. He therefore implies that capitalists can affect wage rates. According to the author, capitalists assign almost all surplus products to themselves and generate inequality in the society. The disadvantage, and at the same time the very advantage, of this approach is that it concentrates on capitalistic mode of production only.

Final approach to the topic to be considered is one by Tolstoy (1886). Like Smith, Tolstoy analyzes the earliest market relations in history. Opposite to Smith, Tolstoy claims that slavery has caused the earliest division of labor, inequality, and growth. The author implies that Smith's concept of specialization and division of production factors into three is groundless. He believes that an individual tends to avoid specialization since the individual prefers to practice different types of jobs to a single one. Yet the author does not eliminate a possibility that specialization of labor may be caused by individual wills. By relying on historical data, Tolstoy, however, concludes that external force, which is slavery, has given occasion to specialization, economic growth, and income inequality.

Among the above perspectives, I will mostly apply one by Tolstoy since his approach provides a general picture of the earliest market relations. In essence, my model will analyze Tolstoy's concept deeply, and my analysis will serve as a development of the author's idea.

More specifically, I will construct a model which studies individual behavior in a situation that represents the first market interactions. The model is based on game theory. First, I will construct a model of simple game with two individuals and two goods. Later, I will develop it further, and the complicated model will include numerous individuals and numerous goods and/or services.

3. The Model

Times span between primeval and slavery ages is commonly believed to be a period when the earliest market relations started taking place. To construct a model, I will make assumptions on individual freedom, exchange/trade, and division of labor to correspond to reality of the above time period. I apply most of the assumptions for simplification purposes, and later I will relax them.

One of the assumptions of my model relates to individual freedom. I assume that a person is free to do anything he wants, and no one restrains his freedom. Nevertheless, in order to maintain the sense of freedom, a person is absolutely free to do anything, except that which restricts the freedom of another. This idea eliminates the existence of monopoly, oligopoly, government, and any other institutions and/or powers which can exercise power to compel a person to act against his will. Each person makes his individual decisions, and each one acts on the basis of the decisions he made.

Next, I assume that, in a state of nature in which absolute freedom exists, all people in workforce are homogenous in their needs and abilities.[1] Each person produces those types of goods and services which maximizes his utility. Since everyone has approximately the same needs, each person produces that same set of goods and services which every other person does. That each person produces the same set of goods and services eliminates existence of division of labor. Since there is no specialization of labor, the production of a person is barely high enough to satisfy his needs. In other words, a person produces just enough to meet his own needs because there is no division of labor which causes improvement in production. In light of these points, it logically follows that there is no need for exchange.

Also, in such society, there is no need to specialize. Given that there is no power that forces a person to exchange, let us assume that a person chooses to specialize in production

[1] The assumptions of the homogeneity of people and freedom are reasonable to describe the state of societies in ancient times before slavery and after primeval periods, times when no institutions to control people's actions had been established. According to Boatwright et al. (2004), 4000 years BC when degree of specialization and that of income inequality were insignificant as well as technological improvement correspond to that time in the territory of modern Italy. During those times, people were close to absolute homogeneity in their needs and abilities. Each man was busy hunting and/or producing agricultural goods. Each woman was busy in the agricultural sector too, but she also was busy doing jobs which naturally tend to be done by women—such as taking care of children—instead of hunting. Men's and women's duties differed to some extent; still specialization did not reach that degree which caused great improvement of labor. Also no human established institutions which had restrained people's freedom. A tribe might have certain rules, but those rules were designated to support the main principle of liberty—do not do actions which limit others' liberty. Hence, it is not wrong to assume that in earliest periods of human history people were homogenous in needs and abilities.

of a good *X*. He produces that good in such quantity that he possesses surplus. In case, if the other persons in the society exchange their goods and services to the good *X*, the person can improve his utility by exchanging his surplus product with the other goods and services. However, the others do not want to exchange anything with him since each of them produces a set of commodities in such quantities which are only high enough to satisfy each of the others own needs. That is, no one, but the person who specializes, will have a surplus production for the exchange. This means that, if a person specializes in production of a certain good, then the person ends up with consuming only that good only, i.e., the person will not be able to meet his needs. Thus, in this type of society, people do not possess the will to specialize.

3.2.Society with Two Persons and Two Goods

Figure 1 demonstrates the above state of society in a simplified form. I assume that there are two individuals and two different goods. Each faces two choices: to specialize in producing one of the goods or not to specialize, which is to produce both goods. In the case they choose to specialize, it would be logical they will specialize in production of different commodities—specializing in the production of the same good does not make sense. Since I suppose the persons are similar in their needs and abilities, the level of each ones utility in identical cases are equal. Although the model is a simplified one, it is relevant to apply it for an analysis of the type of society described above.

In the figure, the numbers in the brackets show the level of utility of each person. In the brackets, the numbers on the left represent *Person 1*, and the numbers on the right represent *Person 2*. The numbers are chosen arbitrarily, but that does not affect the overall outcome.

If no one specializes, then the level of utility of each person is equal to *5*, which is less than the outcome *(7;7)*, which occurs when both choose to specialize and exchange their goods. In the latter case, each consumes more than each does in the former case. In each of the other two cases, a person who specializes consumes only that good, in production of which he specializes; and the other person who produces a set of both goods consumes that set because that set of goods is utility maximizing and also is barely high enough to meet his needs. Although the one who specializes consumes more of the good in production of which he specializes, more consumption of that good only decreases his initial level of utility (from *5* to *2*) since only consumption of a combination of the two goods can satisfy his needs.

Person 2 / Person 1	Specialize	Not Specialize
Specialize	(7;7)	(2;5)
Not Specialize	(5:2)	(5;5)

Figure 3.1. A two person game with two commodities.

There two equilibriums in the system. They are *(Specialize; Specialize)* and *(Not Specialize; Not Specialize).*

In the model, it is not necessary that, in equilibrium point in which both persons choose *Specialize* strategy, the utility levels of the persons are equal. That point will still be an equilibrium point even if the utilities are different; but each utility levels should not be less than utility level in the other equilibrium *(5;5).*

Furthermore, in the model, I have assumed that a person can produce only one good under *Specialize* strategy and a fixed set of both goods under the other strategy. Now, I will loosen that presumption, and will suppose that a person may choose to partially specialize in production of a certain good under *Specialize* scheme. That is, a person can produce both goods, but a production of one of them is now higher than it has been under *Not Specialize* strategy. Relaxing the assumption leads to four possible scenarios.

It may be that the both persons choose to partially specialize. Despite the degree of that "partial specialization," the proposed results do not change.

It also may be that only one of the persons chooses to partially specialize. In this case, results of the analysis depend on the degree of partial specialization. If the degree of the partial specialization is closer to full specialization, the system has the above two equilibriums. If the degree of partial specialization is closer to the other extreme, then the person who partially specializes is better off in *(Specialize; Specialize)* point, but the other person is worth off in the same point. This scenario leads to only one equilibrium point, which is autarky. Finally, if the degree of partial specialization is such that this strategy of the person does not affect decision of the other person which strategy to choose, then the model again has the following two equilibrium points: *(Specialize; Specialize)* and *(Not Specialize; Not Specialize).*

3.3. Society with n Persons and m Goods and Services

To better fit my analysis to the reality, I say that there is n number of persons in a society. In autarky, each person produces m number of different goods and services.[2] Each faces mainly three choices: to specialize in production of one good or service only and exchange the surplus; to partially specialize in production of one or more goods or services and exchange

[2] If $n>m$, or $n<m$, or $n=m$ do not affect my analysis.

the surpluses; or not to specialize at all, that is, to produce a set of goods and services which meets his needs and, correspondingly, not to exchange, since he does not have any surplus. Also more than one person can specialize in production of the same good or services. And finally, each one has fixed number of pure strategies.

The above system has multiple equilibriums. Given that two persons specialize in different production, *(Specialize; Specialize; ...)* with different combinations instead of multiple full stops, *(Specialize; Partially Specialize; ...)* with different combinations instead of multiple full stops, *(Partially Specialize; Partially Specialize; ...)* with different combinations instead of multiple full stops, and autarky are the equilibriums.

I should note that it is not reasonable to apply mixed strategy game to my analysis. In fact, I do not have enough data and information to support my point. Nevertheless, on the basis of logical judgments, I am inclined to believe that my point is a right one. The reason is that it is so difficult for an individual to repeat the process of specializing and then going back to autarky several times that it is most probable that he does not choose mixed strategy. Usually it takes several years to specialize in production, for instance, of wheat. Once a person starts earning his living by producing wheat only, it is hard for him to switch to autarky—but that is possible. Yet it is extremely hard to repeat such switches several times. Still this is a product of my logical thinking only, which is why a thorough analysis of test my point is needed.

Finally, I will loosen the presumption that the production is barely high enough to satisfy a person’s needs. I suppose that, in autarky, each person produces surplus of some goods. In this case, I have a typical model in which specialization and trade is the only equilibrium.

4. Results

Summing up my above analysis, I have reached the following results. In a free society with two persons and two goods, in which a person can do anything but that which hinders the freedom of the other, in which specialization has not taken place, and in which production without specialization is barely high enough to satisfy the persons' needs, the economic system is in a state of equilibrium. Each individual in that society does not possess the will to specialize or to trade. Only cooperation or an external force can disturb the equilibrium and move the system to another equilibrium—each person specializes and trades.

Supposing that the persons can partially specialize can slightly change the conclusions. Again, an autarkic society is in a state of equilibrium. Also there is another equilibrium point, which is true only if the degree of one of the persons' partial specialization is not extremely low whereas the other person fully specializes. The society can move to that equilibrium only if the persons agree to specialize and exchange their surpluses or if the external force compels them to do so.

In a model with *n* individuals and *m* types of goods and services, the analysis triggers the following outcomes. A free autarkic society in which each individual, similar in his needs and abilities to the other individuals, produces a set of commodities and services which is barely high enough to satisfy his needs is in a state of equilibrium. A society can move to another of the possible equilibriums only if the individuals agree to specialize and exchange their surplus products with each other or only if an external power forces them to do so.

In a similar model, but in which the individuals in the society have initial surplus, the individuals tend to specialize and trade.

4. Explanation and Discussion of the Results

What needs to be paid attention in both models with n individuals and m types of goods and services—the one with no initial surplus production and the other one with initial surplus production—is that, in the equilibrium points, in which the persons choose to specialize, each utility level is not less than the utility level in autarky. This implies that, in the equilibrium point in which the persons choose to specialize, the income inequality is not so high that some live in extreme poverty whereas the others reside in luxury. By extreme poverty, I mean a condition in which a person's utility level is less than that under autarky. If a person's utility level under the equilibrium in which the persons choose to specialize is less than that under autarky, the person leaves the market and chooses to live in autarky.

However, history demonstrates that opposite happened during the slavery period. History informs that the slaves suffered extreme poverty while the slave owners enjoyed luxurious lives. Although the slaves were supposed to choose autarky according to the model, we observe high degree of specialization.

The main reason of the contradiction is that the slaves did not possess freedom—it would have been a quite amazing picture of slaves leaving their owners to live in autarky. There is no doubt that the slaves wanted to escape their owners and to live in autarky; alas, we know that the owners would have punished the slaves if the slaves tried to escape. In other words, the slave owners controlled the slaves' freedom.

That control of freedom is the root cause of the earliest income inequality and possible reason of the earliest economic growth and division of labor. If we assume that there was no surplus in autarky, then the slave owners have compelled specialization among the slaves against the latters' wills. Having forced division of labor, the slave owners have also prevented trade among the slaves to certain degree by taking away substantial part of the slaves' productions. In other words, the slave owners, on the one hand, forced division of labor among slaves and caused economic growth, and, on the other, they triggered income inequality. The latter action would stir the slaves to tend to autarky, but, because their freedom was controlled by the slave owners, the slaves have kept on specializing. If we suppose there was no initial surplus in autarky, then the root cause of the earliest specialization of labor, growth, inequality, and their positive correlation has been slavery.

If we suppose there was surplus production in autarky, then the slave owners forcefully have, first, taken the goods and used the services produced by the slaved and, later, forced specialization. In this case, initially the slave owners have not had to force the slaves to specialize since the "slaves" (the word appears in brackets because free people become slaves only after slave owners control the people's freedom) individually tended to do so. The only purpose that the slave owners had to achieve in this stage has been to forcefully take away production of slaves, thus decreasing degree of trade among the slaves. Such action would cause the slaves to leave the market; yet their right to leave the market was restricted by the slave owners. Having "bitten" most part of the slaves' production, the slave owners now have had to compel specialization. In this case we have similar picture as in the above one with some differences: that the fundamental cause of the earliest specialization of labor and thus economic growth was people's propensity to trade; that the reason of the subsequent specialization, growth, and the earliest income inequality, and the variables' interrelations has been slavery.

Some may argue that the study does not consider the slave owners as persons who specialize in controlling freedom. Although the argument seems sound, it is flawed. The paper analyzes specialization of persons in different branches of productions. All the produced commodities and services in those different branches add up to total production. Control of someone's freedom cannot increase total production; it rather transfers someone's production to another. In essence, the slave owners redistribute income rather than they generate it. This is why control of freedom cannot be considered as specialization in a certain production.

Some other may claim that redistribution of income by slave owners is a service that requires certain effort and has increased entire income in the society by causing specialization. The argument has two drawbacks. One of them is that income redistribution is a type of service that restricts freedom of certain individuals whereas usual service does not. Income has been redistributed mainly from slaves to slave owners against the slaves' wills. However, any type of other services, in a society with no slavery, not only does not affect individual freedom but also is desirable. The other drawback of the argument is that forceful income redistribution, in fact, hinders economic growth. Economists agree that people are less willing to work under slavery than under freedom. Although one of the effects of forceful income redistribution is significant economic growth, it is obvious that, had slavery not taken place, economic growth under freedom would have been higher than under slavery.

Also my findings are in line with those of the earlier authors.

Results of my analysis are consistent with those of Tolstoy's study. According Tolstoy, slavery has caused the earliest income inequality as well as specialization and growth accompanied with inequality. Similarly, my findings state the same. The only difference between the author's study and my work is that the author gains the conclusions on the basis of philosophical judgments whereas I do the same on the basis of game theory.

Similarly, my results are in line with Marx's findings with few differences. Marx states that the main reason of income inequality in capitalistic society is that capitalists control laborers and arbitrarily assign them wage rates. My findings claim that inequality in slavery is a consequence of restriction of slaves' by slave owners. Following Tolstoy's elucidation on evolution of slave owners to capitalists and slaves to workers, I can say that Marx and I came to identical conclusions by studying different periods of history.

Similar to Marx, Sraffa claims that, in capitalistic system, the prices are not defined by the market forces. Yet the author does not provide information on how the prices are established. My study supports the author's idea by implying that the prices are affected by those who restrict freedom of others. Thus, I will not be wrong to claim that Sraffa's results are in line with my findings.

Though it may look my results deny Smith's theories of division of labor and income inequality, the only difference between the author's study and mine is that I provide more general picture on the issues than Smith does. The author states that division of labor is a consequence of people's propensity to trade. I do not eliminate such possibility. According to my analysis, Smith is true only if there is absolute freedom and people possess initial surplus production. On income inequality, the author distinguishes inequalities within three production factors—land, capital, and labor. He claims that there are two types of forces which cause income inequality within the factors of production. One of the groups includes natural forces, i.e. market forces; and the other group consists of external powers which are exercised by government and/or corporations. Such elucidation of the causes of income inequality is reasonable only if specialization is a consequence to people's propensity to exchange and only if factors of production can be grouped to three as they are done by Smith. My study does not deny such explanation, but it only implies that Smith's conclusions hold only under precise suppositions.

Next, my study does not contradict to Fishman and Simon's, Kuznets' and his followers' studies. This group of authors, as I have mentioned above, analyze the effects of different variables on income inequality and/or economic growth. Again taking under consideration Tolstoy's elucidation of evolution of freedom control from slavery to capitalistic system, it may be implied that the above authors find forces, which are consequences of freedom control and which affect inequality and/or growth.

In addition, my findings may elucidate one of the possible causes why the authors of this group reach contradictory conclusions. The reason of the contradiction may be the following. On one hand, governments of some countries adopt policies purposed to increase freedom in the market, and those of some other states introduce laws which contribute to equal income distribution. Some of the policies achieve success, the others do not. On the other hand, richer income brackets still can influence market prices.[3] Depending on which of the forces higher than the other, income inequality widens/shrinks. However, deeper research on the relation between my study and the study of these authors needs to be conducted.

5. Conclusion

On the basis of the above discussion, I have found that *the reason of the earliest income inequality is the restriction of freedom of some persons by the others*—which is slavery. The cause of the earliest division of labor and economic growth is ambiguous. Yet the cause of specialization and economic growth which had been accompanied with income inequality is the limitation of freedom of some individuals by the others too. *Such limitation of freedom (i.e. slavery) has caused positive correlation of division of labor, growth, and inequality.*

Although my model serves as a general picture of how inequality and growth have appeared, it is restricted to analyze the beginnings of market relations only. It needs to be

[3] According to Naqvi (2008), richer income groups of the United States, decided to move their capital from the US to countries with lower wages, such as China and India. This increased unemployment in the US from 4.6% in 2007 up to 9.3% in 2009. And top 1% income group in the country, who possessed 8% of income, earned 24% of income in 2006.

developed further and the results obtained need to be supported by appropriate data to elucidate the modern economic system.

In addition, I do not consider mixed strategy game. I believe it is inappropriate to apply the mixed scheme to the model. The reason for that is I think that using mixed strategy is so difficult for a person that he does not tend to apply it. Yet this question needs to be thoroughly studied.

Still my analysis helps to view the relation between division of labor, economic growth, and income inequality from a different angle. My findings are more general and analyses are simpler than those of the earlier authors. By applying game theory, I have found that the earliest inequality, and possibly the earliest specialization and growth, is based on restriction of freedom of some people by other ones. This control of freedom is a root cause which has triggered positive correlation between economic growth and income inequality.

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