

An Approach to Consumption of Exhaustible Resources Based on Islamic Justice and Hartwick Criteria

Hamed Najafi, Ghasem Nikjou

Abstract—Nowadays, there is an increasing attention to the resources scarcity issues. Because of failure in present patterns in the field of the allocation of exhaustible resources between generations and the challenges related to economic justice supply, it is supposed, to present a pattern from the Islamic perspective in this essay. By using content analysis of religious texts, we conclude that governments should remove the gap which exists between the per capita income of the poor and their minimum consumption (necessary consumption). In order to preserve the exhaustible resources for poor people (not for all), between all generations, government should invest exhaustible resources on endless resources according to Hartwick's criteria and should spend these benefits for poor people. But, if benefits did not cover the gap between minimum consumption and per capita income of poor levels in one generation, in this case, the government is responsible for covering this gap through the direct consumption of exhaustible resources. For an exact answer to this question, 'how much of exhaustible resources should expense to maintain justice between generations?' The theoretical and mathematical modeling has been used and proper function has been provided. The consumption pattern is presented for economic policy makers in Muslim countries, and non-Muslim even, it can be useful.

Keywords—Exhaustible resources, Islamic justice, intergenerational justice, distribution of resources, Hartwick Criteria.

JEL Classification—P46, Q38, O38, Q32.

I. INTRODUCTION

THE rival between generations is a key issue for all models of long-term policy for the utilization of natural resources. Behavior of the current generation with physical and human capital accumulation, and changing and harvesting of natural resources, affects the welfare of future generations. An important question in this regard is how to allocate exhaustible resources between different generations in a society? Then we require a theory which shows why and how multiple generation's utility to be entered once in a context (Social function) and be reviewed together. In fact, this theory must be based on justice criteria and solve the problem of justice between generations. Following this, in the capitalist economic literature it has seen two major theories: the theory of Bentham utility-oriented (Utilitarianism a la Bentham) [4]

Hamed Najafi (MSc.) is with the Faculty of Economy, Payamnoor of Babol, Iran, Islamic Republic Of (phone: 989128448012, e-mail: hami.najafi2@gmail.com).

Ghasem Nikjou (PHD student) is with the Faculty of Economics, Allameh Tabatabaie University, Iran, Islamic Republic Of (phone: 989122173473, e-mail: mehrdad9456@yahoo.com).

and equality between generations of Rawls [6], which we will explain in the continuing. According to the innate sense of justice, equity is always in people's attention and also Islam emphasizes this teaching in all aspects of human life. Muslim scholars should extract the rules of justice between generations within the Islamic texts and jurisprudence standards. Also, they should provide a model to solve the problem of exhaustible resources extraction.

In the present paper, we provide an appropriate model with a brief overview of: justice criteria's between generations, optimal use of exhaustible resources models of Hartwick [1] and Hotelling [3]. Finally, we critique the mentioned models based on Islamic criteria's.

II. REVIEWING THE IDEAS OF JUSTICE BETWEEN GENERATIONS

One important way to optimize the standard social welfare function is the Bentham's theory of utility-oriented. Majority of current models in macroeconomics dynamic optimization follow Bentham's theory. He considers total discounted utility of different generations over time as the welfare indicator and a way which will maximize this function can be specified. In most of standard growth models that are based on Bentham rule, consumption increases over time until the economy reaches a point of stability. During this way, initial generations will consume less than next generations and will move in the direction of economic growth with help to the capital accumulation.

Hotelling was the first person who wanted to solve the problem of optimal consumption of natural resources with the Bentham utility-oriented criteria. He found a policy rule to solve this problem; "in the optimal path of extraction, mineral price in market must be grow with interest rates" (Risk-free). The logic of this rule is simple, in equilibrium; different assets should pay the same return (Assuming no risk). Owner of exhaustible resource should be indifference between selling per more unit of product and investment of its income for the next period or held mineral under the land and selling it at a higher price in a later period. Therefore, the price growth that will satisfy the indifference condition is equal to the opportunity cost of investment income on other assets, namely interest rate. Hotelling's rule is not only a simple formula of price growth, but also contains an important policy message: "if the exhaustible resource extraction deposit to the market, equilibrium price determines the optimal rate of exhaustible resource extraction over time and justice can be established between the generations". As a result there is no requirement

to government intervention, in order to prevent indiscriminate extraction of exhaustible resources and the market does the best its own. Various studies on the exhaustible product price in the long-term showed that, not only did the prices of these products not grow according to the predictions of the Hotelling's model with the rate of risk-free, but that even a downward price trend has also been observed for some products. Several explanations for this contradiction were offered like changing the extraction technology, finding new resources, introduction of competing products, weak property rights and restrictions on extraction capacity. However, finding a model by which to solve this puzzle is an ongoing effort in the field of resource economic researches, as yet. Hotelling's model was presented in partial equilibrium framework with no interaction to other assets, but the question is: with the possibility of investment on exhaustible resources and physical and financial assets and even human resources, how can we imagine a path for sustainable growth of economy if we be sure, the welfare of future generations will not drop? Bentham criterion, in this context was faced with a major conflict, due to the discount rate, in most models the utility of further generations had not actually made much impact on the welfare function and optimization is focused on earlier generations. Another question is: whether a policy guarantees the sustainability of consumption over time?

In this regard, Solow's article [10] is pioneer. Solow at the beginning of his article has reviewed the famous principle of Rawls justice and paid to the issue of justice between generations rather than justice between individuals within a generation. According to the Rawls rule, government is not allowed inequity in resource allocation unless it improves utility of the poorest people. In fact, Rawls suggests the max-min rule versus Bentham oriented utility theory that offers the total utility of economic agents as a social welfare function, and argues that the social welfare function should be maximizing the existing minimum utility in community. Solow points out: although Rawls himself is not sure about his rule being applied for intergenerational issues, if we use Rawls criterion for intergenerational issues, we will have another achievement. Therefore, Solow proves the application of Rawls justice criterion in the issue of intergenerational justice causes that in bound state, the utility (consumption) of all generations will be equal together.

Hartwick has developed the Solow's idea of fixed consumption with assuming the existence of production cost for exhaustible resources. He suggests a specific rule, known as the Hartwick rule for sustainability. Based on the Hartwick criteria, the government should invest all the revenues derived from exhaustible sources in endless sections (machinery, infrastructure and financial assets, etc.) and use the revenues for public consumption. Thus, the current generation will benefit from investment gains and the productive capital (exhaustible sections) can be transferred to future generations too. The current generation only transfer sale revenues of underground sources to the next generation and does not save anything from the other asset's benefit for future generations. Almost this simple suggestion supports two rules that we examine in the votes of Rawls. The current generation will not

reduce its welfare due to saving for future generation, but they maintain the capital of natural resources for future generations on the other hand. Hartwick shows that assuming a Cobb – Douglas function for production at the community level and following the extraction program, which is very similar to Hotelling's suggestion, consumption-saving policy keeps a steady level of consumption among different generations. The problem's symptoms are simple too. On the one hand, extraction of exhaustible resources will be decreased over time; while on the other hand, accumulation of productive capitals in other sectors will be increased. These two factors abolish each other's effects and provide a measure of stability in consumption for all generations.

III. INTERGENERATIONAL EQUITY POSITION IN ISLAM

In Islam's view, people do not have any preference over another within a generation and distribution of wealth according to justice has been approved by the religion. Also, various generations have equal opportunities in gaining the exhaustible resources and transposition of a generation does not result in profit taking, nor will it leave the next generation disadvantaged. This is verifiable from perspective of the Quran, narrative and rational reasons.

A. Quran

Quran says: All things in the heavens and the earth have been subdued and obedient for you and the great god has created all and among them for you. This verse clearly implies that God's blessings have not accounted to specific individuals, specific groups and even people at the special time and it haven't a specific location, but all people are partners in its exploitation. For example, we refer to the following verse:

اللَّهُ الَّذِي خَلَقَ السَّمَاوَاتِ وَالْأَرْضَ وَأَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجَ بِهِ مِنَ الثَّمَرَاتِ رِزْقًا لَكُمْ وَسَخَّرَ لَكُمُ الْفُلْكَ لِتَجْرِيَ فِي الْبَحْرِ بِأَمْرِهِ وَسَخَّرَ لَكُمُ الْفُلْكَ لِتَجْرِيَ فِي الْبَحْرِ بِأَمْرِهِ وَسَخَّرَ لَكُمُ الْإِنهَارَ. (ابراهيم (14)، 32)

i.e.: The great God created the heavens and the earth and sent water from the sky and thereby brought forth fruits for your provision and domesticated the ship for you to be entered with his command in the sea and he subjected rivers for you [5].

B. Specific Narrative

A version of maftooh onovah lands (the lands which have been occupied with Muslims through the wars) shows, Islam's attention to the future generations. It is narrated from Imam Sadiq (one of 12 Shia Imams) that somebody asked him a question about the Iraq lands, and the Imam said in response: these lands are for all Muslims including those who are Muslims today or in the next days will be a Muslim and those who will born after. It was questioned from Imam Sadiq: could we buy the lands from farmers? "It is not permitted except when it is necessary to purchase for the Muslim's property", he said [2].

C. Practical and Jurisprudence Rules

- C.1: Vaghf: is one of the mechanisms of intergenerational justice that Islamic laws have planned and the Prophet and Imams emphasize and their behavior will also approve this case.
- C.2: Vasiat (Wills or devise): is one of the oldest promises of God to his prophets and their covenant about his nation.
- C.3: Government legislation and public property for natural resources: God obligated the government on serial monitoring of equitable use of natural resources with government legislation and public ownership for it and has blocked ways of the abuse of powerful, rich mans and avoids the monopoly of wealth in specific groups. We see a significant portion of natural wealth as Anfal (Some kinds of Islamic government's properties which earned through the war, sea, gift, mineral and etc.) which is located on government properties and other sectors are not owned by anyone and just the general public can use it.
- C.5: Mechanism of the initial distribution of natural resources: Although in the Islamic system, ownership of resources is mainly placed at the disposal of the public sector; Islamic governments encourage the private sector towards exploitation and value creation. Basically, government activities are complementing private sector activities and governments will intervene in cases where the private sector is not willing to entering into. Many mechanisms are anticipated for exploitation of natural resources such as Ehya², Hyazt³, Aqta⁴, Ejare⁵ and Mosharekat⁶.
- C.6: Mechanism of redistribution of wealth and income: usually tax and social security do the task of redistributing wealth and income in one generation. This means that the government collects some part of income-owners' as income and wealth tax and puts it at the disposal of those who do not have the ability to participate in economic activities. Sometimes this process leads to the imposition of costs to future generations, but by planning and establishing a savings fund for future generations, this defect cannot only be compensated, but also income redistribution can be used in order to secure intergenerational justice too.
- C.7: Restrictive rules: Islam has built some rules to protect the privacy of individuals and prevent abuse of others' rights. For example, the rule of prohibition of disturbance in systems can be useful as the principal deterrent in many cases, such as activities which would damage the next generations. According to this rule, any policy or activity that perhaps leads to disruption in social discipline is unlawful and prohibited.
- C.8: The principle of government sovereignty: The government position is superior in the Islamic economic system. Ownership and supervision of natural resources

². Resuscitation

³. Building up the unused lands

⁴. Assigning public land to people

⁵. Rent

⁶. Partnership

results in that the Islamic government optimizes the advantages of these resources, and prevents an accumulation of resources among individuals, groups, or even a generation.

IV. A NEW APPROACH TO CONSUMPTION OF EXHAUSTIBLE RESOURCES

Economic justice means observance of economic rights in the behavior and economic relations. This target will be achieved as an economic goal when everyone attains his or her right of society's wealth and income. In Islam's view, the origins of right for individuals are two things: work and need.

The right will be actually based on the amount of work and effort. Although in Islam's view, the justice term is different with the concept of equality term, but it is very important that people have equal chances in enjoyment of blessings. Accordingly, Silver says: the distributive or economic justice problem is a rule extraction problem for the distribution of desirable things⁷ among the people in the community [9].

In Islam's view, unlike some socialist views, the equalization of income is not advocated among individuals, but the balance of life and livelihood and empowerment of poor people are supported. Muhammad Baqir Sadr has referred to this sense of justice and recognized it as one of the three pillars of economy, based on two principles of social responsibility⁸ and social harmony [8]. In Islam's ideology, God is reference to determine the share rights of wealth and incomes in society. The verses and narratives show two important principles in this subject: 1. in the first step, a useful and legitimate economic work causes this right; 2. in the second step, poverty causes shared rights for those who cannot provide living costs through their legitimate work.

Verses and Hadith⁹ implies that the poor have rights to wealthy people's properties and the Muslim's treasury¹⁰. As an explanation of the subject, wealthy people should pay Khums¹¹ and Zakat¹² in order to satisfy/meet the poor's needs, and if the provided funds fail to cover this, an Imam should provide for their needs through assets which are known as Anfal and Fay.

Therefore, the duties of an Islamic government in the distribution of resources between generations summarily includes: it should distribute exhaustible resources among all generations fairly, considering a constraint; at first it should satisfy the minimum or necessary consumption¹³ for poorer generations. The above statement is inconsistent with the intergenerational justice of Hartwick. In fact, the Hartwick criteria does not attend to the minimum consumption of the

⁷. Good things

⁸. Public assistance

⁹. Those terms of religion like Quran are important for making decision.

¹⁰. According to the bible verse: <<حوالذين في اموالهم حق معلوم للسائل والمحروم>> (معراج 24 و25)

¹¹. The Arabic term khums literally means one-fifth. It is referred to in the Quran in the sura Al-Anfal ("spoils of war, booty"), especially verse no 41, and in various Hadiths.

¹². Zakat is the compulsory giving of a set proportion of one's wealth to charity.

¹³. It includes all basic requirements such as food, clothing, housing, etc.

poor people whether within a generation or between them. But, based on the distributive justice criteria of Islam, exhaustible resources should distribute fairly to the poor (not all classes), both within a generation and between generations. The Islamic government should anticipate production and consumption growth, and then distribute exhaustible resources between the generations with a constraint of minimum consumption. But, a theoretical model is needed which uses a series of simple assumptions to propose a suitable solution. Following, we present this theoretical model:

A. Model Presentation

Here, based on the World Bank model and the Hartwick model and the research of Tordo and Bacon, per capita consumption of exhaustible resources is provided for all generations as [7]:

$$\bar{C}_H = \frac{(r-n)NPV}{p} \Rightarrow \bar{C}_H = (r-n)h \quad (1)$$

We have \bar{C}_H : Constant per capita consumption of exhaustible resources, NPV: Discounted value of resources¹⁴, p: Population, r: Interest rate, n: Population growth rate, h: per capita value of exhaustible resources.

According to the Hartwick criteria, government should invest all revenues raised from exhaustible resources in endless sectors (machinery, infrastructure and financial assets, etc.) and allocate obtained revenues in public consumption. Therefore, the current generation will benefit from investment's results and the productive capital¹⁵ is transmitted to future generations too. Every person's consumption from exhaustible resources is a constant amount among all generations, equivalent to $C^- = \alpha$. To explain our model, first we need to estimate individual consumption. So, the consumption criterion for an individual is defined as follows:

$$C_t = \begin{cases} C_0 & Y_t < C_0 \\ C_0 & Y_t > C_0 \end{cases} \quad (2)$$

$$Y_t < C_0 \quad (3)$$

and we have: C_0 : Obligatory (initial) consumption, Y_t : Muslim individual income, C_t : current consumption of Muslims.

It should be pointed out that this criterion is the function of a Muslim individual's consumption in the government's view. The government must establish a C_0 (obligatory consumption) for a Muslim when his income is not enough against his costs if ($Y_t < C_0$). The Islamic government can take taxes from the surplus of their income because a Muslim has no right to squander; if ($Y_t > C_0$). Then the government will transfer this surplus to the poor and destitute.

According to Solow's growth model, we assume that the per capita income of poor people grows equally to the growth rate of technology, considering this income is not income of the poor working alone, in fact, it is the collection of their incomes, taxes and government incomes that they transferred

to them transitionally [11]. The relationship is presented as follows:

$$\frac{dy}{y} = \alpha \Rightarrow \int \frac{dy}{y} dt = \int \alpha dt \Rightarrow Y = Y_0 e^{\alpha t} \quad (4)$$

And we have: Y_0 : Primary income of poor people, α : Growth rate of technology.

According to the criteria of Islamic justice, if the government could not provide minimum consumption (C_0) for the poor, it should fill a gap through Anfal or exhaustible resources. Finally:

$$R_t = C_0 - Y_0 e^{\alpha t} \quad (5)$$

R_t : Consumption of exhaustible resources for the poor people¹⁶, C_0 : Minimum consumption of poor person.

Therefore, Islamic governments should invest exhaustible resources in the inexhaustible capitals for the poor (not for all) and allocate obtained profits to the consumption of the poor within a generation. But, the Islamic government should fill the gap of minimum consumption and per capita income of the poor within a generation with direct consumption of exhaustible resources, if this profit could not to fill it. We name the direct consumption of exhaustible resources as h_t that is obtained from (5), as the algebraic expression:

$$c_0 - y_0 e^{\alpha t} = h_t + (r-n) \left(\frac{H}{p} - \int_0^t h_s ds \right) \quad (6)$$

H_t : The total value of exhaustible resources, h_t : Direct consumption of exhaustible resources, r: the average of profit that earned from investments.

According to calculations in the appendix, we see that:

$$h_t = \frac{-\alpha y_0}{\alpha - r + n} e^{\alpha t} + c e^{(r-n)t} \quad (7)$$

And in this equation c (constant) is equal to:

$$c = c_0 - y_0 - (r-n) \frac{H}{p} + \frac{\alpha y_0}{\alpha - r + n} \quad (8)$$

The function of h_t is a descending function that arrived to zero at time T. It shows that the government does not need to direct consumption of exhaustible resources for poor people after this time. The h_t chart is plotted with hypothetical data in MATLAB software. We see that as Fig. 1.

After time T, the Islamic government can distribute only profit of investments based on the Hartwick criteria between the poor and destitute people. This will leads to a constant and stable supply for all generations. Finally based on the optimal pattern of exhaustible resources, consumption can be derived for the poor people of society as:

$$R_t = \begin{cases} h_t + (r-n) \left(\frac{H}{p} - \int_0^t h_t dt \right) & t \leq T \\ \frac{H - \int_0^T h_t dt}{p} (r-n) & t > T \end{cases} \quad (9)$$

¹⁶ -The aggregate of direct consumption from exhaustible resources namely h_t and consumption from interest of exhaustible resources investment on inexhaustible capitals.

¹⁴. Net Present Value
¹⁵. Exhaustible sections

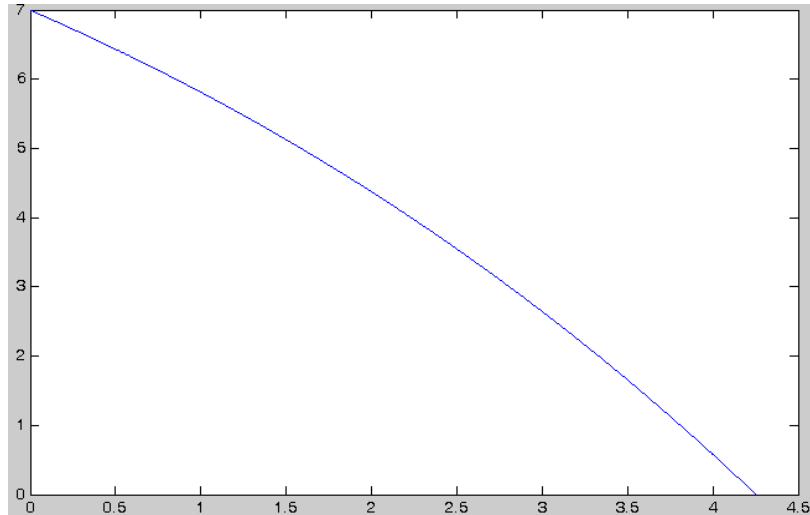


Fig. 1 The h_t chart is plotted with hypothetical data

The curve of criterion (9) is:

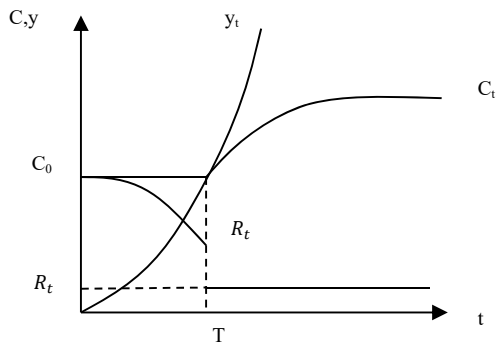


Fig. 2 Graph representation of criterion (9)

V. CONCLUSIONS AND RECOMMENDATIONS

Islam has widely recognized the importance of economic justice, so all of the justice aspects must be studied. The rival between generations is a key issue for all models of long-term policy for utilization of natural resources. Muslim scholars should extract the rules of justice between generation from Islamic texts and jurisprudence standards and must provide a model to solve the problem of exhaustible resources extraction. In the present paper, we presented a model based on Islamic justice with providing important theories of capitalist economy in intergenerational justice field and according to the notions of Muhammad Baqir Sadr¹⁷ and reviewing the Hartwick criteria. Therefore, the Islamic government should invest exhaustible resources in inexhaustible capitals for the poor people (not for all) and allocate obtained profits to the poor people's consumption within a generation. But the Islamic government must fill the gap of minimum consumption and per capita income of poor people within generation if these profits could not fill it. With

¹⁷ -Islam provides a secure life for poor isn't believed that imposed the social guarantee law, is derived from the material conditions of production, rather, it represents a practical value as morally imperative.

this method, government can maintain the exhaustible resources and ensure intergenerational equity and provides the essential consumption of life for poorer generations.

APPENDIX

$$C_0 - y_0 e^{\alpha t} = h_t + (r - n) \left(\frac{H}{p} - \int_0^t h_s ds \right) \quad (10)$$

In (10), we count the difference from parties to t:

$$\begin{aligned} -\alpha y_0 e^{\alpha t} &= h'_t - (r - n) h_t \\ \Rightarrow h'_t - (r - n) h_t &= -\alpha y_0 e^{\alpha t} \end{aligned} \quad (11)$$

To solve this equation, we need an initial condition and to obtain the initial condition, we set t equal to zero in (10):

$$C_0 - y_0 = h_0 + (r - n) \frac{H}{p} \Rightarrow h_0 = C_0 - y_0 - (r - n) \frac{H}{p} \quad (12)$$

Now we solve (11),

$$\begin{aligned} \mu(t) &= e^{\int -(r-n)dt} = e^{-(r-n)t} \\ h_t &= \frac{1}{\mu(t)} \left[\int \mu(t) g(t) dt + c \right] = \frac{1}{e^{-(r-n)t}} \left[\int e^{-(r-n)t} (-\alpha y_0 e^{\alpha t}) dt + c \right] \\ &= e^{(r-n)t} \left[-\alpha y_0 \int e^{(\alpha-r+n)t} dt + c \right] = e^{(r-n)t} \left[\frac{-\alpha y_0}{\alpha - r + n} e^{(\alpha-r+n)t} + c \right] \\ \Rightarrow h_t &= \frac{-\alpha y_0}{\alpha - r + n} e^{\alpha t} + c e^{(r-n)t} \end{aligned} \tag{13}$$

Equation (13) is the whole answer.

Now to obtain the constant c we set the initial condition (4) in (5) from the main text:

$$\begin{aligned} h_0 &= \frac{-\alpha y_0}{\alpha - r + n} + c \Rightarrow c_0 - y_0 - (r - n) \frac{H}{p} = \frac{-\alpha y_0}{\alpha - r + n} + c \tag{14} \\ \Rightarrow C &= C_0 - y_0 - (r - n) \frac{H}{p} + \frac{\alpha y_0}{\alpha - r + n} \end{aligned}$$

REFERENCES

- [1] Hartwick, J. M. (1977), "Intergenerational equity and the investing of rents from resources", *American economic exhaustible review*, vol. 67, pp. 972-974.
- [2] Hore Aameli, تفصيل وسائل الشريعة إلى تحصيل مسائل الشريعة, (1413), Bagher ol Olom publication, Tehran (in Arabic).
- [3] Hotelling, H. (1931), "The economics of exhaustible resources", *Journal of Political Economy*, Vol. 39, pp.137-175.
- [4] James E. Crimmins (1996), *Contending Interpretations of Bentham's Utilitarianism*, Vol. 29, No. 4, pp. 751-777.
- [5] Ibrahim, Quran Surah 14, Verse 32.
- [6] Rawls, J., 'Justice as Fairness', *Philosophical Review*, 46 (1958).
- [7] Robert bacon and Silvana tordo, (2006), "Experience with oil Funds :Institutional and Financial Aspect", *Energy Sector Management Assistance Program (ESMAP)*, World bank group.
- [8] Sadr, Muhammad Baqir, (1971), *Eghtesadona*, Bagher ol Olom publication, Tehran (in Arabic).
- [9] Silver, Morris (1989), *foundation of economic justice*, basil bank well, New York.
- [10] Solow, R. M. (1974), "Intergenerational Equity and Exhaustible Resources", *The Review of Economic Studies*, Vol. 41, pp. 29-45.
- [11] Solow, R. M. (1956), "A Contribution to the Theory of Economic Growth", *the Quarterly Journal of Economics*, Vol. 70, No. 1, pp. 65-94.