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CAPITAL STOCK SIMULATION BY HARTWICK RULE IN IRAN

Abstract:

Fully reinvest of natural resource rents in foreign assets or productive capital such as buildings, roads, machines, human capital or health so-called Hartwick rule. The aim of this paper is to estimate the capital stock in Iran by Hartwick Rule. In other word we estimate PIM method and Hartwick rule for calculate capital stock. The result show that estimated capital stock by Hartwick rule is more than PIM method. Therefore, in Iranian economy, Hartwick rule is not applied because part of natural resource income consumed and genuine saving is negative. If the Hartwick rule would have been followed during the last few decades, Iranian economy would have been much less dependent on oil and other resources.

Keywords:

Hartwick rule, Natural resource, PIM method, Genuine saving

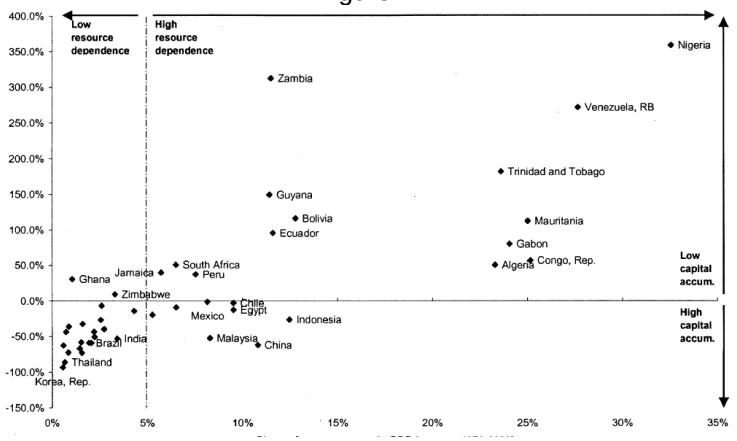
JEL Classification: Q26, N50, O13

1. Introduction

The economists have always been a basic question, is natural resources such as oil and gold could help economic development and growth? How can we use natural resources for growth and development? Today, we have some theories to show the impact of natural resources on development, one of the most important is "natural resource curse theory", Van Der Ploeg (2011). Empirical evidence shows that most developing countries with abundant natural resources are not able to convert these resources into productive assets. However, there is some evidence to suggest that some countries have used of these resources for the welfare such as Norway or Botswana. The key question is why resource rich economies such as Botswana or Norway are more successful while others perform badly despite their immense natural wealth. One reason for the success applied of the "Hartwick rule (1977). Hartwick (1977) says that all revenue from exhaustible resources invests in productive sectors and assets (machinery, infrastructure, health and financial assets) and other revenues (including all the income from other assets) consumed. In this way, the current generation is enjoying the benefits of investment and the productive capital transmitted to future generations. In developing countries when faced with a lack of investment, there is a strong tendency for invest by private sector to the accumulation of capital. But unfortunately the evidence shows that countries can hardly by foreign currencies (from the sale of natural resources) increase capital accumulation. In most countries this is a major cause Outgrown of non-trade sector and capital accumulation has been in non-trade sector, while the small trade sector, (Dutch disease). (Sala-i-Martin and Subramanian, 2003). Almost 80 percent of total budget in Iranian economy is for companies and institutions related to the government as a result of the injection of revenues from natural resources in the economy have been created over the years.

In this paper we estimate the capital stock of Iran's economy by using the Hartwick rule. By asking, if this rule was applied in the Iranian economies the capital stock was how much and to what was the difference the current capital stock? In other words, capital accumulation simulated using by this rule. For example, Hamilton et al. (2006) in an article entitled " Capital Accumulation and Resource Depletion: A Hartwick Rule Counterfactual " using Hartwick rule and using investment data in 30 years and the use of non-renewable resource revenue, capital stock calculated for 70 countries (Figure 1). For example, if you follow the Hartwick rule the Nigeria since 1970, their capitals stock in 2000, almost 2.5 times its current capital stock. According to figure 1 the countries with more natural resources less respect to hartwick rule.

Figure. 1



Source: Hamilton et al. (2006)

2. Hartwick Rule

A key assumption in this rule is that not decreasing consumption over time, Consumption should be constant over time. If we assume that all production to consumption and investment, then the national income accounting as follows:

$$C_t = f(k_t, R_t) - \dot{K}_t \qquad (1)$$

When C_t is denoted consumption, $f(0)$ is production function, K_t is capital stock, $\dot{K}_t = \frac{dk}{dt}$ is growth change in capital stock and R_t is rate of depletion of natural resource.

When, assuming that the following relationship holds:

$$\frac{\dot{f}_R}{f_R} = f_K \qquad (2)$$

$$\dot{K}_t = R_t . f_R \qquad (3)$$

So that $f_R = \frac{\partial f}{\partial R}$ and $f_K = \frac{\partial f}{\partial K}$ respectively, represents the marginal production of natural resources and capital, and the optimum conditions to maximize profits, the marginal production of factor equal to real rent of factor. Eq. (2) is Hotelling assumption that best efficiency condition for the extraction of natural resources. Eq. (3) is Hartwick rule; based on this rule, the value of natural resources (natural resources, multiplied by the return of the net cost of extracting natural resources) is equal to the value of new investment.

Differentiating Eq. (2) and (3) with respect to time, we have:

$$\dot{C}_t = f_K \dot{K}_t + f_R \dot{R}_t - \frac{d^2 k}{dt^2} \qquad (4)$$

$$\frac{d^2 k}{dt^2} = f_R \dot{R}_t + R_t \dot{f}_R \qquad (5)$$

With replacement Eq. (5) in Eq. (4) will be:

$$\dot{C}_t = f_k \dot{K}_t + f_R \dot{R}_t - f_R \dot{R}_t - R_t \dot{f}_R \qquad (6)$$

Or

$$\dot{C}_t = f_K \dot{K}_t - R_t \dot{f}_R \qquad (7)$$

With replacement Eq. (3) in Eq. (7) will be:

$$\dot{C}_t = f_k R_t f_R - R_t \dot{f}_R \qquad (8)$$

Finally, rearranging the Eq. (2) and inserted the Eq. (8) will be:

$$\dot{C}_t = f_k R_t f_R - f_k f_R R_t \qquad (9)$$

Then

$$\dot{C}_t = 0$$

Therefore, the use of savings Hartwick rule to every economy is possible that over time a consumption fixed and exhaustible natural resources efficiently extract.

3. Method and Model

In this section we estimate capital stock by PIM method and Hartwick rule in 2011, for this purpose, the base year 1991 considered. Then we compare of these two methods.

3.1. Capital Stock (PIM Method)

PIM method to calculate the capital stock of the following equation is used:

$$K_t = \sum_{s=0}^{T-1} I_{t-s}(1-\gamma)^s \qquad (10)$$

Where K is capital stock, I is net investment, γ is the capital depreciation rate, and T is time period. We assume that base year is 1991, then time period in Eq. (10) is 20 years ago. Also we assume that Depreciation rate of capital is 5 percent, because according to Central Bank of Iran capital depreciation rate is 4.5%.

With above conditions, Eq. (10) will be as follows:

$$K_{1991} = K_{20} = \sum_{S=0}^{19} I_{t-s}(1-0.05)^s$$

$$K_{1991} = I_{1991}(1-5\%)^0 + I_{1990}(1-5\%)^1 + I_{1989}(1-5\%)^2 + \ldots + I_{1973}(1-5\%)^{17} + I_{1972}(1-5\%)^{18} + I_{1971}(1-5\%)^{19} = 3{,}460{,}480$$

For this purpose we need the information of net investment during 1971 to 1991. This data is available in CBI.ir bank. According to above calculations, the capital stock by PIM in 1991 is equal to, 3,460,480 billion Rials[1].

When the capital stock calculated in 1991, we can be calculated it in 2011 by following equation:

$$K_{2011} = K_{1991} + \sum_{S=1992}^{2011} N_S \qquad (11)$$

Data of investment (N_S) be obtained from CBI.ir and we have:

$$\sum_{S=1992}^{2011} N_S = 4{,}049{,}053$$

With replacement in Eq. (11) will be:

[1] . Constant price in 2000

$$K_{2011} = 3{,}460{,}480 + 4{,}049{,}053 = 7{,}509{,}533$$

The Central Bank of Iran calculated capital stock by PIM method and reported it 7770045 billion Rials, it should be noted that it is not very different with our calculation.

3.2. Capital Stock (Hartwick Rule)

In this section we calculate capital stock when hartwick rule is satisfied. For this purpose it is enough to replace N_S in Eq. (11) by the following equation:

$$N_S = R_S + \overline{S_G} \qquad (12)$$

Where R_S is natural resource income and $\overline{S_G}$ is genuine saving that assume is constant. The Hartwick rule of investing all resource rents in other forms of capital provides a pragmatic guide for sustainable development. Genuine saving is the traditional concept of net saving, namely public and private saving minus depreciation of public and private investment, *plus* current spending on education to capture the change in intangible (human) wealth *minus* the value of net depletion of exhaustible natural resources and renewable resources (forests) *minus* damages of stock pollutants (carbon dioxide and particulate matter) (Van Der Ploeg, 2011).

$$\overline{S_G} = N_S - R_S$$

$$N_S = R_S + \overline{S_G}$$

The minimum standard of hartwick rule is that $N_S = R_S$ established. In other word the standard of hartwick rule satisfied when Genuine saving equal to zero, $\overline{S_G} = 0$. Then we have Eq. (11) by following:

$$K^*_{2011} = K_{1991} + \sum_{S=1991}^{2011} R_S \qquad (13)$$

Capital stock according to the Eq. (13) is known as the capital stock with respect to the Hartwick rule. In this paper the R_S is Total income of natural resources, including oil income, Natural gas revenues and Mining (iron ore, nickel, phosphate, silver, copper, etc.). This data is available in CBI.ir. The total value of natural resources income for 1991 to 2011 is 6,834,423 million rials[2].

$$\sum_{S=1992}^{2011} R_S = 6{,}834{,}423$$

However, along with the previously of K_{1991} , we can calculate Eq. (13) with as follows:

$$K^*_{2011} = 3{,}460{,}480 + 6{,}834{,}423 = 10{,}294{,}903$$

[2] . constant price in 2000

K^{*}_{2011} is the standard method of Hartwick rule of capital stock, that is 10,294,903 million rials for 2011. This means that, if all benefits of natural resources, including oil, natural gas and mining investments would be assigned during 1991 to 2011, the capital stock in 2011 was approximately 10,294,903 million rials, while the capital stock of PIM method is 7,770,045 billion Rials in 2011. The major part of revenues from natural resource is consumed, which is equal to the gap between these two numbers (10,294,903-7,770,045=2524858). In other word, net total investment was less than to total benefits of natural resources ($N_S < R_S$), or the Genuine saving is negative during 1991 to 2011.

4. Results

In this study, we simulation the capital stock in 2011 for Iran, when Hartwick rule is hold and compared it with the current capital stock or PIM method. the result show that, if all the benefits of natural resources, including oil, gas and mining investments during 1991 to 2011 would be assigned, the capital stock in 2011 was approximately 10,294,903 million Rials, while in 2011 the capital stock of PIM method is 7,770,045 billion Rials. In other word during 1991 to 2011, net total investment was less than benefits of natural resources or the genuine saving is negative.

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