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Measuring the Economic Sustainability: A Case of Forest Extraction in Malaysia

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I

INTRODUCTION

In the conventional system of national accounts depletion of natural capital stocks, like man-made capital, buildings and machinery is not accounted for. Resource accounting corrects this discriminatory treatment by adjusting the depletion of natural resource as capital consumption. It includes any loss of value of natural resources caused by economic activities such as felling of trees for development. An appropriate method of measuring the national product or national income, which can be adjusted to account for natural resource depletion, thus is essential for understanding and measuring sustainable income. Sustainable income is the maximum value that individual can use for consumption during a period and still be well off at the end of the period as at the beginning (Hicks, 1946). There are different approaches to measuring the sustainability. *These approaches include Hartwick Hotelling (1977, 1990) approach that refers to estimating the change in the total capital stock and Weitzman (1976) approach that indicates the measuring net domestic product (NDP) as a long run measure for the economic well being.* Among these, the Hartwick model assumes perfect substitution between natural capital and man-made capital**.**

Theorists who allow for unconstrained elasticity of substitution between fixed capital and natural capital support an ethic known as "Weak Sustainability". They believe that an economy is weakly sustainable if it saves more than the combined depreciation of fixed capital and depletion of natural capital. According to the Strong Sustainability (SS) rule, it is not sufficient just to protect the overall level of capital but some of the capital that is non-substitutable must be protected. ***Hence there is a contradiction with the weak substitutability by assumption, which allows for unconstraint substitution between and among the man-made capital on one hand and man-made and natural capital on the other.*** The case of this strong sustainability rule is based on the combination of a number of factors: presence of uncertainty about ecosystem functions and their total service value and the

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irreversibility of some environmental resource degradation and/or loss. Strong sustainability does imply the changing economic resource allocation over time in such a manner so that it does not affect the overall ecosystem parameters significantly. A certain degree of "decoupling" of the economy from the environment should therefore be possible through technical change and environmental restoration investment with a moderate growth rate. In order to keep the record of the state of economic sustainability, the measurement of it is required. *Hartwick (1977, 1990) appropriate sustainability measure is derived by the product of marginal rent and the change in the resource stock that equals the negative amount of resources extracted known as "Hotelling Rent". The other way of measuring the sustainability is simulated from the work of Weitzman (1976) on NDP differs from* Gross Domestic Product *(GDP), where it includes net and not gross investment. NDP= C+I, where C is the consumption and I denotes net investment in man-made physical capital. In both the approaches the measurement error takes place when perfect substitutability assumption is violated. Replacing extraction of some natural capital through investment in reproducible capital may not guarantee in keeping total capital intact. On the other hand, uncorrected benefits from some natural capital such as forestry as habitat and life support to ecosystem and failure to make appropriate investment in order to compensate the loss or regeneration of the anticipated benefits may overstate the estimate of NDP.* The present study aimed at testing the sustainability of Malaysian economics with respect to forest resource extraction.

This study reports on the estimation of resource depletion by adopting the user cost method for the natural forest, rubber holding and plantation forest of Peninsular Malaysia. In the case of valuation of timber resources the present study takes into account the variations of resource rents among different group of species for natural and plantation forest. This does not apply to rubber because of single species. The net growth rate used is obtained by multiplying the gross growth rate by 0.7 as used by Malaysian Forestry Department (*Growth of Malaysian Forestry Field Manual 1997*) i.e, (2.75*0.7 = 1.95 m3/ha / year for all species >30cm dbh. *The rationale of this factor was used because the forest growth is estimated of standing trees, during harvesting some losses are definitely incurred that need to be adjusted in volume terms. For precision in economic valuation of forest resources net growth is taken into consideration rather than the gross one.*

The forest plantation in Peninsular Malaysia is mainly planted with *Acacia mangium* and few others at a rotation of 15 years with an annual growth rate is $10m^3$/ha. The rubber trees are due for replanting at the age averaging 25 years timber is made available. The domestic log price of Peninsular Malaysia was found higher than that of the Sarawak Freight on Board (FOB) log price, thus domestic log price well reflects the supply and demand situation in the log market. The data for GDP, public, private consumption was obtained from *Annual Yearbook of Statistics, Malaysia* (1972-97).

The paper consists of five sections including introductory section. Section II illustrates the theory of resource rent and estimation method of resource depletion, Section III has highlighted the measurement of economic sustainability with respect to forest resource extraction, Section IV focuses on sustainability test for resource extraction in Malaysia. Finally the policy recommendations are presented in Section V.

II

THEORY OF RESOURCE RENT AND ESTIMATION METHOD

In the literature of resource economics Hartwick's rule states that the economies should invest their exhaustible resource rent in reproducible physical capital in order to sustain the economy. It turns out that due to current extraction, the value of resource stock is declining over time. The investment of resource rent in physical capital refers to allowing for decline in exhaustible stocks. The investment of rent in human capital means of "allowing for" the decline in the exhaustible stocks the depreciation in one stock is balanced off by investment in another. Thus the value of extracting firm can be considered the present value of the future benefits from its flow of services:

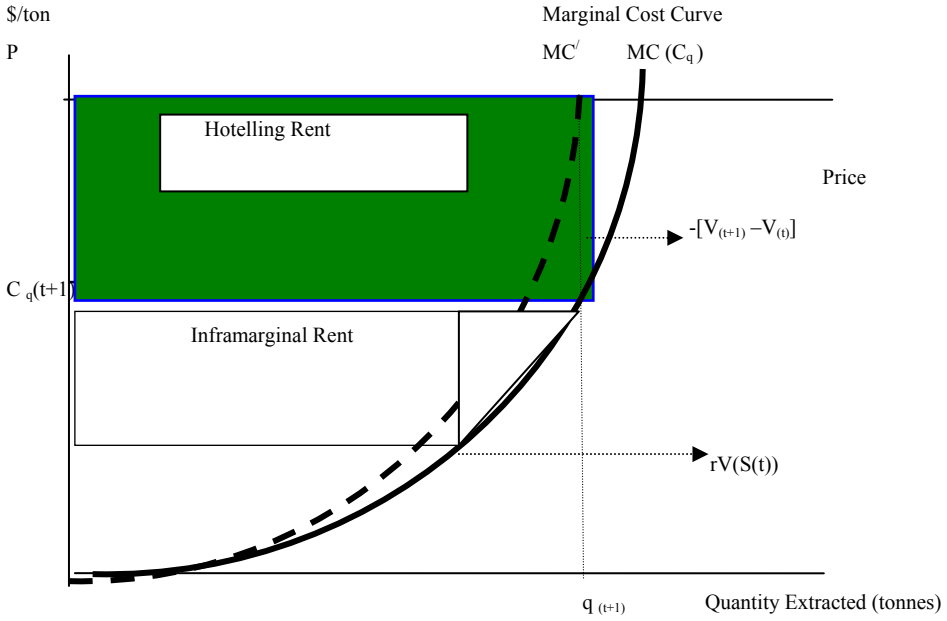
$$V(S(t)) = \int_{t}^{T} pq^*(u) - c(q^*(u))e^{-r(u-t)}\,du$$

where p is the price of the resource, q is the optimal quantity extracted, r is the discount rate and V(S(t)) is the value of the firm with S(t) reserves remaining. Differentiating with respect to time and manipulating the basic equilibrium condition for every time shows that the change in the value of a firm from current extraction is profit from that extraction plus interest on the market value of the firm. Rewriting the above equation in discrete form is as follows:

$$rV(S(t)) = pq_{(t+1)} - Cq_{(t+1)} - [V_t - V_{(t+1)}]$$

The market price of the resource sold and profit earned r per cent from time t to time (t+1) equals to the current income generated out of resource extraction plus the value of resource depreciation. The value of resource depreciation is equal to the Hotelling rent: the amount of non-renewable resource extracted in a given period times the difference between price and marginal extraction cost. The decline in the stock value equals the change in the stock's quantity multiplied by the marginal profit from an additional unit of stock, where "$p-C_q$" is the marginal profit. In other words, the resource stock is depleting in value by Hotelling rent which is equal to

$$\left(p-C_q(q(t)\right)q(t)$$



Source: Adapted from Vincent *et al.* (1997) and Billah (2000).

Figure 1: Components of Resource Rent

Figure 1 shows that the marginal cost curve can be decomposed as (UC + MC = MC'), in which UC is the user cost. The total resource rent is the area above the marginal cost curve (MC) and below the price line, but to the left of the production level. The total resource rent is divided into two components. The first, on the top are the rectangle given by the product of user cost and the amount produced**.** This rectangle is termed the total "Hotelling rent".[1]

The second component is known as "inframarginal rent"[2] that can be used for consumption. Hartwick's Rule states that the total Hotelling rent must be reinvested in order to sustain consumption, inframarginal rent is the portion that can be consumed.

In employing Hartwick Rule, the Hotelling rent as a measure of user cost, to be reinvested to sustain the economy and not used for current consumption. Thus, in the user cost approach of resource accounting, the Hotelling rent is deducted to obtain the adjusted Gross Domestic Product (AGDP). The user cost approach explicitly separates capital consumption from recorded income and production to isolate a true sustainable income stream.

Estimation Method of Resource Depletion

The present study adopted "user cost" method for the estimation of forest resource depletion. The user cost in the case of forest resource is defined as the

future benefits that are given up by felling trees in the current period. Prior to harvesting virgin forest its natural regenerative capacity remains unchanged. The net growth is assumed at a steady state. Only, when the virgin forest is harvested, there is the loss of productive capacity that signifies a diminished level of natural capital. Hence, it is inappropriate to apply a user cost to an area in which natural regeneration has not been compromised.

The present study estimated user cost using the species wise actual log production. The species wise stumpage prices (RM/m^3) for annual production of log was obtained using the real prices and average logging cost (1978 base year). The potential stumpage value was projected up to the second cutting cycle to capture potential benefits for the second cycle of the natural forest, where by after 1996 the next 30 year cutting cycle is taken into account based on the Selective Management System $(SMS)^3$ assumption. The incorporation of the second cycle is necessary to capture the low productivity expected in the subsequent cycle. The total potential benefits foregone (opportunity cost) is then capitalised back to the year under consideration from 2026 to obtain the capitalised value. During this period, the occurrence of resource (forest) depletion is determined as the portion of revenues, which would need to be set aside and reinvested each year to maintain the forest resource.

The capitalised value, which capitalises future returns, is most commonly used method for valuing sustainable forest harvest (Klemperer, 1996). For a forest, the estimation of the change in capitalised value from one period to the next relates largely to the time cost of money and the fact that an investor is one year closer to harvest. The value of the forest inventory at any point in time is based only on the expected returns at harvest and the waiting period.

$$CV_t = \sum_{t=m}^{n} SV\ t\ /(1+i)^{m-t}$$

where CV is the sum of discounted flow of future net benefits (rents from forest resource) over t periods starting in period *m and ending in period n* and discounting at rate i (i.e., capitalised value). The discount rate is assumed to be 6 per cent based on the total productivity growth rate of Malaysia for 1996. Then the capitalised value is thus estimated for 55 years until the end of the second cutting cycle after 1996. The difference between the present years capitalised value from the following year gives the "user cost." The formula is as follows

$$USC_{(t)} = CV_{(t)} - CV_{(t+1)}$$

where $USC_{(t)}$ is the user cost in year t;
$CV_{(t)}$ is the capitalised value in year t calculated as the discount sum of rents in year t until the end of the second cutting cycle;

$CV_{(t+1)}$ is the capitalised value in year (t+1) calculated as the discount sum of rents in year (t+1) until the end of the second cutting cycle.

III

ECONOMIC MEASURE OF SUSTAINABILITY

Pearce and Atkinson (1993) proposed a measure of economic sustainability called indicator of weak sustainability. Their model is based on the neoclassical assumption borrowed from Hartwick and Solow's approach that physical capital and natural capital are perfectly substitutable for each other. Pearce-Atkinson Measure (PAM) measures the value of capital depreciation against net savings. Net savings are obtained by deducting consumption and physical capital depreciation from gross domestic product. If PAM is greater than zero the economy is judged to be sustainable. This will be positive if saving exceeds the sum of physical and natural capital depreciation. The purpose of this test is that if a country fails to qualify in weak sustainability test, it is unlikely to pass a stronger test.

Atkinson and Proops (cited from Hanley and Spash, 1993) adopted the PAM measure incorporating the exports and imports. In practice, natural resources are not always perfect substitutes, rather in many cases they are complementary to each other. The estimation of the depreciation of all natural resources is not always available in order to justify the substitutability.

The World Bank (1995) introduced a similar measure of economic sustainability test named "genuine savings." This test measures the efforts to create new wealth in the nation. Vincent *et al.* (1997) observed that the World Bank (1995) analysis of "genuine savings" over-estimated the resource depletion as it equated the total resource rent to genuine savings. In practice, the market imperfection and government intervention of resource pricing may distort the resource rent in developing countries. *Keeping in view of all these constraints, the current best available practice is taken into consideration for the present study.*

IV

ECONOMIC SUSTAINABILITY TEST FOR RESOURCE DEPLETION

The estimation of resource depletion enables the adjustment to be made with GDP, both at the forest-sector level and the economy at large. The analysis ends at 1996 since no forecasting is made for forestry GDP to the next century as demonstrated in Figure 2.

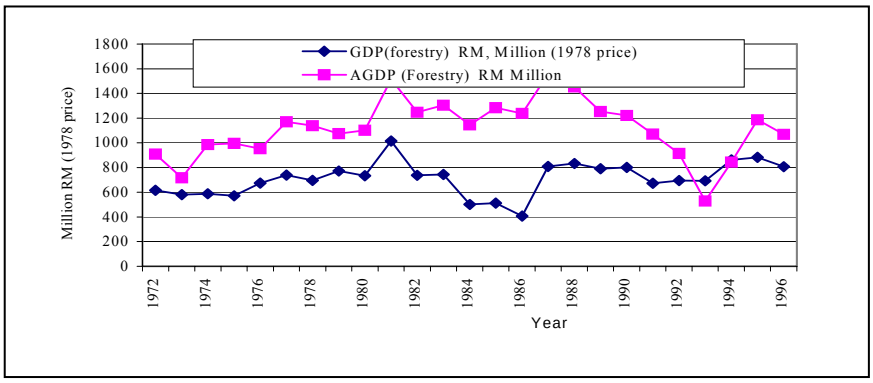


Figure 2: Change in Forestry Sector GDP and AGDP

As the user cost decreased and becomes negative over time, the forestry sector AGDP exceeded its GDP all through the 1980s and 1990s. The average AGDP increased by 11 per cent and the per capita AGDP also increased by 7.19 per cent over the study period. The increasing trend of sectoral (forestry) AGDP and per capita AGDP after adjustment with resource depletion indicates the economic sustainability of the sector. In the seventies where the economy was dependent on natural resource extraction, forest resources were extracted exceeding the long run regenerating the potential of the resource. The country has been extracting timber excessively by borrowing from the future. This trend can be substantiated by the high hectarages of forest opening during the seventies. But owing to increasing conservation awareness, export trade restriction on primary logs and rising real prices in the eighties and nineties, the current high rents would more than compensate the reduction in quantity extraction rates. Forest opening for timber extraction was more conservative at rates below the increase in present values of future rents (current saving of rents for the future).

The above trend implies that the extraction of timber from the forest resources is sustainable with current rents derived not affecting the future harvest opportunities owing to reinvestments into the sector. But this information merely provides the performance within the forestry sector. To evaluate the economy-wide impact on the country, the adjustment of income and investment parameters ought to be evaluated at the national level. However, it should be noted that the sectoral GDP has not been reduced by the forest capital depletion which may impact the whole economy.

Pearce Atkinson Measure (PAM) for Sustainability

A new measure of economic sustainability, formulated by Davis Pearce, offers a warning regarding the nation's future (Pearce and Atkinson, 1993b). The weak

sustainability refers to the case where the assumption of perfect substitutability is considered. The Pearce-Atkinson measure (PAM) is defined as

$$PAM = \left(\frac{S}{Y}\right) - \left(\frac{\delta M}{Y}\right) - \left(\frac{\delta N}{Y}\right)$$

where

S = Savings
Y = National income
M = Reproducible capital
N = Natural capital
δ = Depreciation

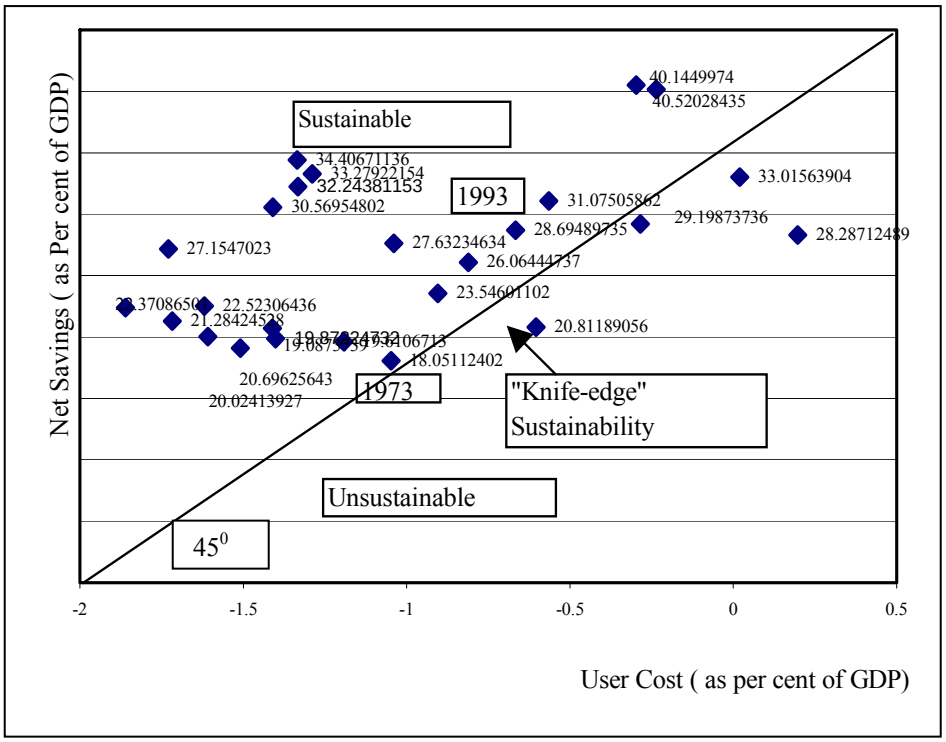


Figure 3: Pearce's Indicator of Sustainability: User Cost Method

The PAM indicator of sustainability plots the percentage value of natural capital depletion (forestry) over GDP against the percentage net savings over GDP as indicated in Figure 3. The figure showed that with the exception of (1973) and (1993), the percentages of net savings over GDP were above the 45^0 line or indicator of marginal or "knife-edge" sustainability. This demonstrates that the economy of Peninsular Malaysia is sustainable. *These exceptions occur because of economic*

expansion that leads to growing demand for timber by wood processing industries. Later on corrective economic measures and necessary interventions made the adjustment.

"Genuine Savings" Test for Economic Sustainability

The World Bank (1995) reported a similar measure of economic sustainability known as "genuine savings". This can be defined as follows:

$$GS = GDP - (PC_b + PC_p + Km_d + Kn_d)$$

where

GS = Genuine savings
GDP = Gross domestic product
PC_b = Public consumption
PC_p = Private consumption
Km_d = Physical capital depreciation
Kn_d = Natural capital depreciation.

This measure is computed as GDP minus the sum of public and private consumption, physical capital depreciation and natural capital depreciation. The "genuine savings" indicator serves as a measure of the efforts to create new wealth (World Bank 1995; Kellenberg, 1995). Although an optimal level of "genuine savings" for developing nations is not provided, negative "genuine savings" indicate that the economy is in unsustainable path**.**

"Genuine savings" which is computed as the GDP minus the sum of public and private consumption, physical capital depreciation and natural capital (forestry) depreciation, serves as an indicator of efforts for new wealth creation as shown in Figure 4. It indicates that the "genuine savings" remain positive throughout the three decades but fell sharply in 1976, and from 1984 to 1988. There is also decreasing trend from 1992-94. Nevertheless, since no negative percentages were obtained, the economy can be said to remain on a sustainable path as shown in Figure 4. In *the observation of micro trend over the period it is found that in the early 1970s the user cost was high because of the higher extraction of logs. With the reduction of log production into the second half of the 1970s and the 1980s owing to introduction of log export restriction, the user cost declined further. Despite the total export ban, from the year 1986 onward user cost started to increase till 1993 when it became positive because of economic expansion and high demand from the wood processing industries. From the year 1994 again user cost started to decline and remained negative to the year 1996.*

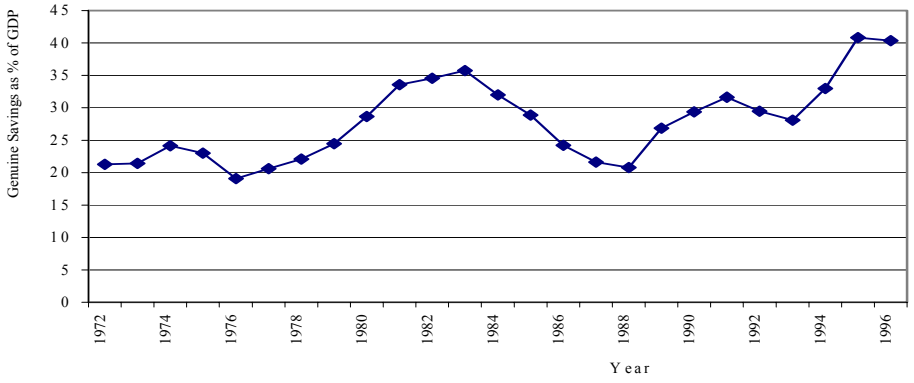


Figure 4: Genuine Savings as Per cent of GDP (USC) Method

V

POLICY RECOMMENDATIONS

Resource-rich countries can sustain their consumption levels, if they accumulate stocks of reproducible capital at a rate that matches the economic depletion of natural capital. The findings of the present study covering only the forestry sector suggest that Peninsular Malaysia made a successful transition away from natural resource exploitative activities towards reproducible capital related production. The revenues generated from forest resource extraction have been channeled and reinvested in such a way so that the overall economic growth rate was sustained over the last two and a half decades.

The physical loss in terms of quantity is being compensated by the increase in value in value-added production, supported with efforts at forest rehabilitation and discovery of new uses from agricultural tree plantation.

A sustainable economy demands an ecologically balanced of environment for which there is a need to maintain the carrying capacity of the environment. In order to maintain this balance, the threshold level of the resource should not be exceeded. Therefore, development strategies and resource management programmes have to be designed in such a manner that the optimal rate of extraction of timber is ensured without exceeding the threshold level.

The investigation of the present study is based on the valuation of timber resources only. Renewable resources like forestry have many other potential values such as minor forest products, environmental and amenity services, carbon sequestration, soil conservation, protection of catchments area, wildlife habitat and medicinal values. In view of this, the forest resource can be treated as supplementary capital inputs for other capital assets in the production process of the economy.

More comprehensive information for computing the impacts of timber extraction on the non-timber values of goods and environmental services may reveal a different scenario of sustainability. Before undertaking any resource extraction programme a detail economic and environmental valuation will provide more accurate policy signal in the planning process. Thus, the possible strong sustainability test may interface the economy and ecology.

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NOTES

1. Hotelling Rent refers to value of resource depletion especially non-renewable resources. This is equal to amount of resources extracted in given period times the difference between price and marginal cost of extraction. For example, $(p-C_q(q(t)))$, where P stands for unit price of natural resource, C_q is the marginal cost of extraction and q(t) is the changes in the quantity stock because of extraction.

2. Total resource rent has got two components; inframarginal rent and hotelling rent. The "user cost" is used in this study of resource accounting where one part of is being deducted from GDP for reinvestment to keep the economy sustainable in order to compensate resource depletion. The other part of the resource rent is used for current consumption in order to maintain sustainable level of consumption, which is known as inframarginal rent in resource economics.

3. SMS refers to systematic felling of a chunk of forest area, where adequate numbers of mother trees are being left for natural regenerations.

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