The NNP and Sustainability in Open Economy: Highlights on Recent World Economy and on Open Economy of Bangladesh

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ABSTRACT

This paper discusses the theory of the net national product and, emphasizes on social welfare and sustainable accounting in open economy. It is observed that the world economy following an egalitarian path, the aggregate capital gains being positive is equivalent to the interest rate tending to decrease. This is important for the concept of net national product in open economies. Martin Weitzman gives a foundation for net national product as the stationary equivalent of a wealth maximizing path when there is a constant interest rate and no exogenous technological progress. The NNP should equal the maximum consumption level that can be sustained. The ordinary Hartwick rule gives a sufficient condition for constant consumption in a closed economy with constant population and stationary technology. An attempt has been taken in this paper to discuss the net national product and sustainability in open economy. The paper also highlights the recent world economy and the open economy of Bangladesh.

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1. INTRODUCTION

Weitzman (1976) has shown that net national product (NNP) can serve as an indicator of welfare in a closed economy with a constant population and no exogenous technological progress. Weitzman's contribution is of course for the foundation of open economies. In the aftermath of the World Commission on Environment and Development (WCED 1987), this is now an important item to investigate whether the concept of NNP can serve as an indicator of sustainability. Weitzman published his seminal paper (Weitzman 1976) on the significance for dynamic welfare of comprehensive national income accounting aggregates, where he had included important theoretical contributions on welfare and sustainability. Hicks (1946:172) wrote:

"*It would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was in the beginning*.''

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Following Hicks (1946) and WCED (1987) it seems that the concept of a sustainable development is the same as the concept of NNP could serve as an indicator of sustainability. Hence NNP should equal the maximum consumption level that can be sustained. The ordinary Hartwick rule (Hartwick 1977, Dixit, Hammond and Hoel (1980) gives a sufficient condition for constant consumption in a closed economy with constant population and stationary technology. To sustain constant consumption in the Hartwick rule prescribes reinvesting all resource rents in reproducible capital. This rule we can not apply to open economies, since the underlying stationary technology assumption is violated when gains from trade are taken into account. Many authors seem to indicate that Hartwick rule is relevant to an open economy whose reproducible capital is defined to include foreign assets. Hartwick (1977) refers to it as a 'Saudi Arabian' rule, but Hoel (1981) expresses it for a single resource-exporter (Asheim 1996). Hence Hartwick rule does not apply directly to open economies, since stationary technology assumption is violated when gains from trade are taken into account in a general equilibrium setting. Actually a resource-rich economy need not reinvest all resource rents in domestic and foreign assets for the sustainable constant consumption (Asheim 1986). Since the increases resource prices on the world market, the economy's technology will not be constant. So that the economy may therefore be able to sustain a positive stationary level of consumption, and if NNP is to serve as an indicator of sustainability may have a positive NNP. Hence capital gains can not be excluded when the closed world economy is split into the open economies that the separate countries represent. If each country wants to keep its national wealth constant, consumption equals a measure of NNP which includes capital gains. But if all countries add together to form a closed world economy then the purpose is to keep the level of consumption constant. So that consumption equals a measure of NNP that does not include capital gains (Asheim 1996, 2010, 2011).

Corsetti, Dedola and Leduc (2010) studied the optimal monetary stabilization policy in interdependent open economies, by proposing a unified analytical framework systematizing the existing literature. BCBI (2011) gave detail reports of gross domestic product (GDP) and economic structure of Bangladesh. EEE (2010) discussed the export-import of various countries and world open economy. Snieska, Draksaite and Vasauskaite (2011) have analyzed the national competitiveness. This is particularly important for small open economies, which rely much on international trade and foreign direct investment and cannot alter the world market. By considering limited financial capabilities and resources, we get one of the most important tools to increase competitiveness of the country which is to implement and exploit the advanced knowledge. They have proposed that stochastic nature of the economy should be considered as one of the essential factors in increasing competitiveness of small open economy by employment of advanced management of the net foreign debt.

We have defined open and closed economy with their beneficial sides and drawbacks in section-2 following Hillier (1991), Irwin (1996), Parker (1998), Orr (1998), Koenig (1998) and Yergin (1998). The simple economic model is described in section-3 following Asheim (1997) and Mohajan (2011a, b). Weitzman's fundamental results for closed economy is discussed in section-4 and Hartwick's open economy is introduced in section-5 following Weitzman (1976), Hartwick (1977), Dixit, Hammond and Hoel (1980), and Asheim (1996), which will be helpful to understand the NNP and open economy in section-6. We have discussed briefly the economy of the world, and the open economy of Bangladesh in sections-7 and -8 respectively following EEE (2010) and BCBI (2011). Final section-9 gives concluding remarks.

2. CLOSED AND OPEN ECONOMIES

A closed economy is a self-contained economic unit which has no business or trading relations with anyone outside of that unit. The closed economy is characterized by government owned industries, protective tariffs, extensive government regulations and price controls, and such other policies under control of the

government. In closed economy the production of goods and services depend on the government. The basic equation of a closed economy is as follows:

$$Y = C^d + I^d + G^d,$$

where Y = GDP / national income,

C^d = consumer consumption of domestic goods and services,

I^d = investment in domestic goods and services, and

G^d = government expenditures on domestic goods and services.

In an open economy industries have a tendency to be privately owned rather than owned by the government and market forces are allowed to determine production level. The basic equation of an open economy is the same as that of a closed economy except two new terms are added; Export (*EX*) and Import (*IM*):

$$Y = C^d + I^d + G^d + (EX - IM),$$
$$Y = C^d + I^d + G^d + NX.$$

The term $(EX - IM)$ is usually called net exports and is sometimes expressed as the term *NX*.

Open or closed economy exists in the theory only. In real life no economy is purely open or purely closed. Since, no country in the world allows unlimited free access to its markets. If a country may follows open economy but its policies allow market forces to determine production and prices (Hillier 1991 and Irwin 1996).

2.1 Beneficial Sides of Open and Closed Economy

There are many advantages to an open economy; some of them are as follows:

The open economies are shaped with inventions and the capital to research them. Countries classified as having a free market have been responsible for the vast majority of inventions since the 19th century.

Under an open economic system it is easier to move around income brackets. It is easier to become rich or poor when one left to one's own devices as opposed to a closed economy where resources are allocated by the government.

Massive increases in efficiency and productivity happen from the survival of the fittest aspect of open economy. The firms which have higher costs than others, by producing inefficiently will go out of market. Since consumers will choose more efficient products.

Open economy leaning countries have higher GDPs than closed leaning economies. This is because they produce more and exports more.

In open economy due to the huge wealth level, it is easy to collect taxes. For example, it is easier to get taxes from a very rich person than from a person who is very poor and have no ability to buy food to mitigate hunger.

Open economy nations generally spend more or have more efficient social programs.

In closed economy there are some advantages as follows:

The closed economy is controlled by the government, so that the workers have a guarantee of permanent job in the industries. As a result unemployment does not increase alarmingly.

In closed economy World Bank, International Monetary Fund, USAID, UNDP etc. can not apply any condition in products and markets, as they are not involved in open economy. External interference is not possible in closed economy due the restrictions of the government.

The widening gap between the richest and the poorest citizens of the country, which follow closed economy, usually does not create.

Foreign debts are comparatively lower in closed economy follower countries.

Chile, a South American country moved from closed to open economy and free market policies, and became the fastest growing economic country in Latin America from 1983 to 1993. Chile reduced its tariffs to 11% which was one of the lowest rates in the world. As a result products became more competitive in the international market and obtained a surplus of $90 million in 1991 (Parker 1998).

2.2 Drawbacks of Closed and Open Economy

As like Chile to follow open economy Argentina face serious difficulty in 1997, a wide spread social unrest rose up due to widening gap between the country's richest and the poorest citizens. When Soviet Union collapsed, Russia trended to open economy and face same problem as Chile (Yergin 1998). To establish open economy Germany face high level of unemployment throughout the nation and same result face South Korea to move in open economy (Orr 1998 and Koenig 1998). USA, China and India follow mixed strategy that is they follow both open and closed economy. As a result these countries apparently avoid such situations which the Germany and South Korea faced. The imposition of tariffs and duties has always been a source of revenue for the governments of these countries. In closed economy there is no competition in the world market, so that sometimes their products are comparatively lower in qualities. Citizens have little chance to be billionaires as major portion of the business is controlled by the government. There is a restriction by the government on import items in closed economy. To implement a big project the country face difficulties with run short of money. Recently North Korea and Cuba are facing such problems.

2.3 Emerging Economy

An emerging market economy (EME) is defined as an economy with low to middle per capita income. Such countries constitute approximately 80% of the global population, and dominate about 20% of the world's economies. The term was coined in 1981 by Antoine W. Van Agtmael of the International Finance Corporation of the World Bank. EMEs are characterized as transitional, which means that they are in the process of turning from a closed economy to an open market economy. An EME will also reform its exchange rate system. Since a stable local currency builds confidence in an economy, especially when foreigners are considering investing. Exchange rate reforms also reduce the desire for local investors in various sectors to send their capital abroad. An EME is also most likely receiving aid and guidance from large donor countries and/or world organizations such as the World Bank and International Monetary Fund. One key point of the EME is that there is an increase in both local and foreign investments. Foreign investment is a signal that the world has begun to take notice of the emerging market. When international capital flows are directed toward an EME, the entrance of foreign currency into the local economy adds volume to the country's stock market and long-term investment to the infrastructure. For the recipient country, the employment levels rise, labor and managerial skills become more refined. So that a sharing and transfer of technology visible in the country. In the long run, the EME's overall production levels must rise. As a result the GDP of the country increases, so that eventually lessening the gap between the emerged and emerging worlds. South Korea is an emerging country but India does not follow the economy as like South Korea. In the 1950s, South Korea was a very poor developing country. Its GDP per capita at the end of Korean War was less than $800. In less than forty years, South Korea's GDP per capita increased about more than ten times, and reaches to $7235. But India still remains a poor, labor abundant economy, with a deprived state of demographic and social developments. According to Nehru, Swanson and Dubey (1995), South

Korea has the highest average education stock and the highest growth rate of education stock among developing countries. Unfortunately India is at a relatively low level in both categories due to follow of non-emerging economy (Maksymenko and Rabbani 2009).

3. THE NOTATIONS AND ECONOMIC MODEL

We assume that population is constant and the current instantaneous well-being at time *t* depends on the vector of commodities $\mathbf{C}(t) = (C_1(t),...,C_m(t))$ consume at time *t*. Here **C** is fully disaggregated consumption bundle, containing everything that influences current well-being, including environmental amenities and other externalities but supplied labor corresponds to negative components. Current consumption is supposed to be fully observable, along with its associated *m*-vector of efficiency prices. The consumption $\mathbf{C}(t) \geq 0$ generates utility $u(t) = u(\mathbf{C}(t))$, where *u* is a time-invariant strictly increasing , concave and differentiable function and derived from the vector of the consumption flows. In our model $u(\mathbf{C}(t))$ indicates the instantaneous well-being at time *t* which is observable along with its associated vector of accounting prices. Assume that the vector of capital stocks at time *t* be $\mathbf{K}(t) = (K_1(t),...,K_n(t))$, which indicates not only different kinds of man-made capitals, but also stock of natural capital, environmental assets, human capital (education and knowledge capital accumulated from R&D-like activities) and other durable productive assets. Here the initial given stock is $\mathbf{K(0)} = \mathbf{K_0}$. For any vector of capital stocks **K** at time *t*, the resource allocation mechanism determines the consumption and investment flows. Let $Q(t)$ be competitive price of the capital stocks in terms current consumption. Let the vector of net investment at time *t* be $\mathbf{I}(t) = (I_1(t),...,I_n(t)) = \dot{\mathbf{K}}(t) \geq 0$, where $\dot{\mathbf{K}}(t) = \frac{d\mathbf{K}}{dt}$. The net investment flow of a natural capital asset will be negative if the overall extraction rate exceeds the replacement rate. A consumption-investment pair $(\mathbf{C}(t), \mathbf{I}(t))$ at time *t* is possible if and only if $(\mathbf{C}(t), \mathbf{I}(t)) \in A(\mathbf{K}(t); t)$, where *A* is a sufficiently smooth set which indicates society's productive capacity. From the common sense we can say that the current instantaneous well-being of a society indicates its instantaneous well-being is increased by moving from C_1 at time t_1 to C_2 at time t_2 if and only if $u(C_1) < u(C_2)$.

The NNP is the maximized market price of current productive capacity in a perfect market economy where $\mathbf{C}(t)$ and $\mathbf{I}(t)$ must include in NNP and valued at market prices. Since time is continuous and it passes, so that NNP changes both $\mathbf{C}(t)$ and $\mathbf{I}(t)$. Because $\mathbf{K}(t)$ and $A(\mathbf{K}(t))$ change due to a non-zero vector of net investments, and market prices of consumption and investment flows change. Since NNP is used for consumption at present period and accumulation of capital goods yields increased future consumption. This relates NNP growth to welfare improvement which requires a notion of dynamic welfare. Welfare judgments should not only take into account the utility derived from present consumption, but should also reflect the utility possibilities inherent in future consumption. For this purpose, we assume that the welfare judgments of the society are described by complete and transitive social preferences on the set of utility paths. For any pair $x, y \in Y$, *xPy* denotes that *x* is strictly preferred to *y*, where $Y = \{x, y, z,...\}$ is the set of individuals in the society. Hence, for $x, y \in Y$ completeness implies *xPy* or *yPx* such that $x \neq y$, and transitivity implies if *xPy*, *yPz* then *xPz*.

4. WEITZMAN'S FUNDAMENTAL RESULTS

Weitzman (1976) considered an economy maximizing at time *t* as follows:

$$\int_{\tau=t}^{\infty} e^{-\delta(\tau-t)}\,\mathbf{C}(\tau)\,d\tau \tag{1}$$

over all feasible consumption paths, where δ is the positive consumption discount rate. Expression (1) measures current wealth. Let $\left(\mathbf{C}^*(\tau)\right)_{\tau=t}^{\infty}$ be a consumption path maximizing (1) over all feasible consumption paths. Let $X(t)$ denotes the consumption NNP at time t. Hence to satisfy the Weitzman foundation of NNP, the level of consumption must sustain infinitely which would yield the same wealth as the wealth-maximizing path (Asheim 1997):

$$\int_{\tau=t}^{\infty} e^{-\delta(\tau-t)}\,X(t)\,d\tau = \int_{\tau=t}^{\infty} e^{-\delta(\tau-t)}\,\mathbf{C}^*(\tau)\,d\tau\,,$$

$$X(t) = \delta \int_{\tau=t}^{\infty} e^{-\delta(\tau-t)}\,\mathbf{C}^*(\tau)\,d\tau\,, \tag{2}$$

where $\int_{\tau=t}^{\infty} e^{-\delta(\tau-t)}\,d\tau = \frac{1}{\delta}$. Kemp and Long (1982) generalized Weitzman's analysis to the case of concave utility function for maximization of welfare as follows:

$$\int_{\tau=t}^{\infty} e^{-\rho(\tau-t)}\,u\left(\mathbf{C}(\tau)\right)d\tau \tag{3}$$

over all feasible consumption paths and ρ is the positive utility discount rate. Expression (3) measures current utilitarian welfare and $\left(\mathbf{C}^*(\tau)\right)_{\tau=t}^{\infty}$ maximize (3) over all feasible consumption paths. Let $U(t)$ denotes the utility NNP at time t. To satisfy the Weitzman foundation of NNP, $U(t)$ has to be the level of utility must sustain indefinitely which would yield the same welfare as the welfare-maximizing path (Asheim 1997).

$$\int_{\tau=t}^{\infty} e^{-\rho(\tau-t)}\,U(t)\,d\tau = \int_{\tau=t}^{\infty} e^{-\rho(\tau-t)}\,u\left(\mathbf{C}^*(\tau)\right)d\tau\,,$$

$$U(t) = \rho \int_{\tau=t}^{\infty} e^{-\rho(\tau-t)}\,u\left(\mathbf{C}^*(\tau)\right)d\tau\,, \tag{4}$$

where $\int_{\tau=t}^{\infty} e^{-\rho(\tau-t)}\,d\tau = \frac{1}{\rho}$. Differentiating (4) with respect to t we get;

$$\dot{U}(t) = \frac{\lambda(t)}{\int_{\tau=t}^{\infty} \lambda(\tau)\, d\tau} \left(U(t) - u\left(\mathbf{C}^*(t)\right)\right)$$

$$= \rho_\infty(\mathrm{t}) \left(U(t) - u\left(\mathbf{C}^*(t)\right)\right), \text{ where } \frac{\lambda(t)}{\int_{\tau=t}^{\infty} \lambda(\tau)\, d\tau} = \rho_\infty(\mathrm{t}),$$

$$\left(U(t) - u\left(\mathbf{C}^*(t)\right)\right) = \frac{1}{\rho_\infty(t)}\, \dot{U}(t). \tag{5}$$

Equation (5) indicates that the difference between the stock of utility annuities at time *t* and the actual utility level at time *t* equals the rate at which utility annuities can be accumulated times the price of such annuities. If $\left(\mathbf{C}^*(\tau)\right)_{\tau=t}^{\infty}$ is the unique path maximization (3) and $\left(\mathbf{C}^*(\tau)\right)_{\tau=t}^{\infty}$ does not yield constant consumption, then a constant utility flow equals to $U(t)$ is not attainable. The Weitzman foundation gives an upper bound for the level of utility that is actually sustainable. The economy acts as if it maximizes;

$$\int_{\tau=t}^{\infty} \lambda(\tau) u\left(\mathbf{C}(\tau)\right) d\tau \tag{6}$$

over all feasible consumption paths, where $\lambda(\tau)$ is the positive utility discount factor applicable at time τ. The path $\left(\lambda(\tau)\right)_{\tau=t}^{\infty}$ gives the present value prices at which marginal utility at one time can be exchanged for marginal utility at some other time, so that $\left(\lambda(\tau)\right)_{\tau=t}^{\infty}$ determines utility interest rates. Let

$$\lambda(\tau) = \lambda(0) e^{-\rho\tau}. \tag{7}$$

Differentiating (7) with respect to t we get;

$$\dot{\lambda}(\tau) = -\rho\, \lambda(0) e^{-\rho\tau} = -\rho\, \lambda(\tau)$$

$$\Rightarrow \rho = -\frac{\dot{\lambda}(\tau)}{\lambda(\tau)} = -\frac{\lambda(t)}{\int_{\tau=t}^{\infty} \lambda(\tau) d\tau} \tag{8}$$

for all *t*. The instantaneous (very short-term) utility interest rate is given by;

$$\Rightarrow \rho_0(t) = -\frac{\dot{\lambda}(\tau)}{\lambda(\tau)}, \tag{9}$$

and the infinitely long-term interest rate is given by;

$$\rho_{\infty}(t) = \frac{\lambda(t)}{\int_{\tau=t}^{\infty} \lambda(\tau) d\tau}. \tag{10}$$

Differentiating (10) with respect to *t* we get;

$$\frac{\dot{\rho}_{\infty}(t)}{\rho_{\infty}(t)} = \rho_{\infty}(t) - \rho_0(t).$$

Hence $\rho_{\infty}(t)$ is decreasing if and only $\rho_0(t) > \rho_{\infty}(t)$.

Let $p(t)$ denotes the present value price of consumption at time *t*, and let $\mathbf{q}(t)$ denote the vector of present value prices of the capital stocks at time *t*. The competitive path $\left(C^*(t), \mathbf{K}^*(t), \mathbf{I}^*(t)\right)_t^{\infty}$ is regular at present value prices $\left(p(t), \mathbf{q}(t)\right)_t^{\infty}$ and utility discount factor $\left(\lambda(t)\right)_t^{\infty}$ if at each *t* (Asheim 1997):

R-1: $\int_0^{\infty} \lambda(t) u\left(\mathbf{C}^*(t)\right) dt$ exists and is finite,

R-2: $\mathbf{q}(t)\mathbf{K}^*(t) \to 0$ as $t \to \infty$.

Under the above regulatory conditions there exists a path of present value prices $\left(p(\tau)\right)_{\tau=t}^{\infty}$ such that maximizing (6) is equivalent to the maximization of

$$\int_{\tau=\mathrm{t}}^{\infty} p(\tau)\mathbf{C}(\tau) d\tau \tag{11}$$

over all feasible consumption paths, where $p(t)$ measures current wealth. The instantaneous utility interest rate can be written as;

$$r_0(t) = -\frac{\dot{p}(\tau)}{p(\tau)}, \tag{12}$$

and the infinitely long-term interest rate can be expressed as;

$$r_{\infty}(t) = \frac{p(t)}{\int_{\tau=t}^{\infty} p(\tau) d\tau}. \tag{13}$$

Differentiating (13) with respect to *t* we get;

$$\frac{\dot{r}_\infty(t)}{r_\infty(t)} = r_\infty(t) - r_0(t),$$

which indicates that $r_\infty(t)$ is decreasing if and only $r_0(t) > r_\infty(t)$.

To satisfy the Weitzman foundation, $X(t)$ must be the stationary equivalent of $\left(\mathbf{C}^*(\tau)\right)_{\tau=t}^{\infty}$ as follows:

$$\int_{\tau=t}^{\infty} p(\tau) X(t)\, d\tau = \int_{\tau=t}^{\infty} p(\tau)\mathbf{C}^*(t)\, d\tau\,,$$

$$X(t) = \frac{\int_{\tau=t}^{\infty} p(\tau)\mathbf{C}^*(t)\, d\tau}{\int_{\tau=t}^{\infty} p(\tau)\, d\tau} = r_\infty \int_{\tau=t}^{\infty} \frac{p(\tau)}{p(t)}\, \mathbf{C}^*(\tau)\, d\tau\,. \tag{14}$$

Differentiating (14) with respect to *t* we obtain;

$$\begin{aligned}\dot{X}(t) &= \frac{p(t)}{\int_{\tau=t}^{\infty} p(\tau)\, d\tau}\, \left(X(t) - \mathbf{C}^*(t)\right) \\ &= r_\infty(t)\, \left(X(t) - \mathbf{C}^*(t)\right), \\ \left(X(t) - \mathbf{C}^*(t)\right) &= \frac{1}{r_\infty(t)}\, \dot{X}(t)\end{aligned} \tag{15}$$

where $X(t)$ is an upper bound for sustainable income. We observe that the differential equation (15) has the same interpretation as (5). For small open economy, $\left(p(\tau)\right)_{\tau=t}^{\infty}$ is exogenously determined by the international capital market, and $\left(\mathbf{C}^*(\tau)\right)_{\tau=t}^{\infty}$ can be changed into a constant consumption path without changing the supporting prices. Brekke (1996) showed that $X(t)$ is an exact indicator of sustainability for such an economy.

5. HARTWICK RULE IN OPEN ECONOMY

The Hartwick rule (Hartwick 1977, and Dixit, Hammond and Hoel (1980) gives a sufficient condition for constant consumption or utility in a closed economy with constant population and stationary technology. The main feature of this rule is that reinvests all rents from the flow of resource depletion into reproductive capital. Many authors seem to indicate that Hartwick rule is relevant to an open economy whose reproducible capital is defined to include foreign assets. Hartwick (1977) refers to it as a 'Saudi Arabian' rule, but Hoel (1981) indicates it for a single resource-exporter (Asheim 1996). In this section it is shown that Hartwick rule does not apply to open economies, since the stationary technology assumption is violated when gains from trade are taken into account in a general equilibrium setting. A resource-rich economy need not reinvest all

resource rents in domestic and foreign assets in order to sustain constant consumption. Since production possibilities show constant-returns-to-scales (CRS), $\mathbf{K}(t)$ includes human capital components' being employed as labor. If human capital can not be accumulated or depleted, the corresponding components of $\mathbf{K}(t)$ must be zero and the corresponding components of $\mathbf{I}(t)$ must be non-positive.

A feasible path $\left(\mathbf{C}(t), \mathbf{K}(t), \mathbf{I}(t)\right)_{t=0}^{\infty}$ has competitive present value prices $\left(p(t), \mathbf{q}(t)\right)_{t=0}^{\infty}$ if and only if

$\left(\mathbf{C}(t), \mathbf{K}(t), \mathbf{I}(t)\right)$ maximizes instantaneous profit $p(t)\mathbf{C} + \dot{\mathbf{q}}(t)\mathbf{K}(t) + \mathbf{q}(t)\mathbf{I}(t)$ subject to $\left(\mathbf{C}(t), \mathbf{K}(t), \mathbf{I}(t)\right) \in A$.

The imputed rents to the assets are equal to $\left(-\dot{\mathbf{q}}(t)\right)$, which measures the marginal productivity of the capital stocks. For CRS we get,

$$p(t)\mathbf{C}(t) = -\frac{d}{dt}\left(\mathbf{q}(t)\mathbf{K}(t)\right). \tag{16}$$

The path $\left(\mathbf{C}^*(t), \mathbf{K}^*(t), \mathbf{I}^*(t)\right)_{t=0}^{\infty}$ with competitive prices $\left(p(t), \mathbf{q}(t)\right)_{t=0}^{\infty}$ is called a regular maximin path (RMP) if and only if (Burmeister and Hamond 1977);

1. $\mathbf{C}^*(t) = \mathbf{C}^*$ (constant)
2. $\mathbf{q}(t)\mathbf{K}(t) \to 0$ as $t \to \infty$.

An RMP is efficient and maximizes $\inf_t\left(\mathbf{C}(t)\right)$ over the collections of feasible paths. Equation (16) and RMP (conditions -1 and -2) implies that,

$$\mathbf{C}^*(t) = \frac{\mathbf{q}(t)\mathbf{K}(t)}{\int_{\tau=t}^{\infty} p(\tau)\, d\tau}. \tag{17}$$

Dixit, Hammond and Hoel (1980) showed that RMP satisfy not only the generalized Hartwick rule, where $\mathbf{q}(t)\mathbf{I}^*(t) = \text{constant}$, but also obey the ordinary Hartwick rule where $\mathbf{q}(t)\mathbf{I}^*(t) = 0$ for all t. With CRS, the ordinary Hartwick rule implies that consumption is equal to the production contributions of the capital stocks and can be expressed as follows:

$$\mathbf{C}^* = -\frac{\dot{\mathbf{q}}(t)\mathbf{K}^*(t)}{p(t)}. \tag{18}$$

If the RMP is stationary that is if $\mathbf{I}^*(t) = 0$ for all t then (17) and (18) are identical and can be written as:

$$\dot{\mathbf{q}}(t) = -\frac{p(t)}{\int_{\tau=t}^{\infty} p(\tau)\, d\tau}\ \mathbf{q}(t).$$

Since $p(t)$ is an exponentially decreasing function, so that we can write as follows:

$$-\frac{\dot{p}(t)}{p(t)} = \frac{p(t)}{\int_{\tau=t}^{\infty} p(\tau)\, d\tau}. \tag{19}$$

Such a path defines a price system with one constant interest rate,

$$\dot{\mathbf{q}}(t) = -\frac{\dot{p}(t)}{p(t)}\ \mathbf{q}(t).$$

But if RMP is not stationary then we get;

$$-\frac{\dot{p}(t)}{p(t)} \neq \frac{p(t)}{\int_{\tau=t}^{\infty} p(\tau)\, d\tau},$$

as a result (17) and (18) are not identical.

6. NNP AND OPEN ECONOMY

The NNP is defined as the maximized market value of current productive capacity in a perfect market economy. Weitzman showed that NNP can serve as an indicator of welfare in a closed economy with constant population and with no technological progress. The welfare indicator is given by $\mathbf{C}(t) + \mathbf{Q}(t)\mathbf{I}(t)$. Obviously NNP includes current consumption and the value of net investments but capital gains $\dot{\mathbf{Q}}(t)\mathbf{K}(t)$ are not included. This condition is for the closed economy with constant population and with no exogenous technological progress which follows from the Hartwick's rule (Hartwick 1977, and Dixit, Hammond and Hoel (1980), since $\mathbf{Q}(t)\mathbf{I}(t) = 0$ at anytime along such an eagalitarian path.

If the Weitzman-Hartwick concept of NNP is being used in an open economy living solely by harvesting non-renewable resources then NNP equals to zero. Hence we can write, $\mathbf{C}(t) = \mathbf{Q}(t)(-\mathbf{I}(t))$, where $(-\mathbf{I}(t))$ is the vector of extraction. Dasgupta (1990) claimed that NNP in such an economy is equal to zero but paradoxical. Since, with increasing resource prices on the world market, the technology of economy will not remain constant. Capital gains can not be excluded when the closed world economy is split into the open economies which the separate countries represent. On the other hand, each country could include capital gains fully by assuming NNP be given by $\mathbf{C}(t) + \mathbf{Q}(t)\mathbf{I}(t) + \dot{\mathbf{Q}}(t)\mathbf{K}(t)$. In such an economy living solely by harvesting non-renewable resources, then national wealth remains constant. Hence we can write;

$$\frac{d}{dt}\left(\dot{\mathbf{Q}}(t)\mathbf{K}(t)\right)=\dot{\mathbf{Q}}(t)\mathbf{K}(t)+\mathbf{Q}(t)\mathbf{I}(t)=0,$$

which indicates that if the target is to keep the national wealth non-decreasing, then a concept of NNP which includes capital gains. This is a paradox.

We assume that the economy of the world is competitive and to be split into open economies with subpopulation of constant size. Each of these countries obtains a fraction of the total consumption which equals productive contributions of the factors of production of its own. Each country's national wealth comprises of the full productive capabilities of its factors of production. So that it is necessary to treat all factors of production, including labor as capital goods, the market prices of which correspond to the present value of future earnings.

Let $\left(\mathbf{C}^*(t),\mathbf{K}^*(t),\mathbf{I}^*(t)\right)_{t=0}^{\infty}$ denotes a competitive equilibrium of the world economy with capital prices $\left(\mathbf{Q}(t)\right)_{t=0}^{\infty}$, where the consumption good serves as numeraire. The CRS imply that consumption exactly suffies to pay capital owners the marginal products of their capital stocks plus the resource rents. So that stocks can be expressed as follows:

$$\mathbf{C}^* = R(t)\mathbf{K}^*(t)+\mathbf{Q}(t)\left(-\mathbf{I}^*(t)\right), \tag{20}$$

where $R(t)$ is a vector measuring the marginal productivities of the capital goods as stocks. From the arbitrage equation we get,

$$i(t)\mathbf{Q}(t)=R(t)+\dot{\mathbf{Q}}(t), \tag{21}$$

where $i(t)=\dfrac{\dot{\mathbf{Q}}_r(t)}{\mathbf{Q}_r(t)}$ denotes the instantaneous consumption interest rate and $\mathbf{Q}_r(t)$ being the resource price. From (21) we can write;

$$i(t)\mathbf{Q}(t)\mathbf{K}^*(t)=R(t)\mathbf{K}^*(t)+\dot{\mathbf{Q}}(t)\mathbf{K}^*(t). \tag{22}$$

Equation (22) indicates that instantaneous return on the capital stock equals the sum of the aggregate capital gains. In an efficient maximum path, the Hartwick rule implies that

$$\mathbf{C}^*(t)\rightarrow\mathbf{C}^*(t)+\mathbf{Q}(t)\mathbf{I}^*(t), \tag{23}$$

and the CRS imply that;

$$\mathbf{C}^*(t)+\mathbf{Q}(t)\mathbf{I}^*(t)=R(t)\mathbf{K}^*(t) \tag{24}$$

and the arbitrage equation implies that;

$$R(t)\mathbf{K}^*(t)\rightarrow\left[\frac{R(t)\mathbf{K}^*(t)}{R(t)\mathbf{K}^*(t)+\dot{\mathbf{Q}}(t)\mathbf{K}^*(t)}\right]\times i\,\mathbf{Q}(t)\mathbf{K}^*(t). \tag{25}$$

Hence, the maximum sustainable consumption level,

$$\mathbf{C}^*=\left[\frac{R(t)\mathbf{K}^*(t)}{R(t)\mathbf{K}^*(t)+\dot{\mathbf{Q}}(t)\mathbf{K}^*(t)}\right]\times i\,\mathbf{Q}(t)\mathbf{K}^*(t) \tag{26}$$

falls short of the instantaneous return on the capital stocks $i\,\mathbf{Q}(t)\mathbf{K}^{*}(t)$ if and only if the aggregate capital gains $\dot{\mathbf{Q}}(t)\mathbf{K}^{*}(t)$ are positive (Asheim 1996).

Since, the world economy implementing an efficient maximin path, the aggregate capital gains are being positive which is equivalent to the interest rate tending to decrease. Consider a country *a* choosing an efficient maximin path which can not allow it fully to consume the instantaneous return its capital stocks. Using (21) we can write;

$$i(t)\mathbf{Q}(t)\mathbf{K}^{a}(t) = R(t)\mathbf{K}^{a}(t) + \dot{\mathbf{Q}}(t)\mathbf{K}^{a}(t), \tag{27}$$

if the aggregate capital gains are positive. Using (27), we can write equation (26) as follows:

$$\mathbf{C}^{*} = \left[\frac{R(t)\mathbf{K}^{*}(t)}{R(t)\mathbf{K}^{*}(t) + \dot{\mathbf{Q}}(t)\mathbf{K}^{*}(t)}\right] \times i\left[R(t)\mathbf{K}^{a}(t) + \dot{\mathbf{Q}}(t)\mathbf{K}^{a}(t)\right], \tag{28}$$

which indicates that a country's share of worldwide sustainable consumption equals its share of worldwide wealth. Hence, if an efficient maximin path is implemented and the aggregate capital gains are positive, then some part of the instantaneous return on a country's capital stock must be used to augment the country's national wealth.

7. THE RECENT ECONOMY OF THE WORLD

In 2009 the world has suffered from the global financial crisis (GFC). This GFC is recovered in the next year and international monetary fund (IMF) has estimated that the global output has grown by 5% (EEE 2010). It is estimated that in this recovery the contribution of China and India is about 7.3%, compares to 3% growth in advanced economies. The IMF forecasts that the Chinese economy will grow by 9.6% in 2011. But the growth in Europe remained weak reflecting the ongoing impact of the GFC and high government debt levels in several countries, namely Greece, Ireland, Italy, Portugal and Spain. The IMF provided significant loans to alleviate the financial crisis. In 2011 Greece faces serious financial crisis. This financial crisis makes most of the people of Greece unemployed. France and Germany pledge to pay loan to recover this unexpected financial crisis. The IMF estimates that Europe grew by 2.1% in 2010, with individual growth rates ranging from 3.5% in Germany and 5.5% in Sweden, to decline of 4.5% in Greece and 1% in Ireland but IMF's forecast is partially fulfilled. Japan in 2010 recovers strongly with gross domestic product (GDP) growth of 3.9%. But in March 2011, Japan experienced a large earth quake and tsunami that resulted in substantial loss of life and damage to infrastructure. The change in world economy influenced by the change of US improved in the second half of 2010, but unemployment increased about 9.6%. The real estate prices have been slowed but the US government fails to recover it. The US passed a new fiscal stimulus package in late 2010 which includes further quantitative easing of up to $600 billion and the IMF forecasts that the US economy will grow by 2.8% in 2011.

The world economy is expected to continue to recover in 2012, with the IMF forecasting global growth of 4.5% compared to 4.4% in 2011. Growth in the emerging economies is expected to be led by Asian economies, including China, India and Indonesia. Despite the positive outlook in developing Asia, significant inflation risks remain, particularly in China. For example, food prices and prices of other essential articles, in many developing economies increased significantly in 2010, placing upward pressure on wage growth (EEE 2010).

The IMF forecasts that US economic growth will strengthen slightly to 2.9% in 2012. But this will be challenged due to unemployment, reverse weakness in housing sector and to face Middle-East crisis.

The IMF outlook for Europe is mixed. The forecast expresses that the growth in advanced European economies is expected to continue at below trend rates in 2012.

In 2011 the USA and some European countries such as Greece and Italy face serious economic crisis due to open economy. This situation arises because of increased unemployment and the difference of the wealth between rich and poor.

The natural disasters in the Asia Pacific region including flooding, cyclones, earthquakes and tsunami have also affected economic growth. Economic experts' opinions are hopeful and they express that these are short-term but long-term improve seems glorious.

The outlook of IMF may vary due to unrest civil war in the Middle-East and North Africa in early 2011. Since disrupted world oil supply will substantially increase oil prices which will affect the world economy. The IMF estimates that a 10% price increase in the crude oil reduces global GDP by between 0.2 to 0.3% (EEE 2010).

8. OPEN ECONOMY OF BANGLADESH

Bangladesh is a densely populated (population in 2011 is about 1423 million) developing country of South Asia with the total area of 147,570 sq km. About 90% of its populations are poor and about 60% citizens are illiterate. Again natural disasters such as flood, cyclones, draughts etc. constantly pursue its lot every year, which break the backbone of the economy and frustrate future planning of economic development. Economy is sick due to high inflation rate, poor energy supply in industries and unemployment. As Bangladesh is a very small country, it depends on foreign aids. Its economy is open after the independent from Pakistan in 1971 but it failed to develop its economy due to political instability and failure to create a strong human capital. It depends on World Bank, Asian Development Bank, IMF, USAID etc. who provide loan to Bangladesh with strong conditions. So that Bangladesh can not use the loan properly to develop its economy.

The years after independence, the size of Real GDP, Per Capita GDP and their growth rates were very small and the condition slightly improved from 1990. Yet the growth trend and the structural changes of GDP in Bangladesh are not satisfactory. Many problems are responsible for this unsatisfactory GDP. These factors are: shortage of domestic food production; narrow structure of exports; increasing growth rate of imports; failure in the invocation of much Foreign Direct Investment; a defective banking system with cumulative interest of loans; continuous loss in the public enterprises; poor infrastructure, inefficient taxation; high inflation rate, social and political corruptions, political instability and the serious deterioration of law and order situation (BCBI 2011).

Major exports of Bangladesh are readymade garments, frozen fish and seafood, tea, chemical products, raw jute and jute goods, leather, manpower etc. Major imports of Bangladesh are rice, wheat, sugar, edible oils, oil products, gasoline, fertilizer, scrap vessels, machinery and equipment, chemicals, steel etc. To follow open economy Bangladesh can not export competitive materials in the world markets but much fortune losses to import necessary materials. As a result it failed to gain high benefits from open economy. Moreover it has a permanent energy crisis due to shortage of electricity and natural gases. So that it cannot provide continuous energy supply in industries and NNP is not satisfactory, which is a permanent problem of Bangladesh (BCBI 2011).

9. CONCLUDING REMARKS

In this paper we have introduced Weitzman's fundamental results of closed economy and Hartwick's rule in open economy to realize NNP and open economy properly. The paper defines NNP in open economies as the

sustainable consumption and measures this concept using the prices that exist if consumption at any time equals the maximum sustainable level. We have shown all the mathematical calculations and theoretical concepts in some detail. In 2011 the USA and some European countries such as Greece and Italy face serious economic crisis due to open economy. This situation arises because of increased unemployment and the difference of the wealth between rich and poor. We feel the importance to describe briefly the recent world economy and the open economy of Bangladesh to clarify the concept of open economy to the readers.

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