Pindiriri, Carren

Article

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Cogent Economics & Finance

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Suggested Citation: Pindiriri, Carren (2014) : A theoretical analysis of the effectiveness of sustainable development assistance on environmental quality, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 2, Iss. 1, pp. 2-11, https://doi.org/10.1080/23322039.2014.939293

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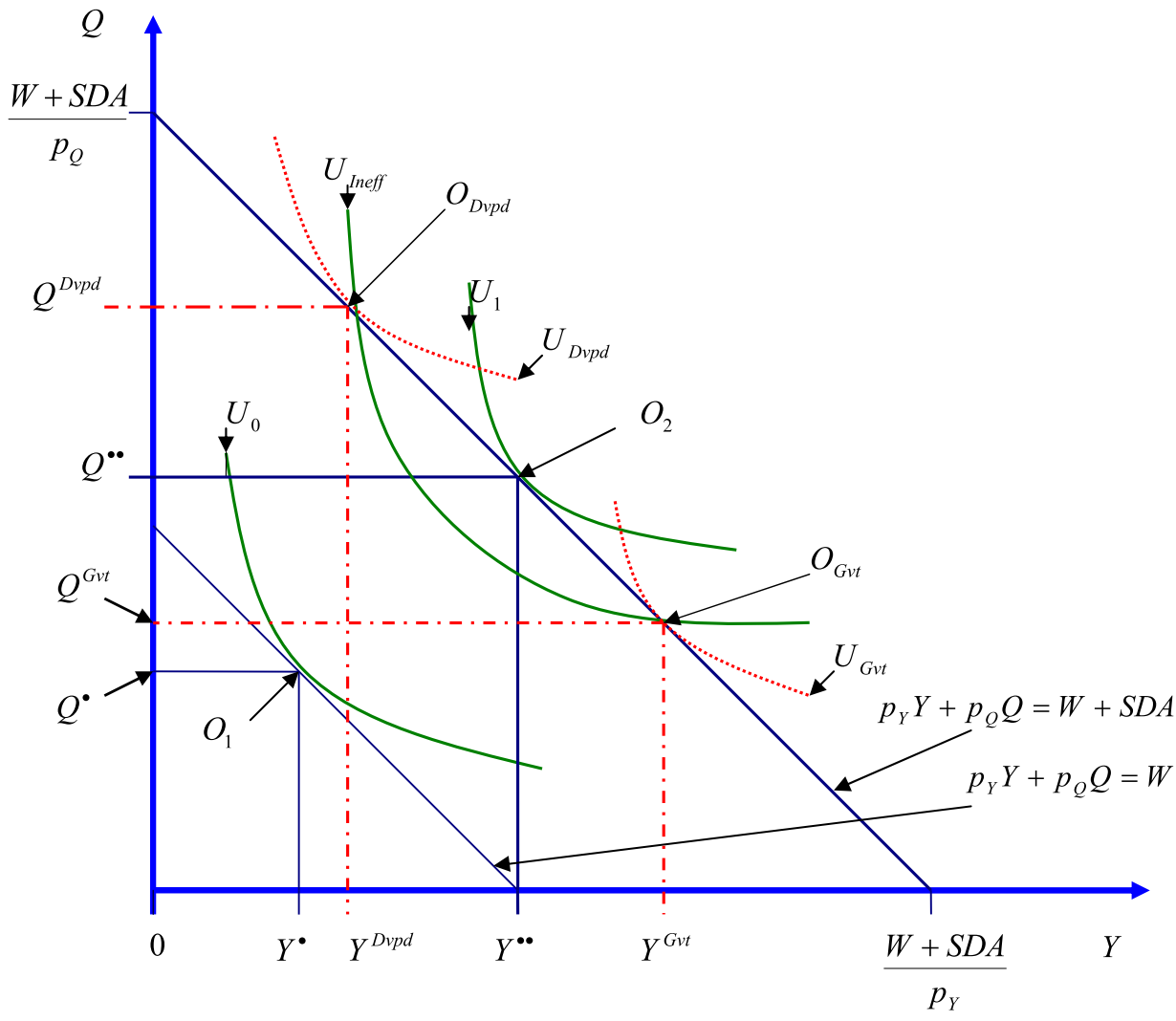

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Cogent Economics & Finance (2014), 2: 939293

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A theoretical analysis of the effectiveness of sustainable development assistance on environmental quality

Carren Pindiriri[1*]

Received: 02 August 2013
Accepted: 21 June 2014
Published: 30 July 2014

*Corresponding author: Carren Pindiriri, Department of Economics, University of Zimbabwe, Harare, Zimbabwe
E-mail: cpindiriri@sociol.uz.ac.zw

Reviewing editor:
Caroline Elliott, University of Huddersfield, UK

Additional article information is available at the end of the article

Abstract: A number of empirical studies have been carried out to assess the impact of sustainable development assistance (SDA) and aid on environmental quality in poor countries, but these studies have been characterized by weak theoretical anchor. It is against this background that this paper provides a theoretical basis from which empirical models of the effectiveness and impact of SDA on environmental quality can be derived. The paper applies the classical consumer theory of utility maximization, Keynesian macroeconomic model and further suggests an incentive-based approach (post-cure financial SDA model) in explaining the effectiveness of environmental financing. The theories discussed in this paper confirm the results obtained by previous empirical studies on environmental financing.

Keywords: theory, environmental quality, sustainable development assistance

JEL classifications: Q52, Q54, Q56

1. Introduction

Developing countries have not been willing to trade off output for environmental quality improvements; the reasons being that they are poor and their contribution to greenhouse emissions is relatively small. On the basis of this reasoning, developing countries have been so reluctant in devoting significant resources to fighting the surging growth of greenhouse gases emissions. Kolstad (2000) argues that the willingness to pay for environmental quality is very low for poor people. It is therefore paramount to compensate the poor for the incurred opportunity cost of environmental quality improvements in order to inculcate interest for environmental investment. Following a number of conventions such as the Kyoto protocol of 2002, the developed world has generally agreed to fund

ABOUT THE AUTHOR

Carren Pindiriri studied Doctor of Philosophy (DPhil) and Master of Science (MSc) in Economics at the University of Zimbabwe. He also holds Master of Philosophy (MPhil) in Environmental and Development Economics from the University of Oslo, Norway. His research interests are environmental and economic growth economics. He has been involved in climate change research since 2009 and the research reported in this paper is to find efficient ways in reducing GHGs emissions.

PUBLIC INTEREST STATEMENT

The research highlights that sustainable development assistance helps in improving environmental quality if the receiving countries use it for environmental activities. In this way, it helps developing countries to see how they can best use the assistance. On the part of the assistance providers, the paper highlights the importance of monitoring. It alerts aid providers that any aid should be accompanied by monitoring mechanisms. To academics, the research provides the basic economic theories explaining the effectiveness of aid in developing countries. So the research provides support to both policy-makers and academicians.

sustainable development in the poor world. Over the past decades, financial assistance for sustainable development has been increasingly flowing from rich countries to poor countries.

Developed countries and international organizations such as the United Nations, World Bank and the Organization for Economic Co-operation and Development (OECD) have been providing aid for sustainable development to poor countries. Sustainable development assistance (SDA) is the aid given to poor countries for developmental processes, which includes official development assistance (ODA) and other forms of assistance for sustainable development. The United Nations programmes include the United Nations Development Programme (UNDP) and United Nations Environmental Programme (UNEP), which initiated the Carbon Finance for Sustainable Energy in Africa (CFSEA) in conjunction with the World Bank.

Information from the UNEP Annual Report (2007) clearly show that by 1990, SDA inflow to Africa had exceeded its average of the 1970s decade by more than three times. The same report show that Sub-Saharan Africa only, received US$17.2 billion from SDA providers such as the United States, Development Assistance Committee of the OECD, World Bank, Japan's ODA, United Nations, among others. In 1992, the Government of Japan announced its intention to significantly augment and increase its ODA in environment. The Japanese authorities considered environmental issues in developing countries as critical.

In the 2000s, the UNEP in conjunction with the World Bank initiated a programme known as "CFSEA" which involved the development of an initial pipeline of Clean Development Mechanism investment opportunities in Zambia, Mozambique, Mali, Ghana and Cameroon. Although SDA inflow to poor countries has been increasing, there are questions as to whether it is an effective way of managing environmental hazards in developing countries. Questions on how the financial assistance is used by the recipients have been commonly asked. Is the assistance used for its sustainable development purpose? Does the assistance improve the state of poor countries through clean growth? Is it effective in improving both air quality and output?

The effectiveness of aid and SDA is well documented in a number of empirical studies (Bourguignon & Sundberg, 2007; Dollar & Pritchett, 1998; Najam, 2002; O'Brien & Ryan, 2001; Rajan & Subramanian, 2005; World Bank Development Report, 2006). Most of these studies have been based on pure empiricism without any theoretical anchor. Literature reveals that more empirical work has been done on the effectiveness of SDA on economic growth and environmental quality. However, less effort has been applied in linking the effectiveness of SDA to classical economic theories. It is in this regard that this paper aims to offer some possible theoretical explanations of how SDA affects environmental quality. The main objective of the paper is therefore to provide a theoretical support to the already existing body of knowledge on SDA effectiveness.

2. Theories of SDA

Effort to link the effectiveness of environmental financing to economic theories has been very subdued. While there is general consensus about the need for the rich countries to assist the poor countries with resources for environmental management, little is known about whether such assistance can be efficiently allocated and effectively used in poor countries. The effectiveness of SDA in environmental management can equally be demonstrated using contemporary economic theories. In this paper, we incorporate SDA in classical and Keynesian economic theories. The first part, 2.1, theorizes SDA effectiveness using the consumer theory of utility maximization whilst Section 2.2 incorporates SDA in the Keynesian national income model. Lastly, Section 2.3 suggests a conditionality-based model (Marshallian productivity theory).

2.1. Optimal allocation of SDA in poor countries

In this section, we apply the consumer theory of utility maximization in demonstrating the efficient allocation of SDA in developing countries. We assume that developing countries are utility maximizers, that is, they attempt to maximize their utility given a change in their resource constraint.

The developing country's resource constraint expands as a result of the financial assistance. So the question is, "how does the financial assistance allocation deviate from optimal allocation?" The assistance can be used to finance either dirty output growth or clean output growth by the receiving countries. Sometimes recipients share the assistance between output growth and environmental quality activities. But how the assistance is used does not matter in its effectiveness but what matters is the receiving country's preference between environmental quality improvement and output growth. The chief objective of SDA is to finance activities that expand poor countries' output (Y) without hurting the environmental quality (Q).

Developing countries' preferences between output growth and environmental quality tend to diverge from those of the assistance providers. In poor countries, commonly characterized by very high levels of unemployment and poverty, consumption preferences tend to be biased towards cheap output growth (dirty output), while the reverse is true for the developed world. It is in this regard that we assume that the output-environmental quality indifference curves of poor countries (recipients of SDA) are biased towards output growth, whereas those of the assistance providers are biased towards environmental quality improvements. Government consumption preferences also tend to deviate from the country's consumption preferences where country preference is defined as the average consumption preference of the citizens. In most poor countries where governments strive to attract the electorate by all means, cheapest means of production are used to produce 'dirty' output and thereby resulting in inefficient allocation of SDA where perfect monitoring does not exist. But in cases where the providers of the assistance can perfectly monitor the use of the assistance, there is a possibility of obtaining inefficient SDA allocation levels with higher than optimal environmental quality. Therefore, the non-optimal allocation of SDA in poor countries might be a result of:

- The influence of assistance providers under perfect monitoring which might force developing countries to bias their consumption towards assistance providers' own preference.
- The influence of developing countries' governments in the absence of perfect monitoring which causes a bias towards cheap output production.

The presence of moral hazard is the main cause of SDA misuse in poor countries. The lack of perfect monitoring by the assistance providers provides an opportunity for most governments in poor countries to misuse the environmental funds especially in politically tense environments. For example, in most poor countries, particularly in Sub-Saharan Africa, the political goal tends to be given more weight than that of sustainable development (Gyimah-Brempong & Traynor, 1999). Under such circumstances, consumption preferences may bias towards cheap output growth.

2.1.1. A model of pre-cure environmental financing in poor countries

The bulk of environmental financing flowing to developing countries falls in this category. Poor countries receive SDA from the rich countries before even putting a unit of effort in environmental management. The provision of the assistance is based on the expectation by the providers that it will be used for clean growth activities by the recipients. We define such assistance as pre-cure, a push factor to apply effort in environmental management rather than a compensatory factor. In other words, the assistance is provided before any effort is applied in environmental management by the receiving countries. When a developing country receives such assistance as a lump sum, its resource constraint is relaxed, that is, the assistance will shift the country's budget line from $p_Y Y + p_Q Q = W$ to a higher level such as $p_Y Y + p_Q Q = W + SDA$ in Figure 1, where Y, SDA and Q are as defined before and p_Y, p_Q and W are the economic average costs of output, environmental quality and country wealth, respectively. The budget shift will in turn results in higher levels of environmental quality and output.

We consider a situation where the average consumption preference of the developing country (SDA recipient country)'s citizens is initially represented by the indifference curve U_0 with a country budget line, $p_Y Y + p_Q Q = W$. The country is efficiently allocating its domestic resources in the

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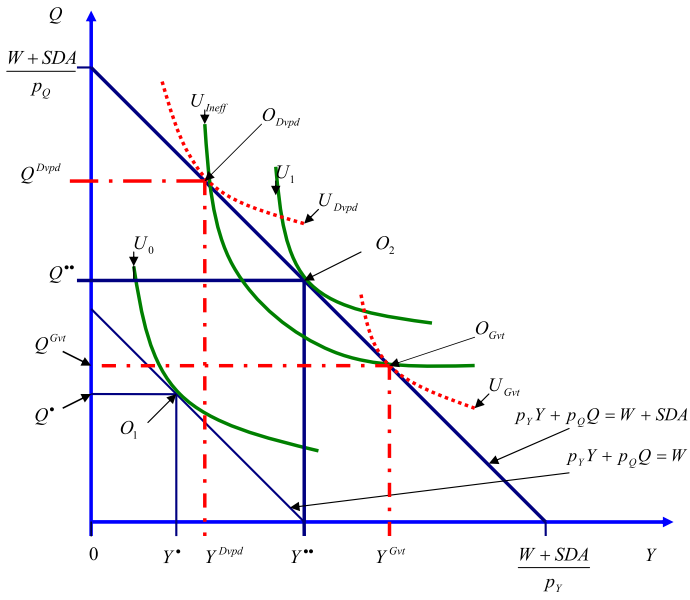

Figure 1. Non-optimal environmental quality and output levels.

Source: Author.
Note: In the absence of information asymmetry and rigidities in enforcement, high demands for environmental quality by SDA providers may sometimes render the assistance inefficient in developing countries. On the other hand, in the presence of moral hazard, governments of poor countries may put too much weight on output growth rendering the assistance inefficient as well.

consumption of environmental quality and output at point O_1 before receiving any form of SDA. A lump-sum SDA will shift the receiving country's resource constraint to $p_Y Y + p_Q Q = W + SDA$ thereby establishing new country optimal consumption levels for environmental quality and output, $Q^{\bullet\bullet}$ and $Y^{\bullet\bullet}$ in Figure 1. In cases where SDA providers have consumption preferences biased towards environmental quality more than the receiving country's average preferences, their expectations about environmental quality from the assistance tend to exceed the optimal of the receiving country. For example, in Figure 1 if the assistance providers have preferences represented by U_{Dvpd} then with perfect monitoring and full control over the use of the financial assistance, they can force the recipients to consume at non-optimal points such as O_{Dvpd} where environmental quality consumption (Q^{Dvpd}) is higher than the country average optimal ($Q^{\bullet\bullet}$) and output production (Y^{Dvpd}) is lower than the country average optimal ($Y^{\bullet\bullet}$). In this case, the SDA receiving country will consume at a lower indifference curve, U_{Ineff}. Excessive demands for environmental quality improvements by SDA providers in the absence of information asymmetry and enforcement inflexibilities are therefore a possible source of inefficient allocation of SDA in developing countries.

Perfect monitoring of SDA use in poor countries is not practically possible. Therefore, most of the inefficiencies of SDA allocation come from the receiving countries rather than from the providers. Deviation of government preferences from the country average preferences is the main source of SDA inefficient allocation in developing countries. The political sphere in most developing countries plays a major role in government policies. Under tense political environments politicians in most developing countries try by all costs to produce more output at lower cost in order to attract support from the majority poor citizens. Hence government preferences may be more biased towards cheap output production.

Governments of poor countries may give more to output production than environmental quality consumption. Consider a situation where government preferences are represented by an indifference curve, U_{Gvt}, then SDA will shift the optimal consumption point from O_1 to O_{Gvt} as shown in Figure 1. At this new allocation point, output (Y^{Gvt}) is greater than the expected average country optimal level ($Y^{\bullet\bullet}$) and environmental quality consumption (Q^{Gvt}) is lower than the expected average country optimal ($Q^{\bullet\bullet}$). The assistance is inefficiently allocated because the country is consuming along an indifference curve which is lower than the maximum possible, that is, the highest attainable indifference curve for the country with SDA is U_1 but instead the country is consuming along U_{Ineff}. Under extreme situations

where government preferences are more biased towards output production or where governments derive insignificant utility from environmental quality production, environmental quality may even deteriorate to levels lower than the initial levels before SDA assistance.

This theory therefore demonstrates that the SDA receiving country's preferences and the process of monitoring matter for efficient allocation of SDA as demonstrated in Gyimah-Brempong and Traynor's (1999) empirical findings. One method that can be used to reduce the possibility of inefficient allocation of SDA is to make use of Non-Governmental Organizations (NGOs) as monitoring institutions. Besides the creation of NGOs, efficient allocation can still be achieved through educational programmes which preach the importance of a clean environment. Environmental education programmes help governments in developing countries redirect their preferences towards clean output production, that is, they influence government preferences (Burnside & Dollar, 2000).

2.2. Financial SDA in a static model with clean-up expenditure

The state of the environment is linked to economic flows in a static model, that is, income from production, Y, is divided into consumption, C, and clean-up expenditures, X. The model also explains the impact of production and consumption waste on the environment. While the static model explains incomes without financial assistance, this section fits in SDA as part of the country's income and attempts to derive and separate the impact of SDA on the environment.

Like in Section 2.1 we assume a lump-sum SDA which relaxes the receiving country's resource constraint. In terms of income, the country's new income level becomes:

$$Y_{SDA} = Y + SDA \tag{1}$$

With an SDA-related income, consumption changes from C to C_{SDA} and clean-up expenditure changes from X to X_{SDA}. The recipient country's income level grows as a result of the lump-sum assistance from $Y=C+X$ to:

$$Y_{SDA} = C_{SDA} + X_{SDA} \tag{2}$$

The quality of the environment depends on the state of clean-up expenditures and the level of economic activity, that is, $Q=Q(Y, X)$; with $Q'_Y<0$ and $Q'_X>0$. However, the SDA changes the values of the clean-up expenditures and economic activity to provide a new function of environmental quality, that is:

$$Q = Q(Y_{SDA}, X_{SDA}) \tag{3}$$

Differentiating Equation 2 gives the following:

$$dY_{SDA} = dC_{SDA} + dX_{SDA} \tag{4}$$

and that of (3) gives

$$\begin{aligned} dQ &= Q_{YSDA}dY_{SDA} + Q_{XSDA}dX_{SDA} \\ &= Q_{YSDA}(dC_{SDA} + dX_{SDA}) + Q_{XSDA}dX_{SDA} \end{aligned} \tag{5}$$

(from (4))

$$= Q_{YSDA}dC_{SDA} + (Q_{YSDA} + Q_{XSDA})dX_{SDA}$$

where Q_{YSDA} measures the change in environmental quality resulting from a unit change in SDA-related income and Q_{XSDA} measures the change in environmental quality resulting from a marginal change in SDA-related clean-up expenditures. We can also define Q_{YSDA} as the impact weight of a change in SDA-related consumption on environmental quality and $Q_{YSDA}+Q_{XSDA}$ as the impact weight of a change in

financial SDA-related clean-up expenditures on environmental quality. An increase in production/income is expected to reduce environmental quality, that is, $Q_{YSDA}<0$ and an increase in clean-up expenditures is expected to improve environmental quality, that is, $Q_{XSDA}>0$. From Equation 5, the term $Q_{YSDA}\,dC_{SDA}$ is negative, that is, $Q_{YSDA}\,dC_{SDA}<0$, since $Q_{YSDA}<0$ and $dC_{SDA}>0$ and $dX_{SDA}>0$. Hence, a necessary condition for environmental quality to improve ($dQ>0$) is that $Q_{YSDA}<Q_{XSDA}$, that is, the environment must be more responsive to SDA-related clean-up processes than to SDA-related production waste accumulation, and the sufficient condition is $(Q_{YSDA}+Q_{XSDA})dX_{SDA}>Q_{YSDA}\,dC_{SDA}$. The inequality illustrates that if SDA increases clean-up expenditures by more than the increase in consumption then environmental quality will improve, that is, in addition to the necessary condition, the conditions $dX_{SDA}>dC_{SDA}$ and $Q_{YSDA}+Q_{XSDA}>Q_{YSDA}$ imply an improvement in environmental quality. In other words, financial SDA improves environmental quality if clean-up expenditure is more responsive to SDA-related income changes than consumption.

In situations where SDA is used as financial capital input in the production process, the usual production function can be conveyed as:

$$Y=Y(K,L,T,SDA) \tag{6}$$

where K, L, T and SDA are physical capital, labour, technology and financial capital, respectively. If we totally differentiate the production function in Equation 6, we obtain:

$$dY=Y_K dK+Y_L dL+Y_T dT+Y_{SDA}\,dSDA \tag{7}$$

where $Y_\tau=\dfrac{\partial Y}{\partial \tau}$ for any τ. The environmental quality function is defined as before, that is, it is a function of output, Y, and clean-up expenditures, X, that is:

$$Q=Q(Y,X) \tag{8}$$

This function gives a total differential equivalent to:

$$\begin{aligned} dQ&=Q_Y dY+Q_X dX\\ &=Q_Y(Y_K dK+Y_L dL+Y_T dT+Y_{SDA}\,dSDA)+Q_X dX\\ &=Q_Y Y_K dK+Q_Y Y_L dL+Q_Y Y_T dT+Q_Y Y_{SDA}\,dSDA+Q_X dX \end{aligned} \tag{9}$$

Ceteris paribus, the partial derivative of environmental quality with respect to SDA is computed as:

$$\frac{dQ}{dSDA}=Q_Y Y_{SDA}<0 \tag{10}$$

where $Q_Y=\dfrac{\partial Q}{\partial Y}<0$ and $Y_{SDA}=\dfrac{\partial Y}{\partial SDA}>0$.

The macroeconomic static theory confirms that in cases where developing countries use SDA as financial production capital input, the assistance tends to cause more harm than good to the environment. This calls for proper scrutiny of activities which can be targeted for SDA financing in developing countries. The model indirectly confirm that environmental funding to developing countries can only effectively improve environmental quality if the funds are not directly invested in output production for the receiving countries. Output growth has been found to be one of the major factors influencing deterioration of the environment in particular air pollution (Seldon & Song, 1992; Shafik, 1994). Hence, the processes of monitoring and identifying areas to be financed are key tenets of an effective SDA fund.

2.3. Incentive-based financing

Unlike the theories explained in Sections 2.1 and 2.2, in this section, we suggest a model that solves moral hazard problems associated with difficulties in monitoring. While in the first two models, we have seen the possibility of SDA misuse by the recipients, we suggest a post-cure[1] model of environmental financing. In this model, developing countries will only receive SDA upon producing evidence

that they have forgone some output in order to improve their environment. The assistance therefore acts as a form of compensation to developing countries for output loss. It will be released as a function of effort applied by the receiving country in improving the environmental quality hence is an incentive-based approach. As a result, it is difficult to misuse the assistance since it is only delivered after effort has been applied. In this model, it is assumed that developing countries seek to maximize utility by allocating their effort optimally between output production and environmental management. By defining environmental quality as Q and suppose that developing country uses α proportion of its effort to improve the environmental quality and use the outstanding effort $(1-\alpha)$ on all other activities like output production, then environmental quality will depend on α, that is;

$$Q = f(\alpha) \tag{11}$$

We define S as the size of the SDA given to a developing country by assistance providers. In this model, S is dependent upon the size of effort or the magnitude of environmental quality achieved by the assistance recipient country. It is therefore defined as some fraction λ of the environmental quality value Q. Suppose the assistance provider gives λ fraction of Q as the SDA size, then;

$$S = \lambda Q = \lambda f(\alpha) \tag{12}$$

When a country applies effort in environmental management, it derives utility from improved environmental quality as well as from the expected financial gain S. For poor countries, when environmental management is compensated by rich countries, their utility from environmental quality will be defined by S. We therefore assume that the arguments in the utility function of a developing country are the size of SDA (S) and output level (Y), that is:

$$U = U(S, Y) = U(\lambda Q, Y) = U(\lambda f(\alpha), Y) \tag{13}$$

Apart from the cost of producing Y which we define as $C(Y)$, developing countries incur some costs, $C(\alpha)$, in the application of effort to environmental management. We consider these groups of costs in utility maximization problem. The assistance providers also seek to maximize the benefits derived from what they provide as assistance. Improvement in environmental quality which is the main objective of the provision of SDA by the developed countries stands as the benefit derived by these rich countries. We express the benefit Q in monetary terms $M(Q)$. The assistance provider seeks to maximize its expected benefit;

$$E\left[M(Q) - S\right] = E\left[M(f(\alpha)) - S\right] \tag{14}$$

Subject to the receiving country's participation constraint (PC),

$$E\left[U(\lambda f(\alpha), Y)\right] - C(\alpha) - C(Y) \geq U^{*} \tag{15}$$

and the incentive compatibility constraints (ICCs). The first-order conditions of the PC of the receiving country provide a solution for the ICC for the choice of effort given λ, that is:

$$E\lambda\left[U'_{\alpha}(\lambda f(\alpha), Y)\right] f'(\alpha) - C'(\alpha) = 0$$
or
$$E\lambda\left[U'_{\alpha}(\lambda f(\alpha), Y)\right] f'(\alpha) = C'(\alpha) \tag{16}$$

and,

$$E\left[U_Y'(\lambda f(\alpha), Y)\right] - C'(Y) = 0$$
or
$$E\left[U_Y'(\lambda f(\alpha), Y)\right] = C'(Y) \quad (17)$$

The Marshallian productivity theory explained here and the resultant output in Equation 16 confirm that optimal/efficient effort in environmental management occurs when the marginal cost of effort is equal to the expected marginal utility from the financial assistance. Condition (16) clearly shows that developing countries cannot continue to apply effort in environmental management when the cost of an additional unit of effort exceeds the marginal benefit derived from that unit of effort. Conversely, there is an incentive to apply additional effort when the benefit derived from a marginal unit of effort is greater than its cost. The size of λ which lies in the range [0, 1] acts as an incentive for developing countries to consider environmental management activities, hence it influences the size of optimal effort levels. When the value of λ is very large, say close to one, developing countries have a larger incentive to apply more effort in environmental quality improvements. But with λ close to zero, developing countries tend to apply subdued effort in cleaning their output. Full financing implies $\lambda=1$ and no financing is when $\lambda=0$. Under circumstances with full financing (full compensation for output loss), developing countries are expected to apply maximum effort which falls as λ falls.

The incentive-based financing model demonstrates that optimal effort allocation by developing countries in environmental management with SDA can be achieved if the assistance is only provided as a function of the environmental quality achieved by the recipient country. This model can be a solution to most SDA providers who face problems of prohibitive monitoring costs. The model is derived from a Marshallian model in Bardhan and Udry (1999) which was applied for agricultural productivity. In this paper, we use the same approach but now to environmental financing. Although post-cure financing has not been more common in environmental management, the United Nations' CFSEA is a good example of such models. The theory therefore confirms activities already on the ground.

3. Conclusions

The theories explained herein clearly show that variables which explain the ineffectiveness of environmental financing in environmental management come from both the suppliers of the assistance and the receiving countries. On the supplier side, it is the demand for excessive environmental quality levels and the absence of a perfect monitoring system that cause inefficient allocation of SDA in receiving countries. On the other hand, the receiving side has its own share of allocative inefficiency of SDA. This is explained by the relative importance of output to environmental quality in the receiving countries, moral hazard problems and lack of incentives to apply more effort in environmental quality improvements. The main implication of the theories discussed in this paper is that financial assistance in environmental management can be efficiently allocated to produce optimal levels of output and environmental quality in developing countries if the sources of inefficiencies are addressed from both the supplier and the receiver sides. The theories also confirm the results obtained in a number of empirical studies (Bourguignon & Sundberg, 2007; Clemens, Radelet, Bhavnani, & Bazzi, 2004; Dollar & Pritchett, 1998; Najam, 2002).

Funding
I acknowledge the Norwegian Government's Quota programme which made it possible for me to start this research in 2008. In addition, I extend my acknowledgements to UNWIDER and AERC for providing funds in my attempt to find ways of reducing GHGs emissions.

Author details
Carren Pindiriri[1]
E-mail: cpindiriri@sociol.uz.ac.zw
[1] Department of Economics, University of Zimbabwe, Harare, Zimbabwe.

Citation information
Cite this article as: A theoretical analysis of the effectiveness of sustainable development assistance on environmental quality, C. Pindiriri, *Cogent Economics & Finance* (2014), 2: 939293.

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Note
1. Post-cure refers to "after treatment." Thus, post-cure SDA is the assistance given to developing countries to compensate their effort in improving environmental air quality.

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