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Environmental Quality and Economic Growth: The Case of Pacific Island Countries

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Abstract

The aim of this paper is to investigate the relationships between environmental quality and economic growth for Pacific Island countries. According to the Environmental Kuznets curve (EKC) hypothesis, environmental quality is high at low levels of economic development. However, as countries develop, environmental quality worsens until it starts to improve at higher levels of economic development. Whereas several empirical papers have tested this hypothesis for both developed and developing countries, this is the first study to address this issue for Pacific Island countries. The results of both graphical and polynomial regression models indicate that an EKC relationship exists for Kiribati, New Caledonia, PNG, and the Solomon Islands. However, this is not the case for Fiji and French Polynesia. The finding of an EKC relationship does not imply that economic growth by itself will solve environmental problems. In order to achieve a significant improvement in environmental quality, there is a need for governments to increase expenditures on environmental management, as well as on public education and awareness.
Keywords: economic growth, environmental quality, environmental curve Kuznets hypothesis, Pacific Island Countries

Introduction

Does environmental quality improve as a country develops? This question has been the source of intense debate since Grossman and Krueger's landmark paper on the environmental impacts of the North American Free Trade Agreement. In that study, the authors concluded that there is an inverted U-shaped relationship between pollution levels and income growth (GROSSMAN and KRUEGER 1991, GROSSMAN 1993). That is, there is an increasing level of pollution for people living in lower income countries. However, as incomes rise, pollution levels decline. This phenomenon has now come to be known as the environmental Kuznets curve (EKC) hypothesls after Nobel laureate Simon Kuznets who proposed a similar relationship for income inequality and income levels (KUZNETS 1955). The existence (or non-existence) of an EKC has significant policy implications. If true, it lends support for the view expressed by various people that as countries develop they will experience a cleaner environment (BECKERMAN 1992, BARTLETT 1994). It also provides justification for the view that pollution is a

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necessary evil for countries at an early stage of development and that economic growth is the key to solving environmental problems.

The EKC debate has generated a considerable amount of empirical studies, some of which are reviewed in the next section. However, to date, none of these studies have specifically considered the case of Pacific Island countries. The term 'Pacific Island Countries (PICs)' as used in this study refers to the developing countries and territories in the Pacific Islands region and excludes the two OECD countries, Australia and New Zealand (Fig. 1).

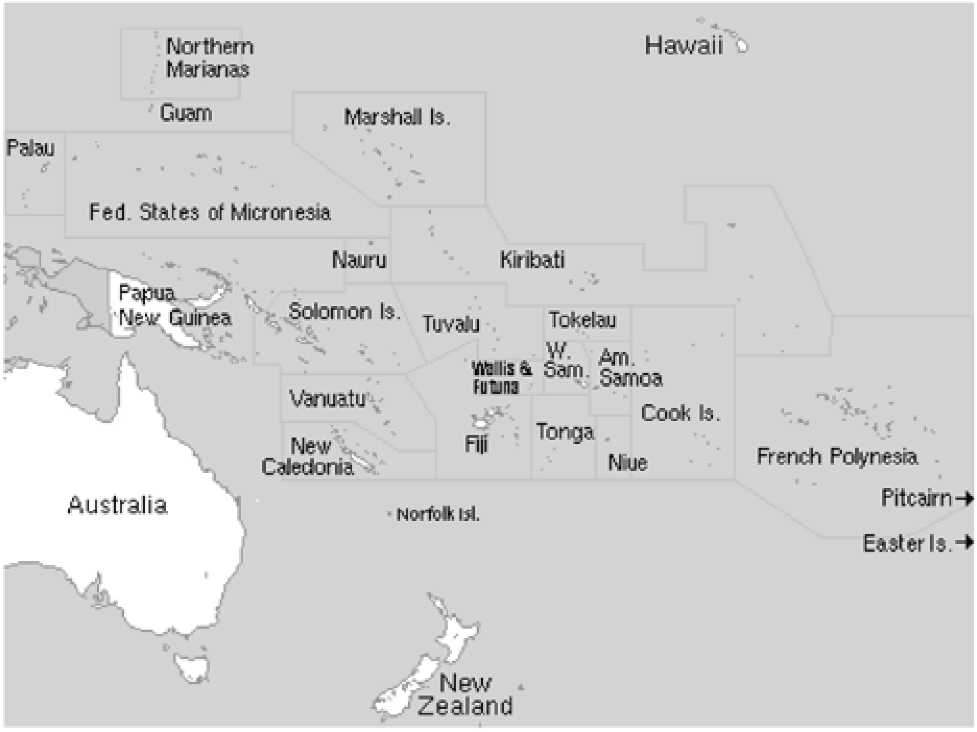

Fig. 1. Map of Pacific Island countries, Australia and New Zealand.
Source: http://www2.hawaii.edu/~ogden/piir/micro.html#FSM

As can be seen from Table 1, the PICs are diverse in terms of land area, population, resource endowment and economic attainment. For example, the largest country in the region in terms of population and land area is Papua New Guinea (PNG) with a population of over 5.7 million and a land area of 461,690 sq km. On the other hand, the smallest is Tokelau, an atoll state with a population of only 1,500 and a land area of just 12 sq km. The PICs face unique socioeconomic problems arising from their smallness in terms of size. Most of the PICs are not only small but are themselves made up of a number of small islands, which result in a number of disadvantages. These disadvantages include a narrow range of resources and high population density, which increases the pressure on already limited resources. There is also a tendency for excessive exploitation of natural resources, causing premature resource depletion.

Table 1. A List of Pacific island countries and territories

Country/Territory	Political status	Land area (sq km)	Population (2004 estimate)	Geographic Type
American Samoa	US territory	240	57,000	High islands and atolls
Cook Islands	Independent, New Zealand-affiliated	180	19,000	High islands and atolls
Federated States of Micronesia	Independent, US- affiliated	702	109691	High islands and atolls
Fiji	Independent	18,376	840,000	High islands and a few minor atolls
French Polynesia	French Territory	3,521	252,692	High islands and atolls
Guam	US Territory	549	166,773	High islands
Kiribati	Independent	726	97,813	Predominantly atolls
Marshall Islands	Independent, US- affiliated	720	61,218	Atolls
Nauru	Independent	21	13,287	Raised coral island
Niue	Independent, New Zealand-affiliated	258	2,166	Raised coral island
Palau	Independent, US- affiliated	475	20,000	High islands and atolls
Papua New Guinea	Independent	461,690	5,771,947	High islands and a few minor atolls
Solomon Islands	Independent	29,785	465,793 219,246	High islands and a few minor atolls
Tokelau	New Zealand territory	12	1,500	Atolls
Tonga	Independent kingdom	696	101,982	High islands
Tuvalu	Independent	26	10,900	Atolls
Vanuatu	Independent	12,189	207,331	High islands and a few atolls
Samoa	Independent	2,934	183,746	High islands

Source: McGregor (1999).

Another characteristic of the PICs is that they tend to have high degrees of endemism and levels of biodiversity, but the relatively small numbers of the various species impose high risks of extinction and create a need for protection. Due to the small size, isolation and fragility of island ecosystems, biodiversity in these countries is among the most threatened in the world today.

In view of the unique problems facing the PICs, the objectives of this paper are to empirically examine the relationships between environmental quality and economic growth in order to determine whether or not an EKC exists, and to discuss the policy implications. Due to limitations of data, we are only able to consider one indicator of environmental quality, namely, CO_2 emissions for the following PICs: Fiji, French Polynesia, Kiribati, New Caledonia, PNG and the Solomon Islands.

The remainder of the paper is organised as follows. To set the context for the paper, Section provides some information on the structure of production in the PICs. Section 3 provides a brief review of the EKC literature, while Section 4 describes the methodology used and the data sources. The empirical results are presented and discussed in Section 5, while the sixth section discusses the policy implications. The final section contains the summary and conclusions.

The Structure of National Output in the Pacific Island Countries

The majority of the PICs (with the exception of French Polynesia) may be classified as lower middle income countries with per capita GDPs of less than US$4,000. The per capita GDPs for 2004 range from US$555 (Kiribati) to US$14,670 (French Polynesia). The average per capita GDP (2004) for the sample of countries used in this study is US$2,874. As can be expected, most of the PICs are reliant on agriculture for to provide export income and employment. In countries such as PNG, Fiji and the Solomon Islands, there are large subsistence sub-sectors within the agricultural sector. Figs. 2a-2e shows time series data of the key components of national output for periods from 1965-2006 for a selected number of PICs for which data were available.

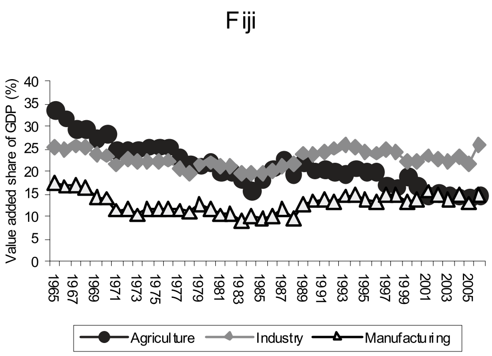

Fig. 2a. Fiji: Value added share of GDP.

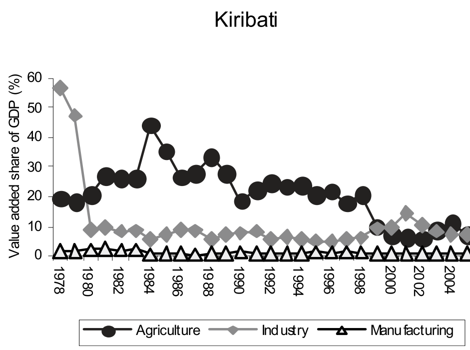

Fig. 2b. Kiribati: Value added share of GDP.

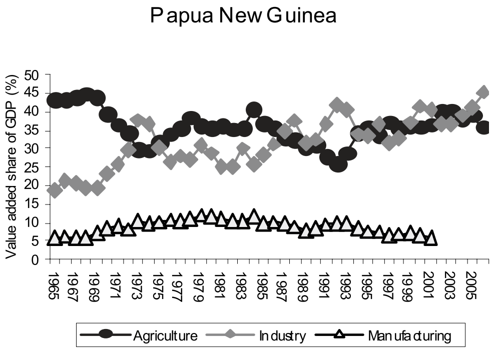

Fig. 2c. PNG: Value added share of GDP.

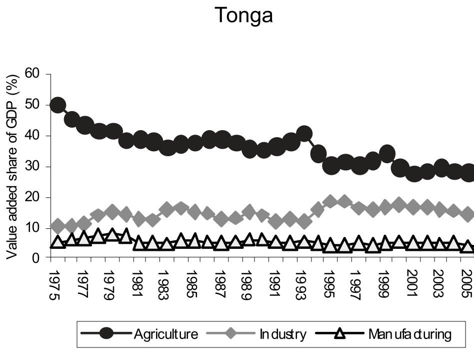

Fig. 2d. Tonga: Value added share of GDP.

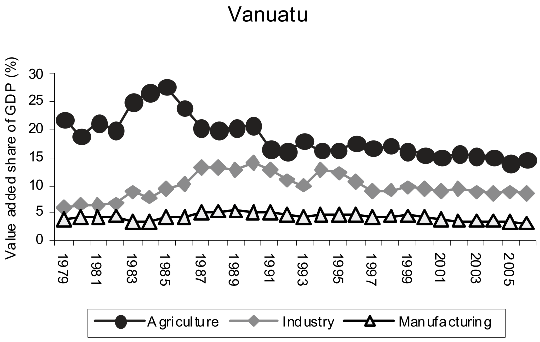

Fig. 2e. Vanuatu: Value added share of GDP.

It can be seen that in all the countries, except PNG, agricultural value added as a percentage of GDP has declined over time. For example, in Fiji, agriculture has decline from 35% of GDP in 1965 to 15% in 2006, and in Tonga, it has declined from 50% in 1975 to 26% in 2006. However, in PNG, agriculture's contribution to GDP has declined at a slower pace from 43% in 1965 to 36% in 2006. The figures also show that the level of industrialisation in the Pacific region is very low. Apart from the bigger countries (i.e. Fiji and PNG), the share of industry in GDP for the remaining countries is less than 15%. In the PNG, the share of industry in real GDP has increased from 19% in 1965 to 45% in 2006, while in Fiji it has remained static over time at about 26% of GDP. What is not shown in these figures is that tourism, which is classified as services, is increasingly contributing a greater share of output in countries such as Fiji, New Caledonia and Vanuatu.

Brief Review of the Literature

The basic premise of the EKC hypothesis is that at very low levels of economic growth, environmental effects are low. However, as development proceeds, the rate of pollution increases. At higher levels of economic development, various factors (e.g. structural change, improved technology) cause pollution levels to decline. An example of an EKC for sulphur dioxide is shown in Fig. 3. A typical feature of the EKC is the inverted U shape which suggests that pollution levels reach a maximum level with respect to income levels, after which it begins to decline. The maximum level of pollution is referred to as the 'turning point' and forms the focus of the debate about pollution control.

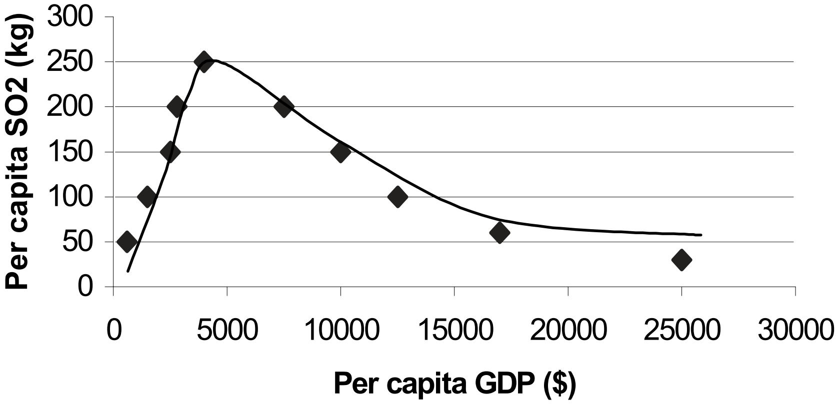

Fig. 3. A hypothetical EKC for sulphur dioxide.
Source: Asafu-Adjaye (2005)

Various theoretical explanations have been given to explain the EKC relationship. For example, ARROW *et al*. (1995) have suggested that as a natural progression of development, economies transform from clean agrarian economies to polluting industrial economies, and then to clean service economies. SURI and CHAPMAN (1998) have put forward the 'pollution haven' hypothesis, which is that more developed economies are shifting their pollution intensive production processes to the developing economies. Another explanation for the relationship is that richer countries have a higher demand for environmentally friendly products, cleaner technologies and also environmental laws (EKINS 1997). Finally, Stokey (1998) has argued that below a certain threshold level of economic activity, only dirty technology is used. Pollution continues to increase linearly with economic growth until the threshold is passed and cleaner technologies can be used, resulting in the inverted U-shaped EKC.

To date, empirical support for the EKC hypothesis has been mixed. Following the initial findings of GROSSMAN and KRUEGER (1991, 1995), further support for the EKC hypothesis was provided by a number of studies including SHAFIK and BANDYOPADHYAY (1992)[1], PANAYOTOU (1993, 1995), SELDEN and SONG (1994), CROPPER and GRIFFITHS (1994) and COLE *et al*. (1997). More recent studies have shown that not all environmental pollutants conform to the EKC. For example, ASAFU-ADJAYE (1998) found that CO_2 emissions per capita increased with increasing income. SURI and CHAPMAN (1998) tested the EKC hypothesis by including variables for international trade and concluded that trade makes a significant contribution to the shape of the curves but could find no support for the EKC hypothesis. More recent studies have questioned the EKC using some of the environmental indicators from the earlier studies. For example, HARBAUGH *et al.* (2000) re-examined the empirical evidence for the EKC for SO_2, smoke, and total suspended particulates using data from SHAFIK and BANDYOPADHYAY (1992) and GROSSMAN and KRUEGER (1995), with the benefit of an additional ten years of data. They concluded that there is little if any empirical support for the existence of an EKC for these pollutants. ASAFU-ADJAYE (2003) tested the EKC hypothesis by analysing the relationship between biodiversity and economic growth using indicators of species diversity and income per capita as proxies for biodiversity and economic growth, respectively. He rejected the existence of an EKC and concluded that economic growth has an adverse effect on biodiversity. Although there have been numerous EKC studies, few have considered the case of developing countries. Apart from this study, the only other developing country based study was conducted by VINCENT (1998) for Malaysia. He found that none of six pollution-income relationships estimated using a panel data set for Malaysian states could confirm the existence of an inverted U-curve.

A number of prominent scholars have criticised studies of the EKC. Prominent among them are a group of economists, led by Nobel laureate Kenneth Arrow, who met in Sweden in 1995 to consider the relationships between economic growth and environmental quality. They concluded that an inverted U-curve is not evidence that it will happen in all cases or that it will happen in time to avert the adverse impacts of economic growth (ARROW *et al.* 1995). Other critiques of EKC studies can be found in STERN (1998), EKINS (1997) and ROTHMAN (1997).

Methodology

On the basis of the EKC hypothesis, we specify a model in which environmental quality in a given country is a function of the level of income. As indicated earlier, environmental quality is measured here by CO_2 emissions intensity and income level is measured by per capita real gross domestic product (GDP). Two equations are therefore tested:

$$E_i = \alpha_0 + \alpha_1 GDPi + \alpha_2 GDP_i^2 + \varepsilon_i \qquad (1)$$

$$E_i = \alpha_0 + \alpha_1 GDPi + \alpha_2 GDP_i^2 + \alpha_3 GDP_i^3 + \varepsilon_i \qquad (2)$$

Where,

E_i = CO_2 emissions intensity (kt/US$);

GDP = real per capita GDP (constant US$);

ε_i = random error term, and

α's = parameters to be estimated.

Equation (1) is a second order polynomial, while Equation (2) is a third order polynomial. A polynomial regression function is adopted here to account for the fact that the relationship between environmental quality and income may not be a linear one. A polynomial function is appropriate when the underlying response function is unknown, in which case the polynomial function provides a good approximation to the true function. Scatter plots of the environmental quality-income relationships (shown below) provide some justification for our choice of the polynomial function.[2]

The countries included in the sample and the time period for the analysis were determined by the availability of sufficiently long time series data. Data on the above variables for carbon dioxide emissions were obtained for the specified periods: Fiji (1961-2004), French Polynesia (1965-2000), Kiribati (1970-2004), New Caledonia (1965-2000), PNG (1961-2004), the Solomon Islands (1967-2004), Vanuatu (1979-2004), Samoa (1978-2000), and Tonga (1981-2004). All the data series were obtained from the online version of the *World Development Indicators* (WORLD BANK, 2008).

Tables 2a and 2b provide the summary statistics for the nine countries in the sample. Average per capita incomes for the sample are variable, ranging from a high of US$11,648 for French Polynesia to a low of US$602 for PNG. New Caledonia and PNG have the lowest average population density of 8 persons per sq km, while Tonga has the highest of 139 persons per sq km. There is also great variability in average total CO_2 emissions and CO_2 emissions intensity. The highest average total CO_2 emissons of 1763 kt is recorded for New Caledonia, while the lowest is 26 kt for Kiribati. In terms of CO_2 emissions intensity, the highest average of 2.586 kt/US$ is observed for PNG, while the lowest of 0.032 kt/US$ is observed for French Polynesia.

Table 2a. Means of the main variables

Indicator	Fiji (1961-04)	French Polynesia (1965-00)	Kiribati (1970-04)	New Caledonia (1965-00)	PNG (1961-04)	Solomon Islands (1967-04)
GDP per capita (constant 2000 US$)	1648	11648	604	10918	602	687
Population density	34	45	91	8	8	10
Total CO_2 emissions (kt)	644.8	390.6	26.1	1762.79	1614.27	116.17
CO_2 emissions intensity (kt/US$)	0.379	0.032	0.048	0.165	2.586	0.163

Table 2b. Means of the main variables.

Indicator	Vanuatu (1979-00)	Samoa (1978-00)	Tonga (1981-04)
GDP per capita (constant 2000 US$)	1235	1194	1333
Population density	16	63	139
Total CO_2 emissions(kt)	70.1	122	86.5
CO_2 emissions intensity (kt/US$)	0.057	0.102	0.063

Results and Discussion

Figs. 4 to 9 provide scatter plots for the environmental quality-income relationship for the first six countries in the sample. The trendlines for Fiji (Fig. 4) and French Polynesia (Fig. 5) indicate that for these countries CO_2 emissions intensity increase linearly with increase in per capita income or economic growth. Clearly, in these two cases an EKC does not exist. For Kiribati (Fig. 6), CO_2 emissions intensity has declined gradually with an increase in economic growth. New Caledonia's scatter plot exhibits the classic EKC phenomenon. The best fitting trendline in this case is a second order polynomial (quadratic inverted U) with a turning point of about US$9,000 per capita (Fig. 7). If this relationship is true, it would imply that New Caledonia has already passed that point, given its per capita income of US$10,918.

The scatter plot for PNG (Fig. 8) is an S-shaped cubic curve, suggesting that CO_2 emissions intensity has increased steadily but has reached a maximum level of US$650 and has started to decline. The results for the Solomon Islands indicate that the best fitting trendline is a third order (cubic) polynomial function. In this case, the scatter plot reveals that there are two turning points (Fig. 9). CO_2 emissions intensity initially declined, and then begun to increase when the country reached an income level of

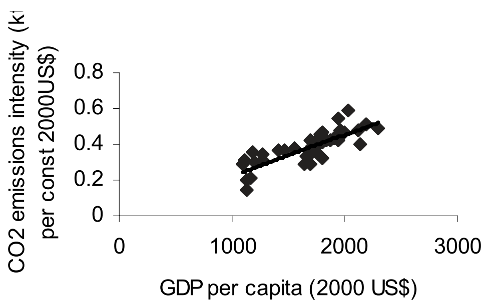

Fig. 4. Fiji: GDP per capita-CO_2 emissions Intensity.

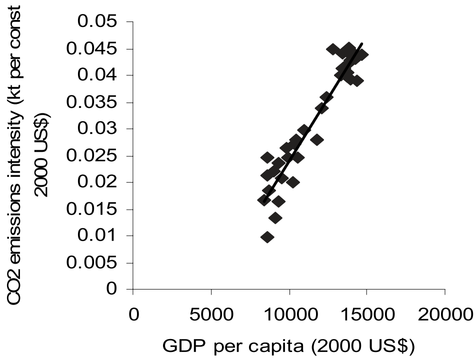

Fig. 5. French Polynesia: GDP per capita-CO_2 emissions intensity.

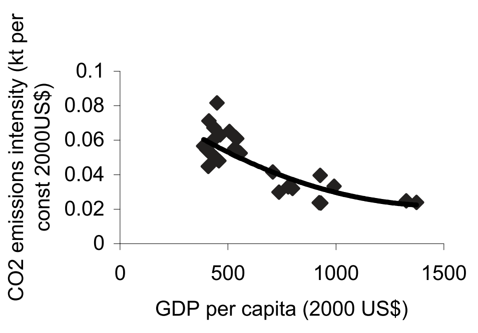

Fig. 6. Kiribati: GDP per capita-CO_2 emissions Intensity.

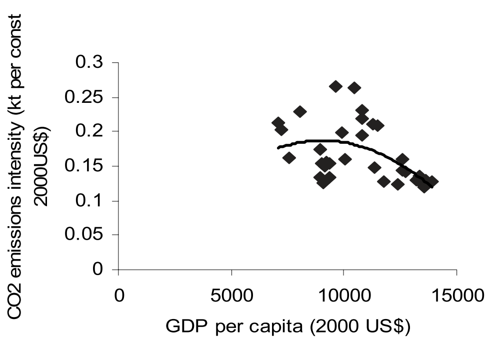

Fig. 7. New Caledona: GDP per capita-CO_2 emissions intensity.

US$500, climbing to a maximum level of about US$750, after which CO_2 emissions intensity began to decline again.

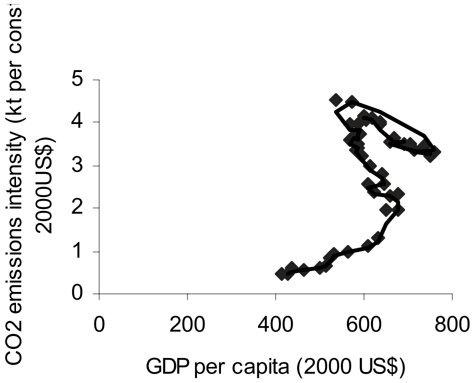

Fig. 8. Papua New Guinea: GDP per capita-CO_2 emissions intensity.

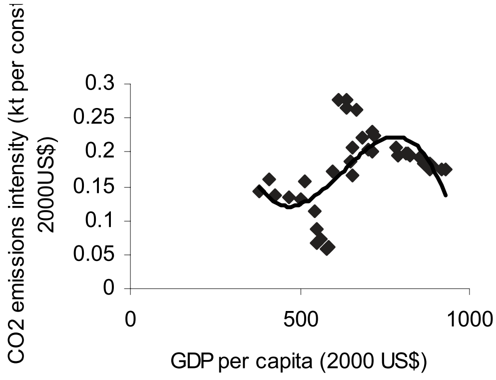

Fig. 9. Solomon Islands: GDP per capita-CO_2 emissions intensity.

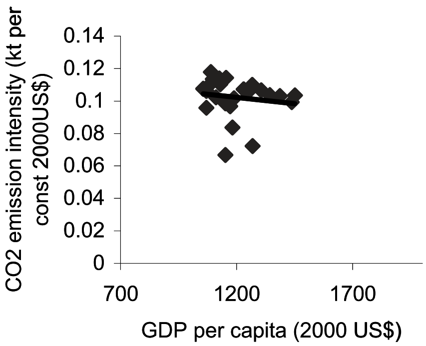

Fig. 10. Samoa: GDP per capita-CO_2 emissions intensity.

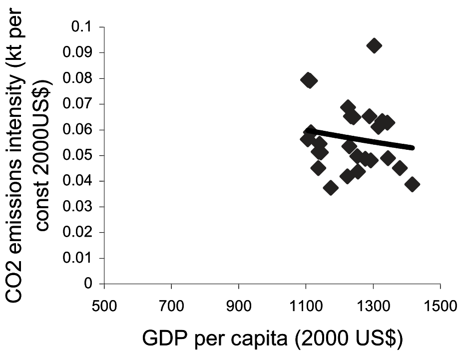

Fig. 11. Vanuatu: GDP per capita-CO_2 emissions intensity.

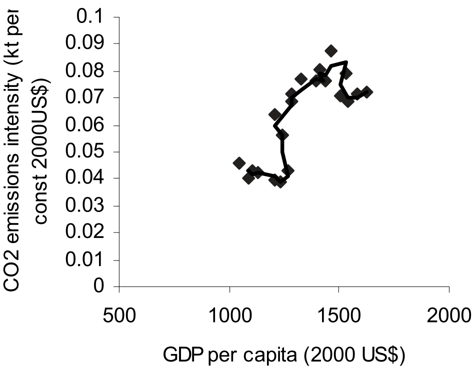

Fig. 12. Tonga: GDP per capita-CO_2 emissions intensity.

The last three scatter plots (Figs. 10-12) are for Samoa, Vanuatu and Tonga. The scatter plots for Samoa (Fig. 10) and Vanuatu (Fig. 11) indicate that generally carbon emissions intensity has declined with increase in per capita GDP. The scatter plot for Tonga (Fig. 12) shows an S-shaped curve similar to that observed for PNG and the Solomon Islands, implying that after increasing linearly with income, CO_2 emissions intensity has started to decline.

These graphical results may be summarised as follows. The findings for the environmental quality-income relationship are not uniform for this sample of Pacific Island countries. For Kiribati, New Caledonia, PNG, Samoa, Vanuatu, and the Solomon Islands, the initial indications are that CO_2 emissions intensity has declined with increase in economic growth. However, the pattern of the decline is different for each country. In Kiribati, Samoa and Vanuatu, the decline has been gradual with increasing growth, which runs counter to the EKC prediction that emissions will worsen before they start to improve. New Caledonia is the only country showing the classic inverted U-curve. In the case of PNG, Tonga and the Solomon Islands, an EKC appears to exist with multiple turning points. In these countries, we observe an S-shaped curve, which appears to indicate that emissions intensity has started to decline. Finally, in the case of Fiji and French Polynesia, contrary to the EKC hypothesis, CO_2 emissions intensity has shown a tendency to increase with an increase in economic growth. In these two cases, we cannot speculate as to whether there would be a turning point, although in the case of Fiji, the scatter plot indicates a slowing down of the rate of increase in CO_2 emissions intensity. To further explore the significance of these preliminary results, we now turn to the polynomial regression models.

Tables 3a and 3b display the results for the polynomial regressions. The graphical results shown earlier were used to select the most appropriate (or best fitting) function for a given country. Therefore, in the case of Fiji and French Polynesia (Table 3a, columns 1 and 2), a linear function is fitted. "It can be seen that in both cases, the coefficient on GDP is positive and significant, confirming the linear relationship between income and emissions intensity". In the case of Kiribati and New Caledonia (Table 3a, columns 3 and 4), second order polynomials are fitted. "The coefficient on GDP^2 for Kiribati is negative and significant, confirming the graphical result that there has been a linear decline in CO_2 emissions intensity as per capita income has increased". The coefficient on GDP in the New Caledonia regression is positive although not significant, while the coefficient on GDP^2 is negative and significant. This confirms the graphical finding that there is an inverse U-shaped relationship between per capita income and environmental quality.

The final set of results (Table 3a, columns 5 and 6) are for PNG and the Solomon Islands. On the basis of the graphical results, third order polynomials were fitted for these two countries. The t-statistics for the PNG regression indicate that none of the variables are significant. However, in the case of the Solomon Islands, they are all highly significant, indicating that there are multiple turning points in the income-environmental quality relationship. Therefore, overall, the regression results provide some degree of validity for the graphical results shown earlier.

Table 3a. Regression resultsa

	Fiji	French Polynesia	Kiribati	New Caledonia	PNG	Solomon Islands
Intercept	-0.017	-0.022	0.013	-0.045	-31.269	1.474
	(-0.411)	(-7.062)	-0.301	(-0.247)	(-0.812)	-2.429
GDP	0.002	4.68×10^{-6}	0.0002	5.2×10^{-5}	0.132	-0.007
	(9.137)***	(17.143)***	-1.3991	-1.456	-0.644	(-2.456)***
GDP^2	-	-	-4.1×10^{-7}	-2.9×10^{-5}	-0.0002	0
			(-1.806)*	(-1.742)*	(-0.456)	(2.677)***
GDP^3	-	-	-	-	0	-2.33×10^{-9}
					-0.311	(-2.817)***
R^2	0.666	0.896	0.689	0.300	0.632	0.600
Adjusted R^2	0.651	0.893	0.660	0.258	0.400	0.360
F-Statistic	83.48***	293.86***	23.61***	7.09**	9.12***	6.57**
S.E. of regression	0.053	0.004	0.008	0.036	1.032	0.046
Sample size	45	36	35	36	45	39

Notes:
a. t-statistics are in parentheses.
*** significant at the 1% level.
** significant at the 5% level.
* significant at the 10% level.

Table 3b reports the econometric results for Vanuatu, Samoa and Tonga. These three countries have a relatively shorter time series data compared to the earlier ones. In all three cases, the coefficient on per capita GDP is negative, although that of Samoa is not statistically significant. This result indicates that in these countries, there is no evidence that carbon emissions increase linearly with increase in economic growth. The results for Samoa are not statistically significant based on the very low R^2 and insignificant regression coefficients. However, in the case of Vanuatu and Tonga, the coefficients on GDP are negative and statistically significant, implying that an increase in real per capita GDP has led to a decline in CO_2 emissions intensity. These results strongly support the graphical results presented earlier, from which we can conclude that in these countries economic growth has not necessarily worsened environmental quality.

Table 3b. Regression results (cont'd)a

	Vanuatu	Samoa	Tonga
Intercept	22.191	2.212	2.134
	-2.97	-0.654	-2.32
GDP	-0.053	-0.005	-0.005
	(-2.969)***	(-0.592)	(-2.439)***
GDP^2	0	3.73×10^{-6}	0
	(2.977)***	-0.56	(2.585)***
GDP^3	0	-9.5×10^{-10}	0.000
	(-2.984)***	(-0.531)	(-2.688)***
R^2	0.307	0.083	0.763
Adjusted R^2	0.213	-0.036	0.727
S.E. of regression	0.012	0.012	0.008
Sample size	26	27	24

Notes:
a. t-statistics are in parentheses.
*** significant at the 1% level.
** significant at the 5% level.
* significant at the 10% level.

Policy Implications

In the majority of cases considered in this paper, the evidence suggests that with a higher level of economic growth, it is possible to have a reduction in pollution levels. However, this finding does not imply that economic growth by itself will solve environmental problems. In fact, in two cases, specifically, Fiji and French Polynesia, the results indicate that economic growth is actually associated with worsening carbon dioxide emissions intensity. In order for environmental quality to improve in the PICs, there is an urgent need for policies to control pollution. The most common form of pollution control in the PICs is environmental regulation or standards, which is referred to as the Command and Control approach (ASAFU-ADJAYE 2005). However, in most of the PICs these regulations have been found to be out of date and ineffective. For example, in the case of Fiji, the current anti-pollution laws include the public nuisance provisions of the Public Health Act of 1936 and the provisions for air pollution under the Traffic Regulations Act of 1974. However, these laws are rarely enforced and there are numerous examples of blatant violations. Currently, the only form of pollution control being exercised is through government and local authority licensing, as well as through development compliance requirements for new industries and plants.

In addition to being outdated, the reasons for the ineffectiveness of the current laws include the following: uncoordinated legislation; overlapping responsibilities and lack of coordination among government agencies; lack of training and resources; low and ineffective penalties; and insufficient public education and awareness. These issues are briefly explained below, using Fiji as a case example.

Outdated, fragmented, and uncoordinated legislation

Environmental legislation has been uncoordinated over the past four decades. The first environmental legislation was related to the management of land under the Native Lands Trust Act, 1905 and 1940. This was then followed over time by various legislations with an environmental focus. There are currently about 54 pieces of legislation, of which about 25 affect environmental management. Examples include the following: the Subdivision of Land Act 1937; Marine Spaces Act 1938; the Quarries Act 1939; the State Lands Act 1946; the Town Planning Act 1946; the Fisheries Act 1951; the Land Conservation and Improvement Act, 1953; the Forest Act 1953; the Water Supply Act 1955; the Public Health Act 1955; the Mining Act 1965; the Land Lord and Tenants Act 1976; and the Petroleum Act 1978 (McGREGOR 1999). The fragmented legislation creates loopholes that make effective prosecution difficult.

Recognising the need for better environmental legislation, the government in collaboration with the World Conservation Union prepared a National Environmental Strategy for Fiji in 1993. This led the way for the drafting of a Sustainable Development Bill in 1998. The Bill is intended to provide a legal mechanism for the management of social, economic, environmental and natural resources in a sustainable manner. The Bill underwent several discussions in parliament in 2005/06 but unfortunately it could not be passed into law due to the December 2006 military coup which suspended parliament.

Overlapping responsibilities and lack of coordination among government agencies

There are a number of government agencies responsible for enforcement of the various laws. However, there is no single agency charged with the responsibility for monitoring or coordinating compliance. This often results in duplication of effort by various government agencies. For example, in the area of environmental protection, three government agencies have overlapping responsibilities. These are the Department of Environment, the Department of Mineral Resources, and the Department of Health. Environmental monitoring in mines is carried out by both the Department of the Environment and the Department of Mineral Resources, although the former is responsible for approving environmental impact assessments (EPA) for major mining projects. In addition to the government agencies, there are a number of committees in Fiji that are concerned with environmental issues. These include the National Oil Pollution Committee (Marine Department), the Rubbish Dump Committee (Ministry of Housing, Urban development and Environment) and the National Environment

Steering Committee (Ministry of Housing, Urban development and Environment). This overlap in responsibilities results in duplication of effort in some areas. Given, the limited financial resources of government, it is essential to use whatever is available as efficiently as possible.

The Sustainable Development Bill provides a legal framework for: (a) environmental impact assessments; (b) pollution and waste management; (c) conservation and national parks management; (d) integrated natural resource management; (e) establishment of an effective enforcement and administrative framework for the Department of Environment. The Bill requires the establishment of a National Council for Sustainable Development to oversee the implementation environmentally friendly and sustainable policies. The Minister for Environment is required to establish a Department of Environment and appoint its Director to administer the new legislation. The Bill requires the establishment of an Environmental, Impact Assessment Unit which will assess and examine every development activity to be undertaken by a Ministry, Department or statutory body and other development proposals or projects submitted by other organisations. It also requires the establishment of a Natural Resource Management Unit within the Ministry of Agriculture, Forests and Fisheries within two years of the enactment of the legislation for the function of natural resource inventory, information gathering and management.

Lack of resources and training

One of the major constraints in enforcing and monitoring environmental legislation in Fiji is lack of adequate financial resources to recruit and train personnel.

Table 4. Fiji: Expenditure Allocations from 2007 National Budget

Priority Sector	Amount (F$ millions)
Law and Order	
Fiji Military Forces	89.7
Fiji Police Force	69.9
Education	320.6
Health	150.8
Agriculture	68.8
Fisheries	1.0
Rural and Regional Development	14.2
Infrastructure	179.9
Women, Social Welfare & Housing	29
Vanua Levu Development	9.4
Culture and Heritage	1.6
Sports	1.2

Source: Goverment of Fiji (2007)

For example in the 2007 Budget, the government identified the following areas as priority areas in its expenditure program: law and order, infrastructure, education, health, agriculture, fisheries, and rural and regional development (see Table 4). It can clearly be seen here that the environment is not seen as a priority area by the government. Although the environment is important, unfortunately, environmental agencies are not at the top of the priority list when it comes to allocation of the government budget.

Low and ineffective penalties

The current fines for violation of environmental pollution laws are low and do not pose a significant deterrent to violators. For example, the 1990 Ports Authority of Fiji Regulations provide for a maximum fine of F$400 for pollution offences, while the cost of cleaning up a chemical spill in Suva harbour could run into millions of dollars. An Anti-Litter Act came into force in April 1997 under which a person who breaches the Act can either pay an on-the-spot fine of F$40 or take the option of paying within 21 days. Failure to pay the fine will result in the offender being taken to court where he or she may be required to pay F$100 if found guilty. By comparison, the fine for littering under Western Australia's Litter Act 1979 ranges from A$200-400. Enforcement of Fiji's Anti-Litter Act has been constrained by several problems including large size of area to be covered and insufficient number of inspectors, and problems of properly identifying offenders due to lack of identification cards in Fiji. The penalties for violation of environmental pollution laws will be increased if the Sustainable Development Act becomes law. Under the Act, penalties include F$10,000 or an imprisonment of one year for first offence relating to pollution, F$20,000 or two years for second offence, F$50,000 for five years imprisonment for gross negligence and F$100,000 or 10 years imprisonment for pollution due to reckless disregard for human lives. It is hoped that that the severity of these penalties will act as a significant deterrent.

Insufficient public education and awareness

Although Fiji has a high adult literacy rate (about 85%), and there have been environmental awareness programs in the past, the public response to environmental pollution has generally been poor. There is the need for more public awareness programs and increase in environmental awareness programs in the curricula in the entire school system.

The way forward

In order for PICs to make more rapid progress towards the declining portion of the EKC, there is a need for governments to spend more money on strengthening the government agencies responsible for environmental regulation. There is also a need to streamline the functions of government agencies dealing with the environment, to avoid duplication and minimize inefficiency. There is a need to recruit and train more staff in various aspects of environmental planning and management including collection, interpretation and analysis of environmental data, as well as implementation, monitoring and evaluation of environmental regulations. The environmental training must not be restricted to only environment departments or divisions, It should also be carried out at different levels such as top level government decision/policy makers, middle level specialists, policy analysts and planners, industry groups, the general public, and schools. Some of this education and awareness could be carried out in the print media, TV and radio. For effectiveness, the involvement of community and industry groups, as well as Non-Government Organisations (NGOs) must be encouraged.

Summary and Conclusions

The aim of this paper was to investigate the relationships between environmental quality and economic growth for Pacific Island countries. Specifically, the intention was to determine whether the environmental Kuznets curve hypothesis exists for these countries and to discuss the implications for environmental policy making. According to the EKC hypothesis, environmental quality is high at low levels of economic development. However, as countries develop, the environmental quality worsens until it starts to improve at higher economic levels . While there have been several empirical papers testing this hypothesis for both developed and developing countries, this is the first paper to address this issue for Pacific Island countries.

The analysis of the relationship between environmental quality and economic growth was conducted using both graphical (scatter plots) and polynomial regression models. Due to data limitations, the analysis was restricted to only nine Pacific Island countries, namely, Fiji, French Polynesia, Kiribati, New Caledonia, PNG, the Solomon Islands, Vanuatu, Samoa, and Tonga. Despite this limitation, the sample provides a fairly good representation of the Melanesian, Polynesian, and Micronesian countries which constitute the PICs. The scatter plots indicated that there was no evidence of an EKC for Fiji and French Polynesia. In the case of Kiribati, Vanuatu, and Samoa there was a steady decline in CO2 emissions with increasing growth over time. For New Caledonia, PNG, the Solomon Islands and Tonga, there appeared to be an EKC-type of relationship. However, only New Caledonia exhibited the classic inverted U-curve. The rest show S-shaped curvilinear relationships. This implies that emissions initially declined with growth, but then increased before starting to decline again. The graphical results were confirmed as significant using on the polynomial regressions. In cases where an EKC was found, it is important to stress that the patterns of changes in environmental quality with increase in economic growth were different for each country. This signifies that each country's situation is different and caution must therefore be exercised when considering solutions to this problem.

It was noted that the environmental regulations in most of the countries for controlling pollution are outdated and ineffective. Also, in some cases the environmental legislations are uncoordinated. Various problems were outlined, including overlapping responsibilities and lack of coordination among government agencies, lack of legally enforceable criteria for air and water quality, lack of training and resources, low and ineffective penalties, and so on. A call was made for governments to increase the expenditure on environmental management and on public education and awareness.

To conclude, a note on the limitations of this study and areas for further research is necessary. The polynomial regression models used in this study do not sufficiently explain why the estimated relationship between pollution and income exists. However, it is highly likely that the difference between the group of countries for which an EKC exists and those for which it does not lies in factors such as differences in environmental regulations, technology, and industrial composition of GDP. Further research could consider collecting data on these variables, which would enable more complete models to be developed to shed more light on the relationship for each country.

Notes

1. Shafik and Bandyopadhyay's study was the background paper for the United Nations Development Program's 1992 World Development Report.
2. The main disadvantage in using a polynomial regression function is that any attempt to make forecasts or extrapolations beyond the range of the data may result in serious error.

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