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## Precarious Economies: Exploring the Use of Environmental Indicators to Predict Economic Instability

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## Views

# Precarious Economies: Exploring the Use of Environmental Indicators to Predict Economic Instability

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## Abstract

On August 5<sup>th</sup>, 2011 the Standard and Poor's (S&P) international credit bureau, one of three agencies that provide national credit assessments of a country's ability to take on and pay down debt, downgraded the United States' credit rating from its highest level, AAA+, to its second best rating, AA+. The downgrade marked the first time in history that the U.S. did not receive the highest rating from any of the three credit scoring firms.

The S&P report limited its critique of the U.S. economy to the current fiscal crisis. However, this paper speculates that the economic failings that led to the downgrade could perhaps have been foreseen by observing specific environmental indicators. In particular, national petroleum consumption, CO<sub>2</sub> emissions per capita (both high, in the case of the U.S.), and the return on investment that a nation receives for its pollution (annual GDP/annual CO<sub>2</sub> emissions; low, in the case of the U.S.) could be useful environmental indicators of a country's future fiscal performance. Moreover, these environmental indicators may be a sort of "early warning" system that can predict a nation's financial collapse before it is predicted by standard financial indicators (such as debt levels). This article suggests a possible mechanism for such a link, and uses these indicators to speculate which other AAA+ countries may be the next to encounter fiscal challenges that lead to credit downgrades.

**Keywords:** Economy, Sustainability, Policy.

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## 1. INTRODUCTION

On August 4<sup>th</sup>, 2011 nineteen countries, including the United States, held Standard and Poor's (S&P) AAA+<sup>1</sup> sovereign credit rating. S&P, one of three agencies that provide assessments of a nation's credit worthiness, grants AAA+ sovereign ratings to nations that it believes hold the highest degrees of financial security and in which other nations and financial institutions can be confident in the security of their investments. The United States was downgraded to AA+ on August 5<sup>th</sup>, 2011. This event marked the first time in history that the U.S. did not receive the highest rating from any of the three sovereign credit rating firms.

S&P outlines the factors it uses to develop a nation's credit score in its publication *Sovereign Government Rating Methodology and Assumptions* (S&P, 2011, June 30). The document outlines five criteria: political, economic, external, fiscal and monetary scores<sup>2</sup>. In the case of the United States, S&P pointed to political and economic criteria as the driving factors in its decision to downgrade the nation's rating. The primary and secondary factors upon which S&P bases a nation's political score are "the effectiveness, stability, and predictability of the sovereign's policymaking and political institutions" (primary factor, paragraph 37), and "the transparency and accountability of institutions, data, and processes, as well as the coverage and reliability of statistical information" (secondary factor, paragraph 37). The key factors by which S&P develops a nation's economic score are income levels, prospects for growth and economic diversity and stability (paragraph 52).

The credit agency identified political indecisiveness and a lack of proactive policy development at the federal level, and the nation's rising debt burden, as key factors in their action regarding the U.S.'s rating. The S&P report, *United States of America Long-term Rating Lowered to 'AA+' on Political Risks and Rising Debt Burden; Outlook Negative (2011, August 5)*, reads:

We lowered our long-term rating on the U.S. because we believe that the prolonged controversy over raising the statutory debt ceiling and the related fiscal policy debate indicate that further near-term progress containing the growth in public spending, especially on entitlements, or on reaching an agreement on raising revenues is less likely than we previously assumed and will remain a contentious and fitful process.

The political brinksmanship of recent months highlights what we see as America's governance and policymaking becoming less stable, less effective, and less predictable than what we previously believed. The statutory debt ceiling and the threat of default have become political bargaining chips in the debate over fiscal policy. Despite this year's wide-ranging debate, in our view, the differences between political parties have proven to be extraordinarily difficult to bridge, and, as we see it, the

resulting agreement fell well short of the comprehensive fiscal consolidation program that some proponents had envisaged until quite recently.

Our opinion is that elected officials remain wary of tackling the structural issues required to effectively address the rising U.S. public debt burden in a manner consistent with a 'AAA' rating and with 'AAA' rated sovereign peers. (p. 3)

Environmental factors are not listed in the S&P's rating criteria, nor are they included in the calculations of the scores that accompany them. Moreover, S&P did not list environmental factors in its rationale for downgrading the U.S.'s score. This paper speculates, however, that environmental factors including oil consumption, CO<sub>2</sub> emissions per capita, and the return on investment that a nation receives for its pollution output (annual GDP/annual CO<sub>2</sub> emissions) may potentially act as early-indicators of economic weaknesses that could lead to a nation's credit downgrade. This analysis further posits that if analysts observe changes in these environmental indicators early enough they could work to avoid or minimize the economic challenges they portend. These speculations are highlighted by the fact that the U.S. was not the worst economic performer in the AAA+ cohort when its score was downgraded by S&P. It was however, among the least efficient performers in the cohort in terms of these environmental factors and therefore it is valid to suggest that economists look beyond conventional economic indicators in their attempts to understand economic performance and predict credit downgrades.

## 2. THE INTERDEPENDENCE OF NATIONAL ECONOMIES, NATURAL RESOURCE CONSUMPTION AND SOVEREIGN DEBT

Researchers from environmental and economic disciplines have documented the rise and fall of economies at various scales alongside corresponding shifts in patterns of natural resource extraction and consumption (Behrens *et al.*, 2007; Isham *et al.*, 2005; Stiglitz, 1974). Pearce and Turner (1990) provide an excellent summary of the variety of paradigms through which ecologists and economists explore the interdependence of environmental resource use and economics, as well as a summary of research that supports theory development in this arena, in their book *Economics of Natural Resources and the Environment*. Murphy and Hall (2011) document the relationships between economic growth and the consumption of oil, and in doing so highlight the economic growth paradox that underlies much of environmental economics. That is, that working to increase supplies of natural resources, especially fossil fuels, will result in higher prices for those resources that, in turn, undermine economic growth. Furthermore, theorists working at the intersection of the environment and economy do not suggest that economic growth is caused by the consumption of natural resources (Cleveland *et al.*, 2000) but rather hint that natural resources

1 Countries holding the S&P AAA+ rating on August 4, 2011: Austria, Australia, Canada, Denmark, Finland, France, Germany, Guernsey, Hong Kong, Isle of Man, Lichtenstein, Luxembourg, Netherlands, Norway, Singapore, Sweden, Switzerland, United Kingdom, United States. Data taken from S&P Sovereign Ratings List, <http://www.standardandpoors.com/ratings/sovereigns/ratings-list/en/us/?sectorName=Governments&subSectorCode=39&start=100&range=50>. (Accessed September 30, 2011).

2 Definitions and descriptions of each criterion, and the variables used to calculate a nation's scores, can be found in *Sovereign Government Rating Methodology And Assumptions* (S&P, 2011 June 30).

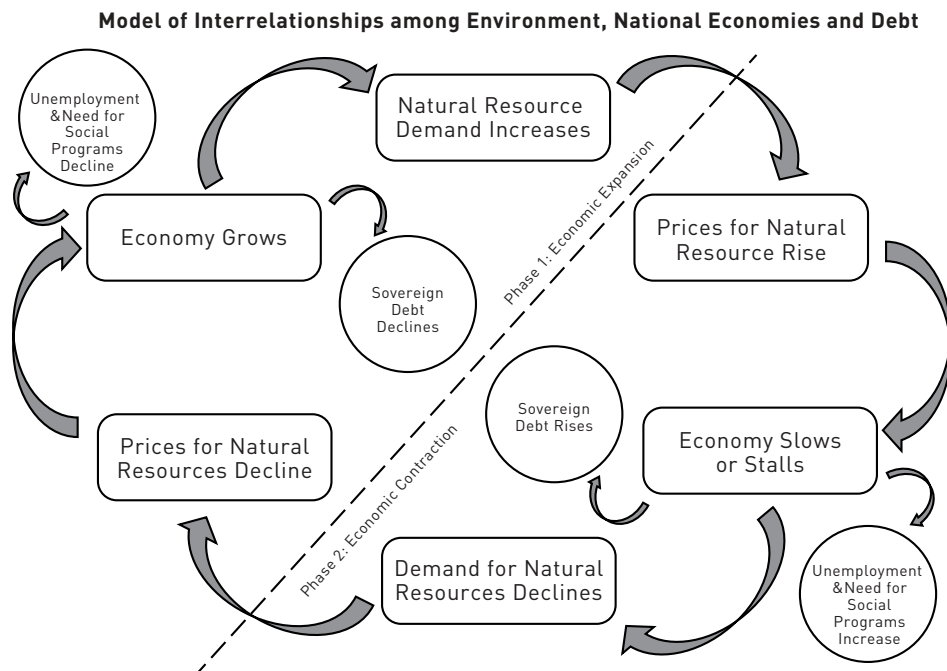


Figure 1. Model of Interrelationships among Environment, National Economies and Sovereign Debt. [Adapted from Murphy and Hall, 2011.]

are more likely a “limiting factor” (Stern, 2000, p. 281) in economic development.

Generally speaking, speculation regarding the relationships between natural resource consumption and economic performance goes something like this: demand for consumer goods drives production. Production is fueled by natural resources. When natural resources are readily available they are inexpensive and manufacturing is cheap. Subsequently, the consumer goods that manufacturers produce are also inexpensive. As a result, demand rises. As production increases to meet demand, the need for natural resources also rises. There follows a corresponding increase in employment in the manufacturing and natural resource sectors. Consequently, government revenues from taxes on the development, sales and profits of natural resources and consumer goods increase and progressive nations are better able to balance their budgets, reduce debt, build surplus cash and develop social programs.

Continued speculation suggests, however, that eventually supplies of natural resources are diminished because industries cannot keep up with demand or resources are no longer available. As inventories of raw materials decline, prices rise. Consequently, prices for consumer goods increase. As prices rise, demand decreases and production slows. Employment levels in natural resource and manufacturing sectors fall accordingly, as do government revenues. As tax revenues

decline, and unemployment rises, the need for government services to support citizens increases. National budget surpluses devolve into deficits and debts rise as governments adjust to citizens’ increasing need for assistance. This cycle is illustrated in Figure 1 (adapted from Murphy and Hall, 2011).

The cycles and feedback loops included in this storyline are difficult to test, and causes and effects are hard to distinguish. Indeed, an observer can begin observing the cycle at any point in the diagram and conclude that all subsequent changes are the result of their initial observation. Put simply, each phase of the cycle can represent a chicken or an egg, depending on the observer’s perspective. Yet, this framing aligns with that provided by Murphy and Hall (2011) and is supported by recent data from the United States.

For example, from 2001-2011 the average price of a gallon of unleaded gasoline in the U.S. rose 110% while the cost of a gallon of fuel oil rose 126%<sup>3</sup>. Consumption of oil decreased by 26% over that span<sup>4</sup>. Simultaneously, the production of and demand for consumer goods declined over that period. Production of durable goods remained stagnant from 2001-2011 (U.S. Department of Commerce, 2001; 2011) and the rate of consumer purchasing from 2001-2009 fell by 10% from the previous decade<sup>5</sup>. Unemployment during that time rose as firms adjusted to the new market. From 2000-2010, unemployment in the U.S. grew by 140%<sup>6</sup>. Likewise, federal revenues

3 United States Bureau of Labor Statistics, Databases, Tables and Calculators by Subject. Consumer Price Index, Average Price Data: Gallon of Gasoline. <http://data.bls.gov/cgi-bin/surveymost>. [Accessed September 29, 2011].

4 U.S. Energy Information Administration, *International Energy Statistics*. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>. [Accessed September 20, 2011]

5 United States Bureau of Labor Statistics, Consumer Expenditure Surveys. Archived expenditure tables for 1990, 2000, 2001 and 2009. <http://www.bls.gov/cex/csx-stdn.htm>. [Accessed September 29, 2011.]

6 United States Bureau of Labor Statistics, Databases, Tables and Calculators by Subject. Labor Force Statistics from the Current Population Survey: Unemployment Rate. <http://data.bls.gov/pdq/SurveyOutputServlet>. [Accessed September 29, 2011].

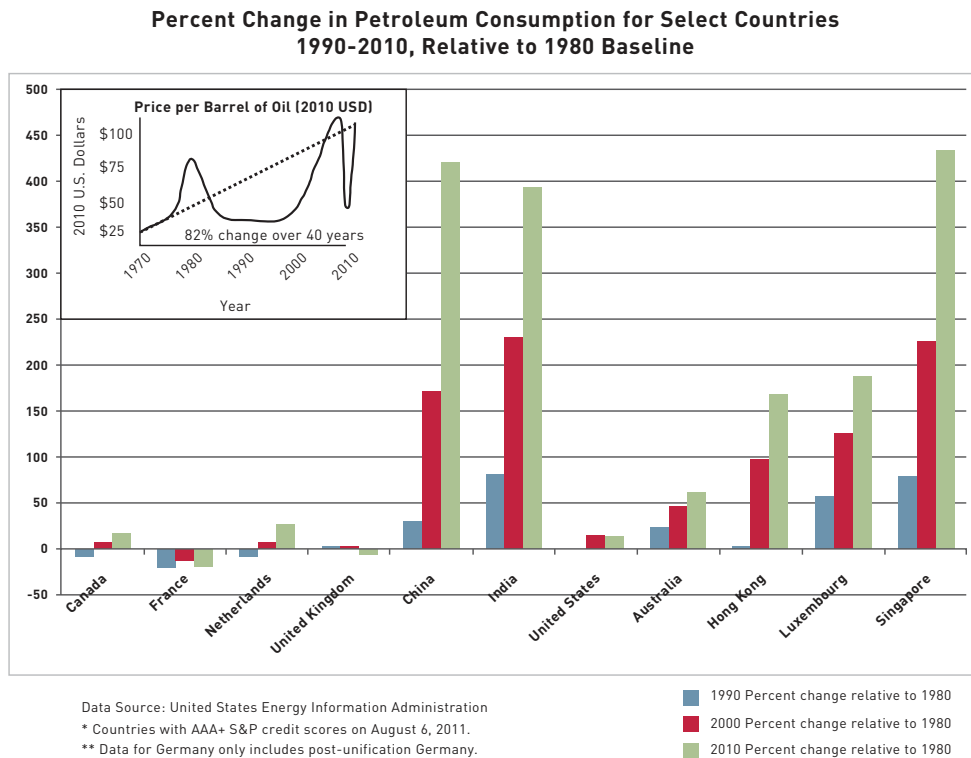


Figure 2. Many AAA+ countries have reduced oil consumption as prices, and competition from other countries, rise. While the U.S.'s consumption over the 30 year span climbed by 12% it has slowed in the past decade.

decreased by nearly 30% from 2000-2011, while the number of families applying for federal temporary financial assistance increased by 20%<sup>7</sup> [U.S. Congressional Budget Office, 2010].

The general relationships outlined in this framing and in Figure 1 also hold for the group of nations receiving the S&P's highest credit rating. Throughout the 20<sup>th</sup> century these nations enjoyed a lightly competitive market for oil, coal, natural gas and other raw ingredients and, as a result, consumed more than their share of the world's natural capital. The AAA+ cohort consistently accounted for approximately 40% of global oil consumption throughout the 1980s and 90s<sup>8</sup>. Speculation that the economies of the AAA+ countries thrived from the conversion of natural goods into material goods because prices for raw materials remained low throughout much of the 20<sup>th</sup> century is justified. Collectively, and as a result, the Gross Domestic Products (GDP) of the AAA+ cohort comprise nearly 30% of the Gross World Product<sup>9</sup>.

At the onset of the new millennium however, the economies of these nations transitioned into the second phase of the economic cycle: the portion that includes economic contraction, rising unemployment and mounting debt. At the tail end of the 20<sup>th</sup> century, international markets began experiencing a rise in competition for natural materials, as China, India and other rapidly developing countries joined in the race to experience the growth of wealthier economies

(Figure 2). The market for natural resources quickly became more competitive and prices rose (Figure 2 insert). It stands to reason that in a world where cheap raw ingredients are suddenly less available, the economies of nations dependent on those materials will shrink, and debts will rise, until alternative sources are available at relevant scales.

Under these conditions it should not be surprising that national economies heavily reliant on cheap natural capital will contract as they progress through a period of adjustment and transition while searching for new sources. Many nations once considered the *crème de la crème* of financial security now face enormous fiscal challenges. Several national governments on the AAA+ list are proposing austerity measures and several face social movements that identify economic challenges among participants' core concerns.

It is not yet known if well-off countries, at the end of the adjustment and transition period, will rebound to their previous patterns and levels of economic activity or if those nations will find themselves living in a new normal, where the growth they once knew is a thing of the past. Given the United States' position as the world's leading consumer and purchaser of fossil fuels, it is reasonable to suggest that the nation was the first to have its credit score downgraded and first to require major economic adjustments because it is the most sensitive to changes in these markets.

7 U.S. Department of Health and Human Services, Administration for Children and Families. Office of Family Assistance. TANF Applications Data and Reports, 2000 and 2010. <http://www.acf.hhs.gov/programs/ofa/data-reports/caseload/applications/application.html>. [Accessed September 29, 2011].

8 U.S. Energy Information Administration website, see footnote 4.

9 Central Intelligence Agency, *The World Factbook*. <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2079rank.html>. [Accessed September 20, 2011].



It is important to note that the environmental and economic relationships outlined here do not occur in a vacuum. Many factors outside of those included in these data and Figure 1 influence national economies. These factors could include national and international politics, the development of new technologies or natural disasters, among others. For example, oil prices and consumption patterns in the U.S. changed in the aftermath of the Arab Oil Embargo of 1973, development of deep water oil drilling technologies in the 1980s and Hurricane Katrina in 2005. It is beyond the scope of this speculative article to spell out these links explicitly, but within its objectives to show that when developing economic policies, nations must consider their relationship to the environment, and patterns of natural resource use.

If it is within the objectives of national governments to maintain economic stability and growth, then national leaders must examine indicators of economic change that allow for early forecasting of economic challenges. Environmental indicators may supply some of those tools. If national leaders limit their tools for forecasting economic difficulties to levels of debt, deficit and unemployment, or ratios of income to expenditures (among other conventional financial indicators), it is possible that economic challenges have progressed past the point that effective mitigation tools are available. Environmental factors, on the other hand, may provide warning far enough in advance to provide time and flexibility for mitigation strategies to be effective at minimizing the impacts of economic challenges.

### 3. EXPLORING THE POSSIBILITIES FOR USING ENVIRONMENTAL INDICATORS TO PREDICT ECONOMIC PERFORMANCE AT THE NATIONAL LEVEL

If the relationships among environmental resource use, economic success at the national level, and debt are accurate, it is conceivable that a nation's future economic performance could be predicted by examining indicators of environmental change. Perhaps the current financial difficulties the U.S. faces, and the credit downgrade, could have been foreseen by observing changes in the patterns of extraction and consumption of natural resources—more specifically, fossil fuels—at the national level.

The United States is the world's largest consumer of oil, accounting for nearly one quarter of global consumption<sup>10</sup>. At the same time, the United States only produces 12% of its energy from renewable sources (U.S. Energy Information Administration, 2011). When national CO<sub>2</sub> emissions are examined on a per capita basis, citizens from the U.S. emit approximately 18.0 million metric tons per person each year. This places the U.S. third from the bottom among other nations in the AAA+ cohort. Furthermore, the U.S. is among the least efficient in the AAA+ cohort at converting fossil fuels into dollars. The United States only generates 2.58 million dollars

of gross domestic product for every million metric tons of CO<sub>2</sub> it emits. This economic gain amounts to only 25% of the return on investment gained by Norway and Switzerland, the most efficient countries holding the AAA+ rating.

The questions this article ponders are: could these factors indicate economic inefficiencies that lead to the development of major financial challenges and subsequent credit downgrades and, if so, could they predict financial challenges before conventional financial indicators such as debt and deficit levels? If so, what might changes in these indicators portend for the economies of the future? If analysts are to use environmental indicators like those outlined for the U.S., what shifts in resource use patterns might they look for to predict stronger economic performances?

In the case of the U.S., a decrease in the ratio of energy produced from the combustion of fossil fuels to renewable sources could indicate more stable energy supplies and prices. It is unlikely that renewable resource prices will fluctuate in response to national or international political developments with the same volatility as non-renewable fossil fuels. Additionally, reducing per capita CO<sub>2</sub> emissions while increasing the return on investment gained from the combustion of fossil fuels could indicate increasing technological efficiencies and declines in the production of waste energy. Each of these shifts points toward more stable economies that support continued growth opportunities. If early warnings provided by environmental indicators are observed, perhaps the time that national economies spend in economic contraction (Figure 1) can be reduced. If economies can be completely decoupled from fossil fuels perhaps this phase can be eliminated altogether.

Framing the reduction of the U.S.'s credit score from an environmental perspective, and accepting the validity of using environmental indicators as predictors of financial challenges, suggests the downgrade of the U.S.'s credit score can be seen as a bellwether for what may befall many nations with financial systems based upon cheap non-renewable resources. When seen in this context, nations like Canada, Australia, Luxembourg, Hong Kong and Singapore should heed the alarm and quickly and proactively launch nationwide programs that incentivize the conversion of their economies to renewable energy sources or risk a downgrade of their own (Figure 3). These countries illustrate inefficient consumption patterns similar to those in the U.S. For instance, Singapore, Australia and Luxembourg each emit more carbon per capita than the U.S.; Canada is close behind. Likewise, Hong Kong, Canada and Singapore generate less revenue per million metric tons of CO<sub>2</sub> emitted than the U.S. The Netherlands, which is nearly as inefficient as these countries, may also be at risk.

These data do not present all of the environmental indicators that might be useful to forecasters working to predict economic changes. Other indicators may be the erosion

10 U.S. Energy Information Administration website, see footnote 4.

Efficiency of S&P AAA+ Countries on August 4, 2011 and Likelihood of Credit Downgrade					
S&P AAA+ countries August 4, 2011	Percent of World Petroleum Consumption*	CO2**/capita	GDP*** /CO2**	National Internal Debt as Percentage of GDP	Credit Downgrade Threat Level Under Hypothesis of this Paper
Canada	2.54%	16.05	2.27	84%	●
Austria	.32%	8.66	5.23	71%	●
Denmark	.19%	9.01	5.85	43%	●
Finland	.25%	9.84	4.48	48%	●
France	2.14%	6.34	6.30	82%	●
Germany	2.87%	9.34	4.00	83%	●
Luxembourg	.07%	21.16	4.40	15%	●
Netherlands	1.16	15.09	2.98	63%	●
Norway	.25%	8.25	8.61	49%	●
Sweden	.40%	5.44	7.10	40%	●
Switzerland	.28%	5.87	9.87	39%	●
United Kingdom	1.86%	8.41	3.86	76%	●
Australia	1.10%	19.07	1.81	27%	●
Hong Kong	.38%	12.47	2.36	17%	●
Singapore****	1.24%	30.66	1.13	106%	●
United States***	22.00%	17.68	2.58	62%	Downgraded August 5, 2011

Data sources: Consumption and emissions data from United States Energy Information Administration. All data for 2010. GDP data from Central Intelligence Agency. All data for 2011.

\*Petroleum Consumption in thousands of barrels per day.

\*\*CO2 emissions measured in million metric tons.

\*\*\* Measured in current prices, USD, millions of dollars.

Figure 3. More credit downgrades are predicted for AAA+ countries that use resources as inefficiently as the U.S.

of biodiversity, depletion of fisheries, desertification, ozone depletion, interference in chemical and biological processes such as nutrient, phosphorous and nitrogen cycles, consumption of additional non-renewable resources such as minerals and rare earth elements, reductions in water quality and quantity, and air pollution for example. Certainly further research is needed in this area. The objective of this article is to make the point that the earlier analysts can predict economic challenges, the more time and flexibility our leaders have to correct them.

#### 4. A NEW CRYSTAL BALL: REFRAMING ECONOMIC FORECASTING TO INCLUDE ENVIRONMENTAL INDICATORS

Discussions of economic policies at the national level in the U.S. focus on conventional financial factors such as debt levels, unemployment statistics and ratios of revenues to expenditures on entitlements. The S&P report *United States of*

*America Long-term Rating Lowered to 'AA+' on Political Risks and Rising Debt Burden; Outlook Negative* (2011, August 5), symbolizes the dominance of this framing. Reliance on conventional indicators however, limits the nation's ability to foresee and respond to economic challenges because once changes in economic factors are observed it is too late to implement mitigation measures. The intractable conflict of the bi-partisan congressional committee created by President Obama to identify debt reduction strategies exemplifies this point (Lowery and Pear, 2011). One reason that the committee may have stalled could be that it has not been successful at reframing its discussion of economic solutions beyond the debate concerning tax increases and spending cuts that have plagued nearly all previous attempts to solve the current debt crisis.

Additionally, limiting the indicators used to forecast change to those most common to the field of economics limits the national discussion of economic policy alternatives because





these signals fail to recognize the environmental context in which the nation's economy is embedded. Reframing the challenge in environmental terms means viewing mounting debt as a symptom of the instability and vulnerability that accompanies the nation's reliance on cheap natural resources, and then tackling economic troubles by addressing consumption habits. Decision makers can try to stop the bleeding with stimulus packages, tax increases and cuts, or reductions in expenditures and other economic interventions, but these policies are likely to fall short of bringing about a revolution in the ways that our economy interacts with the natural world and, as a result, the U.S.'s deficit and debt will continue to grow.

There are many things the U.S., and other nations, could do to transition its crystal ball for forecasting economic challenges to a broader array of tools with early warning capabilities. For example, many of the Environmental Protection Agency's (EPA) current reporting requirements for industrial firms with pollution permits, such as the National Pollution Discharge Elimination System and National Ambient Air Quality Standards program, monitor pollution levels to observe public health threats and violations of laws. At their core, however, these programs assume a certain level of pollution is necessary and accept pollution as a byproduct of industrial production processes. If monitoring programs and agencies such as the EPA reframe their views of pollution to see it as a sign of inefficient industrial processes, toxic water and smog could be seen as a drag on the nation's economy rather than a required component of it. As an indicator of economic changes, the EPA could track fluctuations in pollution levels and see rising levels as a sign of economic inefficiency and that impending economic troubles may loom.

Likewise, the U.S. Fish and Wildlife Service (FWS), the agency responsible for protecting threatened and endangered species, could look at trends in the collective populations of listed species across the nation and view declining populations as withdrawals on our national endowment of natural capital. Endowments are intended to provide capital interest for funding programs, but the principal should not be tapped. Declines in biodiversity could be viewed as dipping into the principal of our natural endowment. The FWS could track the populations of keystone species and species sensitive to environmental changes and view declines in their populations as signs that the repercussions of economic development are insidiously drawing down our national endowment of natural capital, threatening the nest egg of future generations of Americans.

The United States could also learn to view subsidies and tax breaks to industries involved in natural resource extraction as signs of unsustainable business models. Decision makers can remove perverse incentives encouraging the purchase of these products and, in turn, reduce consumption habits. Extractive industries would be forced to modify their business models to more sustainable approaches. Cash used to prop up unsustainable industries could be diverted to paying down

debt. Cabinet agencies such as the Department of Commerce and U.S. Treasury could track rising spending on subsidies and lost revenues from tax breaks, and view these changes as signs of declining economic performance.

Finally, the United States could modify its calculations of GDP to include resources spent on environmental regulation and clean-up as losses. This would mean subtracting the budgets of agencies such as the EPA and FWS, as well as private funds spent on environmental clean-up like that spent by BP following the 2010 Gulf Oil Spill, from the national indicator of economic growth. As environmental degradation increases, the costs of regulation and clean-up would also rise. Increasing clean-up and regulatory costs would be felt as an increasing weight on the economy and signify inefficiencies that could be mitigated through proactive measures.

These possibilities represent just some of the ways that environmental factors could be used to signify changes in economic performance at the national level prior to observing changes in employment statistics, debt and deficit levels. Each needs further research to understand the specific mechanisms by which they may interact with the economy. Additionally, as policy proposals, they may bear unintended consequences that should be addressed.

Finally, the agencies responsible for awarding national credit scores could include environmental factors in their rating criteria. The S&P includes five criteria in its rating system, but none explores a nation's environmental record. Economic and environmental researchers have shown that linkages between the environment and economy are supported by data, and therefore integrating environmental criteria into credit scores is justified. If environmental criteria were included in the S&P's rating system, perhaps the agency's decision regarding the U.S. would have occurred sooner and allowed more time for adjustment. Furthermore, perhaps other countries with similar inefficiencies to the U.S. would take note and modify their use of natural resources as a result. Currently, the policy interventions available to nations experiencing financial difficulties are limited because the criteria under which national economies are evaluated frame policy discourse to a limited set of solutions. Expanding the current evaluation criteria to include environmental factors would broaden the array of tools available to a nation for managing its economy in ways that may allow for more creative and comprehensive problem solving.

## 5. CONCLUSION

This article speculates on the usefulness of environmental factors as indicators of impending economic changes and changes to national credit ratings from credit scoring firms such as S&P. The article uses economic factors including national levels of oil consumption, per capita CO<sub>2</sub> emissions and the return on investment a nation receives for its pollution out-



put (annual GDP/annual CO<sub>2</sub> emissions) to predict credit downgrades for countries receiving the S&P's highest rating, AAA+.

The article is speculative in intention and nature and more research concerning how environmental factors might be used as indicators of economic change should be performed. Areas for future research might be in the identification of additional environmental factors that hold predictive capabilities for environmental change. Environmental factors that might be considered are the loss of biodiversity, disruption of nutrient and chemical cycles such as carbon and nitrogen cycles, and changes in air and water quality, among others. Further research should also explore the contextual factors unique to the economies of a broad array of nations to identify indicators that are specific to national conditions and generalizable across a broad array of nations. Research into the development of an environmental scorecard that could be used to inform the credit scoring processes used by international credit rating bureaus could help these agencies make accurate and proactive evaluations of the nations they assess. Lastly, this article predicts credit downgrades for several countries currently holding the S&P's AAA+ rating. Follow-up research to see if the predicted downgrades ring true will help gauge the validity of using the environmental factors identified in this report as indicators of economic performance.

A final lesson that the S&P credit downgrade incident teaches is that environmental professionals need to work harder to identify ecological factors that might signify looming economic threats. Simultaneously, economists should work equally hard to identify economic indicators of environmental degradation. Integrating signs of change into the common research, monitoring and management strategies of both disciplines will allow for the early observation of events that signify looming threats to the environment and economy alike, and improve our understanding of the intersections of these interdependent disciplines. Achieving higher levels of understanding of the ways that the environment and economy are interconnected will allow decision makers to develop innovative, sustainable and proactive solutions to economic and environmental difficulties that minimize the social instability that often accompanies them.

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