World Economic Crises: Commodity Prices and Environmental Scarcity as Missing Links

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Abstract: This paper first shows that new structural changes in the world’s pattern of development have made demand for primary commodities more income elastic and their supply less price elastic. Thus the commodity price-economic growth links have become tighter than ever before. With this framework in mind we then focus on the potential effects of the financial crisis upon the environment and natural resources in the developing world. We find that the impact of the current crisis can exacerbate environmental and natural resource scarcities in the developing world, and thus may force a tightening of environmental policies over the long run in response to such degradation. This, in turn, may make the supply curve for basic commodities even steeper in the future, thus reinforcing the sensitivity of commodity prices to world economic growth and increasing potential instability in the global economy.
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I. Introduction

New structural factors have affected the emergence and unusual depth of the latest financial crisis and world recession of 2008-09: (1) the growing importance of highly populated countries, most prominently China and India awakening from centuries of economic lethargy, as engines of world growth and massive providers of industrial goods; (2) The increasing scarcity of the environment and certain natural resources which for the first time in history is beginning to be reckoned with in rich and poor countries. As discussed below, these structural changes have significantly tightened the links between world growth and commodity prices because growth has become more commodity-intensive, and the world commodity supply curve is becoming increasingly less elastic.

We focus on the likely effect of the financial crisis upon the commodity supply flexibility in the developing world, the main provider of such goods. We find that the impact of the current crisis is likely to exacerbate environmental scarcities in the developing world and may eventually force further tightening of environmental policies over the long run in response to such degradation. This, in turn, may make the commodity supply curve even steeper in the future thus reinforcing the sensitivity of commodity prices to world economic growth.

Given the great heterogeneity of developing countries in many respects, the impacts of the crisis are likely to vary dramatically across countries and across different types of environmental resources. Naturally it is impossible to capture in one initial review even a small fraction of the variety of potential effects of the crisis on developing countries. We thus choose to provide a taxonomical approach based on a number of key distinguishing conditions in terms of policies, natural resources and other country characteristics, which suggest potentially testable hypotheses about the direction and likely gravity of the environmental impacts of the crisis under a limited number of possible situations. Given that it is of course too early to have empirical evidence about the impact of the current...
crisis, we use two previous crisis episodes, the 1995 Mexico-originated Peso and the 1997-99 Asia crises, as empirical references.

Part II below provides an analysis of the current deep recession within the context of the new structural factors listed above. In Part III we provide the taxonomic analysis regarding the possible impact of the crisis on the environmental resources in the developing countries. We focus mainly on the potential impacts of the crisis on pollution, deforestation and on the extraction of natural resources especially of those situated in fragile environments. Part IV concludes.

II. A new economic order and the Great Recession

For much of the 20th Century persistent economic growth was the privilege of an exclusive club comprising no more than a fifth of the world population (which we henceforth call the “North”). As the North grew richer it experienced continuous structural change leading to an increasing “dematerialization” of its production (López and Stocking, 2009). The structure of GDP in the North became increasingly more focused on services and, in general, on activities that are human capital and high tech dependent while the resource-based and later most manufacturing sectors gradually shrunk as a share of total output. Figures 1 and 1A show the intensity of this process over the last half century in the USA as reflected by the persistent decline of the shares of both commodity outputs as well as of manufacturing output in total GDP. Production of manufacturing, agriculture, forestry, fishing and mining have dramatically reduced their combined participation in GDP from more than 40% in the early fifties to less than 20% in the early 2000s while the share of non-material output (i.e., services) has increased from 50% to more than 70% over the same period.

As Figure 1 also shows that dematerialization of production was not, however, matched by a dematerialization of consumption in the North. In fact, the share of services in total consumer expenditures has remained practically unchanged at about 25% over the same period. While some shifting in the structure of consumer demand away from certain commodities such as food products into services did take place, consumers in the USA
continued to expand their demands for industrial goods, especially durables, at a pace that often exceeded growth of per capita income.

The persistence of a high share of the material based consumption in the advanced countries is dramatically illustrated and in part explained by the evolution of certain important material components of consumption including average per capita residential house size and number of vehicles, as well as by the generation of household waste over time in the USA. As Figure 1B shows, over the last half a century the average house size more than tripled from 290 sq feet per capita in the 1950s to almost 1,000 sq. feet in the early 2000s; the number of passenger vehicle increased from 3.2 to almost 8.5 vehicles for every 10 persons over the same period while the average annual volume of municipal waste generation increased from 2.6 to 4.5 pounds per person over the period. These statistics are highly indicative of the heavy biases of consumption towards material goods over what could be regarded as less tangible but perhaps more sophisticated and “elevated” forms of consumption such as culture, education, and leisure.

This sharp divergence between structural change in domestic production and in consumption has meant that the North has become increasingly more reliant in the rest of the world (the “South”) as a supplier first of primary commodities and, especially over the last three decades, of manufacturing goods as well (Ghertner and Fripp, 2007). In fact, an examination of the evolution of trade flows clearly shows a rapid increase of net imports of primary products as well as of industrial goods over time which is consistent with the fact that the shifts in consumption towards services and away from material goods were much weaker than the structural change that took place in production towards dematerialization of output. Figures 2 and 3 illustrate this for the USA. Figure 2 shows the significant rise in the participation of imports of industrial goods in total US imports. Figure 3 shows the large increases in the imports of manufacturing and industrial goods as a proportion of US output. This is also true for most other commodities including metals (Figure 4). As can be seen in these figures, the rise of the imports of industrial and commodity goods has been particularly steep over the last two decades.

While at times the South was able to exhibit some modest growth, up until the last three or four decades most of the South could not sustain such growth for prolonged periods of time and thus became mainly a passive supplier of primary commodities to the North. As
the North increased its net demand for commodities the South was an effective supplier of them. The fact that the South had what until a few decades ago seemed almost boundless natural resources and imposed practically no effective environmental regulations limiting the heavy environmental damages entailed by their exploitation, combined with a slow expansion of its own domestic demand for commodities as a consequence of its relative stagnation, allowed the North to face stable and low commodity prices (Figure 5).

From colonial times the North had established efficient commodity-producing enclaves in the South keeping the markets in the North as their almost exclusive goal (de Janvry, 1975). The increasing demand for commodities from the North was matched by the continuous exploration and new Northern investments in the expansion of these enclave economies in the South. In a context of resource abundance and no effective regulations limiting the environmental damages causing resource extraction in the South, combined with continuous Northern investments in resource extraction in the South allowed the long run supply curve of commodities to be for a long time essentially flat (López and Stocking, 2009). That is, the world commodity supply exhibited almost infinite price elasticity. This meant that the North could grow with the luxury of constant and even at times declining commodity prices for many decades despite that its consumption patterns continued to be heavily dependent on material goods as opposed to services that ultimately imply a high if indirect commodity component.

As has been well documented by several studies, the commodity production enclaves established in the South by Northern investments spillover very little into the rest of the economies in the South, which meant that they played little role in promoting economic growth in the South (Prebisch, 1959; de Janvry, 1975; Weiskoff and Wolff, 1977). The South remained essentially stagnated thus exerting little pressure on commodity demand which, in turn, facilitated the stability of their prices. This process continued well into the second half of the twentieth Century (Sokoloff and Engerman, 2000; Acemoglu et. al. 2001; Khor, 2000).
**The emerging South**

**First, the “Little” Giants**

Things started to change in the 1970s with the emergence of a few countries in the South mainly in South East Asia which were able to rapidly grow for prolonged periods of time relying on an export-oriented strategy. The emergence of these little giants of manufacturing exports allowed the North to deepen its relative specialization in clean non-material outputs increasingly relying on the old South and new emerging industrializing countries (NIC) as steady suppliers of primary commodities and of industrial goods, respectively. While the NIC were able to grow very rapidly through a phenomenal increase of manufacturing exports to the North, their population was relatively small to have an impact on the world demand for primary commodities, including energy, metals and food commodities. This meant that the expansion of the NIC did not signify greater demand pressures on commodity prices, which as can be appreciated in Figure 5, remained essentially stable.

Thus, by the late 1980s the world had achieved a remarkable equilibrium: The North plus a few NIC were able to grow fast, the North on the basis of clean service oriented production which greatly facilitated its environmentally “sustainable” development at low cost, the NIC supplying the North an increasing portion of its growing industrial demands at low market prices albeit at great domestic environmental costs, and the still languishing old South supplying raw materials also at low prices but at the cost of a continuous erosion of its natural resources and environment\(^1\).

**Next, the “Real” Giants**

The 1990s brought even more dramatic change. The emergence of the new industrial giants (NIG) mainly China, India and a few other large initially poor countries able to grow at remarkably fast rates was in part a consequence of drastic policy reforms in these countries. Interestingly, the North started a dramatic reversal of its environmental degradation by the mid 1970s, which coincided with the emergence of the NIC as suppliers of dirty industrial goods at low costs. This process also coincides with the time when most of the modern environmental regulation in the North begun to be implemented. Perhaps increasingly stringent environmental regulation in the North was made politically acceptable precisely because of the rise of foreign dirty industrial good suppliers. López (2008) provides some evidence showing that one of the reasons why the North is able to enforce significant environmental regulation at a very low cost (estimated at less than 2% of GDP) is the emergence of the NIC and later of other big industrial suppliers which allowed the North to rapidly shift its production away from dirty industrial goods. This view is consistent with the econometric evidence provided by Levinson and Taylor (2008).
countries. These new policies included pro-market reforms, privatization of state enterprises, export promotion through exchange rate policies and other incentives, and weak environmental regulations which effectively meant the ability to grow with little environmental constraints. In addition, the success of these new policies was assured by the rapidly growing consumer demands of the North for industrial goods.

The NIG were as effective suppliers of industrial goods as the NIC but at a much greater scale. Industrial export-led growth allowed them to experience similar unprecedented economic growth for over two decades as the NIC did. Both the NIC and NIG based their development on the rapid expansion of industrial exports which was made possible by undervalued exchange rates\(^2\). This, in turn, meant enormous accumulation of foreign exchange which was recycled into the North, especially the USA and parts of Europe creating large current account deficits\(^3\). The large financial resources flowing into the North made possible low interest rates and a great availability of easy credit. In addition, the inflow of capital from both the NIG and oil exporters into the North contributed to a continuous appreciation of equities and real estate which prolonged the economic boom and financial bubble. This, in turn, fed a massive appetite in the North for more industrial imports from the emerging and prosperous NIG.

Again, a remarkable and seemingly self-sustained equilibrium was created: The NIG’s massive financial assets created by its industrial export success fed the North boom which, in turn, fuelled the continuous expansion of the NIG. In fact, the real annual GDP growth rates of China and India over the last three decades has been consistently above 8\%, more than three times faster than the growth rate in the advanced economies (Table 1). More importantly, the NIG became large contributors to world economic growth. They are estimated to have contributed more than US$ 350 billion to the annual growth of the world in the early 2000s. That is, more than a third of the total annual growth of the world estimated at about $1.1 trillion. As can be seen in Table 2, the participation of

\(^2\) According to Rodrik (2007), both China and India have not only had undervalued exchange rates over the last two decades but the degree of undervaluation has consistently increased over the period. Most of the NIC also based their industrial export take off on undervalued exchange rates although, unlike the NIG, in more recent periods some of them have allowed their real exchange rate to become less undervalued and even at times overvalued.

\(^3\) Germany and Japan-themselves large exporters of technologically sophisticated goods and services- were the exception. The large current account deficits that this process implied for the USA, UK and several other countries in the developed world did not happen in Japan and Germany.
China and India, at about $200 billion, constituted almost 20% of the total annual growth in the world in the 2000-07 period compared to only about 5% in the 1980s.

**Finally, Environmental-cum-Commodity Scarcity**

The new North-NIG boom equilibrium of the 1990s and early 2000s had one important difference to the early North-NIC equilibrium of the previous decades: the NIG constitute almost 50% of humanity compared to at most 5% of the NIC. That is, the emergence of the NIG brought about a dramatic expansion of the growth club and an important segment of the South became an important and rapidly growing consumer of energy and primary commodities. Persistent economic growth ceased to be exclusive to a small portion of humankind, and for the first time in history, benefits more than 50% of the world population.

The startling and persistent growth of the NIG brought about not only a drastic increase in the supply of industrial goods but also a dramatic increase in the NIG net demands for energy, food, and other raw materials. At first, since the NIG started from very low levels of consumption of such goods, their increased demand for these commodities had little consequence for world commodity markets. However, after a decade or so of 8-10% growth rates, the enormous population size of the NIG caused their demand for commodities to reach a sizable portion of the total world demand as evident today. Figures 6 to 8 illustrate the rapid increase in the level of consumption and share in total world consumption of energy as well as certain other commodities over the last two decades of China and India. In fact, by the year 2006 the share of China and India in the world’s total energy consumption had reached almost 20% and their combined share of agricultural commodities such as wheat was more than 25%. Figure 9 shows the rise in India’s and China’s Carbon Dioxide (CO2) emissions over the last 25 years whose combined share in total world emissions reached 25% in 2006.

By the early 2000s the share of the world commodity demand of the NIG became sufficiently large as a proportion of total world consumption to start having a significant effect on their market prices. This meant that fast NIG growth led to a run up on commodities with consequent drastic price increases. Continued rapid economic growth
in both the NIG and the North precipitated the drastic increases in oil and other commodity prices that had begun in 2002.

Environmental and natural resource scarcity, and some paradoxes

The increased connection between commodity demand and economic growth from the incorporation of the NIG into the growth club has happened at the time when natural resources in the South are becoming less abundant, and when the severe environmental consequences of the frenetic expansion of natural resource extraction and use are beginning to be taken seriously in the South. Even if the underground availability of many raw materials may still be plentiful, there are growing signs that their supply must rely in increasingly more expensive sources. More, resource extraction and use have led to massive environmental costs affecting crucial ecosystems including water quality, forests and many other increasingly scarce environments.

Under increasing pressures from international NGOs and parts of domestic civil society, including organizations of the communities most directly suffering the environmental costs caused by resource extraction, developing country governments are at last beginning to take into consideration some of these large environmental costs that commodity extraction entails. More countries are now enforcing at least some modest environmental regulation affecting the use of many ecosystems which tend to be destroyed by resource extraction due to spillover effects. These restrictions ultimately make the extraction of commodities more costly, even in cases where the under-ground availability of the resource good is still plenty.

This means that now, perhaps for the first time in history, the long run supply curve of resource commodities has become price-inelastic. This phenomenon, in conjunction with

\[4\] With some important exceptions, the real limits to the supply of primary commodities are not so much the scarcity of in-ground raw materials, but rather the large and increasing environmental costs that their production entails (Simpson, Toman, and Ayres, 2005). Resource extraction greatly affects water quality (mining, oil extraction), soils and forests (e.g., mountain top removal for coal extraction). The US could, for example, dramatically increase its oil production at the cost of unacceptable further environmental destruction by expanding off-shore or Alaskan production. The enthusiasm of the “drill baby” advocates in the USA which even reached the current administration must have at least cooled a bit in the face of the ongoing massive disaster caused by the off-shore drilling in the Gulf of Mexico. The oil spills in developing countries such as Nigeria reached almost legendary status in the 1980’s with some estimates suggesting one Exxon-Valdèz type of disaster every year.
the increased commodity demand associated with world economic growth explain the
unusual response of commodity prices to fast world growth observed over the 2000s. The
increased effect of world economic growth on commodity demand is likely to be
associated to the emergence of the NIG for at least two reasons: first, the emergence of
the NIG implies that the volume of new world output produced each year has increased
dramatically compared to earlier periods when growth was mainly restricted to a small
portion of the world population. Second, the fact that the NIG are still much poorer than
the advanced economies implies that their structure of production is much more material-
dependent than in the advanced countries. They are still at an earlier phase of
development meaning that GDP is mostly geared toward material and energy intensive
outputs. Thus, the new world growth has become bigger and more commodity and energy
intensive than in the decades prior to the emergence of the NIG. The world commodity
demand curve is now shifting upwards more rapidly over time at a time when world
commodity supply has become less price elastic. Hence, like never before it appears that
world economic growth and commodity prices are now intimately related. Below we
provide empirical evidence about this new phenomenon that has arisen especially over
the last decade.

The increasing growth-commodity price linkages in the 21st Century: Evidence

As shown by Figure 5A the booming times of the 2002-07 period were associated with
very rapid increases in the prices of almost all commodities including agriculture, oil, and
minerals. While commodity price upturns of similar magnitudes have taken place in
earlier times, this is probably the first time in recent history that the commodity price
increases were not associated with exogenous shocks such as wars, cartelization and
political conflicts. This time it appears to be purely an endogenous event associated with
the increased demand for commodities in turn caused by fast world growth. This is
consistent with the idea that world growth has recently become more dependent on
commodities and that the world commodity supply has become less price elastic.

In China, for example, the share of the service sector represents less than 30% of GDP (Farrell and Grant, 2005). Production was thus about 70% geared to energy-intensive and commodity-intensive material industrial goods and others.
The high degree of connection between commodity prices and economic growth in recent times is further confirmed by a more in-depth look at the growth and commodity prices data. Figure 5B shows the quarterly co-evolution of U.S. per capita GDP and world oil prices between the first quarter of the year 2000 and first quarter of 2010. As can be seen, the real price of oil has followed remarkably well the evolution of US per capita GDP. Both measures continuously and rapidly expanded between the last quarter of 2001 and the last quarter of 2007. The economic collapse between the first quarter of 2008 and first quarter of 2009 was associated with an almost equal collapse of oil prices and the subsequent economic recovery since the second quarter of 2009 has been concomitant with a vigorous recovery of oil prices. Moreover, the variations of the world oil price have been closely associated with similar trends in practically all other primary commodity prices. Also, the changes in U.S. GDP in turn are also quite closely correlated with world GDP changes. Thus we have a dramatic positive correlation between world GDP growth and the prices of most primary commodities during the whole decade. The estimated correlation coefficient is 0.87 and highly significant, which is the highest of any ten-year period since 1952.

*Implications for sustained economic growth*

This closed links between economic growth and commodity prices is a new phenomenon that possibly marks a new structural situation that may have dramatic implications regarding the capacity of the world to support steady rates of economic growth in the future. Sustaining economic growth with rising commodity prices is difficult for several reasons. The one that we emphasize here is the connection between rising commodity prices and inflation.

While the inflationary pressures of rising commodity prices may be small, even negligible, in the context of much slack affecting capital utilization as has been the case in the last few quarters this ceases to be the case when such slacks subside as economic

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6 It is remarkable that primary commodity prices so closely follow economic growth even over time intervals as short as quarters. This may suggest that traders have already incorporated into their expectations the fact that a close growth-commodity price link do exist. As soon as the quarterly growth rates are announced commodity prices are adjusted accordingly without waiting for the actual commodity demand effect to be materialized.
growth continues. Once capacity utilization rises the economy becomes increasingly more susceptible to cost pressures arising from continuously rising commodity prices. Thus persistent cost pressures coming from the commodity component of the consumer price index (CPI) which has a low direct weight but high indirect weight as a consequence of the large dependence of consumer expenditures on material goods shown earlier, eventually threaten the so-called core inflation targets. At this point central banks are forced to intervene leading to tight monetary policies and high interest rates. In economies affected by extremely large levels of both private and public debt as has been the case of most advanced economies, even a modest raise of interest rates are likely to have dramatic effects on the fiscal deficits and on household expenditures. This in turn forces a deceleration of economic growth or even negative growth rates.

Much has been made of the prevailing idea that modern economies are less dependent on energy and other primary commodities than in the past. As a consequence macroeconomists have been quick to dismiss any significant connection between inflation and commodity prices. However, while commodity prices have a low cost effect on the productive sector of advanced economies as a consequence of the increasing dematerialization of GDP shown earlier this is not the case for consumption. As shown in previous sections consumers even in rich countries have not embarked in a dematerializing of their consumption patterns in any significant way. Given that primary commodities are basically behind any material goods consumed this implies that the dependence of consumption expenditures on commodities is still very high once we account for both direct and indirect effects of commodity prices. This is reflected in consumer price indexes over the intermediate run once commodity price changes make their way into the prices of the large material component of the consumer budget.

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7 In fact the economy becomes vulnerable to any cost pressures, including labor costs, not just commodity prices. But what makes the commodity cost push more interesting and important is the fact that commodity prices tend, as we showed above, to respond quite rapidly to expanded growth while wages respond mainly when there is full employment or nearly so. As is well known full employment tends to be reached only after protracted periods of fast economic growth. That is, commodity price cost pressures in this new environment tend to manifest themselves well before wage cost pressures arise.

8 See López (2010) for a thorough study of the conditions that have led most advanced economies to these levels of debt. This study shows how the unprecedented concentration of wealth occurring over the last few decades is in a significant part responsible for such equally unprecedented levels of the household debt to income ratios.
Can technical change save the day?

The increasing scarcity of natural resources could in principle be in part off-set with the development of appropriate resource-saving new technologies. New technologies could soften the new tight connection between world economic growth and commodity prices. Paradoxically, sustained high, and for a period, increasing energy and other commodity prices are needed as a key incentive for technical change to be oriented towards the generation of such technologies. The low and stable commodity prices prevailing over most of the 20th Century directed R&D to produce new technologies that were generally capital and energy intensive as well as labor-saving. These new technologies were mostly intensive users of the cheapest factors of production, the environment and natural resources. While some internalization of the true cost of the environment was implemented in the North, environmental compliance costs are in fact extremely low even in the wealthiest countries and the low real prices of commodities during the Twentieth Century reduced incentives to produce technologies that were not commodity intensive.

The connection between commodity prices and the direction of technological change implies a classical coordination problem: Reducing the dependence of economic growth on natural resources and commodities needs high and for a while increasing commodity prices as a signal to the private sector to invest more on the generation of resource and environmentally-saving new technologies. However, as shown earlier increasing commodity prices make the world economies more inflation vulnerable by causing greater cost pressures that central banks need to combat via tighter monetary policies to prevent such cost pressures to become inflationary. That is, to prevent the increased commodity prices from spilling over into generalized price increases the monetary authority may face greater pressures to raise interest rates in booming periods than when commodity prices were not very responsive to world growth. Interest rates jump when higher commodity prices are seen to threaten the low inflation targets. This in turn reduces economic growth and given the currently high connection between growth and commodity prices, the latter fall quite rapidly as soon as world growth decelerates.

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9 As Partha Dasgupta has so eloquently described it, when market prices do not reflect the growing scarcity of the environment the new technologies can be expected to be rapacious in their use of natural resources (Dasgupta, 2005).

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Thus allowing increasing commodity prices to the extent needed to reduce the long run
dependence of world growth on commodities through the development of new resource-
saving technologies would trigger inflation in the context of an accommodative monetary
policy. But this is unacceptable for the North, so monetary policy is used to counter the
threat of inflation\(^\text{10}\). This in principle would not affect the relative price of commodities
while arresting inflationary pressures. However, because of the extreme dependence of
growth on easy credit, the tightening of money rapidly affect consumption which, in turn,
leads to slower or even negative growth. This, in turn, prevents commodity prices from
remaining high and thus cancels the long run incentives to generate commodity-saving
technical change.

III. The crisis and the developing countries

The impact of the crisis in the developing countries is likely to be dependent on certain
key factors. These factors are likely to determine the intensity of the recession as well as
the social and environmental impacts of the crisis in developing countries. The factors on
which we focus below include macroeconomic policies during the boom times prior to
the crisis, the stringency of environmental regulatory regimes, domestic policies in
response to the crisis, and country characteristics associated with factor endowments,
population density and poverty levels.

1. Macroeconomic policies prior to the crisis and the scope for green fiscal stimulus

Most economic crises emerge after periods of fast economic growth. The present crisis is
of course no exception as most developing countries enjoyed several years of rapid
growth in part triggered by a great expansion of commodity exports. In addition, some
countries especially middle income ones and the NIG greatly benefited as a consequence
of the rapid expansion of manufacturing exports. Also, part of the South was able to
attract unprecedented levels of both financial and non-financial foreign investment. The
export boom combined with the capital inflows generated plenty of foreign exchange
which in many cases effectively made the availability of foreign exchange non-binding as

\(^{10}\) The recent low interest rates are feasible in part as a consequence of the world crisis that reduced world
output for several quarters and thus induced lower commodity prices.
a constraint to economic activity. In addition, the export boom contributed to rapid increases in government tax revenues which gave governments plenty of flexibility on the expenditure side. In most cases the combination of export expansion, foreign capital inflows, and rapidly increasing fiscal expenditures, which the tax revenue bonanza permitted, led to high rates of economic growth.

Public savings
The extent to which the countries were able to speed up growth during boom times depended not only on the positioning of the countries to benefit out of the world expansion (types of exports goods, country attractiveness to foreign investors, and so forth) but also on certain key policies. Among them we want to emphasize one: the extent to which the government saved. Some countries were able to increase growth and even reduce poverty in the short run by spending most or all the additional revenues during the boom period in a myriad of programs and creating new social programs, many of which poorly designed. In several cases the government over shot expenditures by using the boom times as an opportunity to rapidly increase public debt.\textsuperscript{11}

Other countries, knowing that the boom would eventually subside, adopted a more cautious approach: they saved a significant part of the increased revenues by paying off existing public debt, increasing foreign exchange reserves and, in some cases, establishing important sovereign investment funds. The accumulation of public savings during the boom times let these countries to be better positioned to use countercyclical policies to face the subsequent crisis than those that did not save or even increased net public debt. That is, they were able to implement fiscal stimulus policies a la USA but financed not by increasing public debt as in the USA but by their own accumulated savings. Among countries that were able to increase public savings the most during the early 2000s boom times were China and Korea in Asia, and Chile and Mexico, in Latin America.

Countries that have saved during boom times may be able to increase social benefits and implement countercyclical pro-employment fiscal expenditure policies during the crisis.

\textsuperscript{11} Some of these countries instead wasted the additional revenues through increased inefficiency, corruption, and satisfying political clienteles.
That is, they can allow themselves to use temporary deficit-financed fiscal policy to stimulate the economy. By contrast, those countries such as Greece that did not save may instead be forced to use pro-cyclical policies which often imply cutting social services and reducing other fiscal expenditures during the crisis. These countries become dependent on IMF support which often imposes restrictive fiscal policies that may be inconsistent with fiscal stimulus. The unemployment and poverty impacts are likely to be magnified in the latter countries and mitigated in the former ones.

All this may imply very different impacts of the crisis for the poor and natural resources, especially those that are open access or semi-open access such as many tropical forests. Increased unemployment and poverty often leads to even greater pressures on such resources by subsistence producers as these resources constitute the ultimate welfare refuge for the poor. In addition, governments that failed to save during the expansive phase may be forced to promote the commercial exploitation of natural resources often at great environmental costs in desperate efforts to reduce the impact of the crisis. Thus, the pressures on natural resources during the crisis due to unemployment and poverty are likely to be more limited among countries that saved in boom times and are thus able to use fiscal stimulus, than for those that saved little.

**Exchange rates and the crisis**

A common effect of crises, especially in countries caught in a vulnerable position due to their past policies, is that their currencies get significantly devalued. Given the fact that most natural resource-intensive products are tradable, exchange rate devaluation often induces an expansion of commodity exports which, in turn, causes more pressure on natural resources. It is of course very hard to separate the effect of exchange rate devaluation from other factors that tend to change simultaneously with the exchange rate and hence it is very difficult to ascertain causality between exchange rate changes and

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\(^{12}\) Extreme opposite examples in Latin America are Chile and Venezuela. Chile’s net public liquid assets increased dramatically during the boom times. Net government foreign assets (foreign reserves plus sovereign fund holdings minus public debt) dramatically increased from less than 2% of GDP in 2000 to more than 30% of GDP by early 2009 (Chile, Central Bank). This was made possible mainly by the extraordinary high prices of copper, Chile’s main export commodity. By contrast, Venezuela saved little of the large oil revenues that it enjoyed over several years. Despite obtaining three times more revenues than Chile during the 2000-06 period, by 2006 the financial position of the Venezuelan public sector was quite precarious with net foreign public asset holdings equivalent to a negligible fraction of GDP (Venezuela, Central Bank).
natural resources. Several studies have at least empirically documented a consistent correlation between exchange rate devaluation and increased pressure on natural resources. Kaimowitz et al. (1999) shows that in Bolivia episodes of exchange rate devaluation have been linked to increased timber exports putting additional strain on natural forests. Similarly, Sunderlin et al. (2000) show that exchange rate devaluation in Cameroon has coincided with periods of increased pressure upon forests. In most cases exchange rate devaluation mainly mitigate declining world export prices so the net effect on domestic commodity prices, the key factor affecting resource exploitation, is ambiguous.

The crisis and budget choices

It has been argued that the crisis presents an opportunity for redressing fiscal budget policies in a way that could be beneficial for the environment (Barbier, 2009). There are two related issues to consider in this respect:

1) Environmentally perverse subsidies: Fuel subsidies, pesticide, water and fertilizer subsidies, as well as a plethora of other expenditures often constitute a heavy fiscal burden in developing countries. According to a recent study, annual fossil fuel subsidies in 20 developing countries reached $220 billion, about 1.5% of GDP and more than 5% of the total government expenditures (UNEP, 2008). The fiscal burden of environmentally perverse subsidies in many countries may become an even heavier fiscal burden in times of financial crises. This could in principle motivate their reduction or elimination leading to important environmental improvement and at the same time to a relief of the tighter fiscal conditions entailed by the crisis. Perhaps one could speculate that the incentives to remove environmentally perverse subsidies are even larger in countries that have failed to save during boom times and, hence, face worse fiscal conditions during the crisis. By contrast, countries that have saved often do not face such a pressing fiscal situation to justify the removal of such subsidies. But even in countries that suffer great losses of fiscal revenues and have no savings to complement them, vested political interest may be too powerful to allow the government to effectively cut costly and environmentally perverse subsidies.

The existing evidence regarding the 1997 Asia crisis- the only one for which there are studies that focus on environmental subsidy expenditures with sufficient detail- shows that most countries did not reduce perverse subsidies (Vincent et al., 2002; World Bank
1999). In Indonesia, for example, subsidies to gasoline more than doubled between the second quarter of 1997 and the last quarter of 1998. The total real budgetary outlays spent in input subsidies including fertilizers, fuels and others increased more than four fold during the same period (Figures 10 and 11). While the case of Indonesia might be particularly aberrant in this respect, it appears that few countries in Asia significantly reduced these subsidies during the crisis. Given that the current crisis may be deeper and have greater fiscal impacts than previous crises, it is possible that greater emphasis on subsidy removal (rather than merely on general fiscal restraint) by the international financial institutions could now be more successful in inducing such removal.

(2) Budgets and green fiscal stimulus: For the reasons discussed earlier overall government expenditures are likely to be drastically reduced in crisis times, at least among countries that had over expansive fiscal policies during the boom times. Budget choices are also likely to be affected. In general governments tend to cut mostly the so-called “discretionary expenditures”, that is those expenditures which are not protected by major interest lobbies. Often environmental protection expenditures fall among this category. Figure 12 and Table 3 show a significant reduction of environmental government expenditures in Indonesia after the Asia crisis. A study of the fiscal effects of the Asia crisis in four countries, Malaysia, Korea, Thailand and Indonesia, has shown that environmental expenditures as a share of total government spending fell significantly in three of them, the exception being Malaysia which kept the same low share (Table 4). That is, the effect of the Asia crisis on the environmental protection expenditures was magnified by a reallocation of fiscal spending against such expenditures.

In previous crises a pre-condition for IMF support to developing countries has been to reduce fiscal deficits (IMF, 2007). Thus, countries that did not build enough financial resources to implement counter-cyclical fiscal policies with their own resources were not able to do so. In past crises most developing countries have been unable to introduce significant counter cyclical fiscal policies and have cut environmental protection budgets (Vincent et.al. 2002). Without such changes, most of the countries that did not save enough in the boom times prior to the current crisis, apparently the majority of them, may not be able to access capital markets to finance fiscal stimulus of any significant magnitude
By contrast, countries that are able to finance their own fiscal stimulus may have the chance to include a green component in such stimulus, but most of them seem to have priorities other than the environment at this point. An additional issue is whether green expenditures can compete with other public expenditures such as infrastructure and other traditional programs in creating jobs.\textsuperscript{13} Still another issue is whether or not green expenditures can generate a sufficiently powerful political and ideological constituency. Traditional programs emphasizing infrastructure have powerful ideological support when it comes to fiscal stimulus\textsuperscript{14}.

A recent study by Khatiwada (2009) has looked at the composition of the stimulus spending packages in 10 advanced countries and 12 developing countries. Among the developing countries only China, Malaysia, Mexico, Argentina, Chile, Korea, Thailand, and The Philippines, have implemented significant fiscal stimulus, rescue packages of more than 2\% of GDP. These countries correspond more or less to countries that prior to the crisis had been able to accumulate enough fiscal surpluses to be able to finance significant rescue packages. China, a country that was able to save the most during the years prior to the crisis was also the one able to develop the largest fiscal stimulus package in the world by devoting more than 13\% of GDP to such purpose (more than twice the size of the US stimulus as a proportion of GDP). However, as Strand and Toman (2010) note, the definitions used by individual countries to account for the “green” components of these packages vary considerably and can include many activities in which environmental improvement (e.g. greater energy efficiency) is only a co-benefit of an otherwise desirable investment.

An important finding is that the share of new social spending and tax cuts in the total fiscal stimulus in the developing countries was only 9.8\% much lower than the 45\% among the advanced economies (Khatiwada, 2009). By contrast, the fiscal stimulus aimed at particular sectors or firms was 43.5\% in the developing countries, a much higher portion that the 37\% devoted to such purpose in the advanced countries considered. This

\textsuperscript{13} A recent paper by Strand and Toman (2010) indicates that the near-term employment impacts of many green investment programs are limited, especially those in renewable energy and energy-efficient heavy infrastructure which are fairly capital intensive.

\textsuperscript{14} Japan circa 1990s constitutes a dramatic example of a massive, single minded and ineffective expansion of fiscal expenditures in infrastructure as a means to mitigate what is by now a chronic crisis.
is important because most of these incentives were subsidies benefiting firms in the industrial sectors many of which are linked to the extraction of natural resources. That is, while these subsidies are not directly environmentally perverse, they can be environmentally detrimental especially given weak property rights and enforcement of regulations affecting environmental resources.

In some countries the stimulus package includes an increase of subsidies that can be considered environmentally perverse. In Mexico, for example, about 15% of the total stimulus money (an amount equivalent to 0.8% of GDP) was directed to furthering the subsidies to gasoline and other fuels. In Indonesia a significant part of the stimulus was devoted to finance voluntary transmigration programs from Java into areas less affected by unemployment, roughly corresponding to frontier areas. Migration into these areas is likely to further deforestation. Of all the developing countries only China includes an important component explicitly directed to environmental protection but, as Strand and Toman (2010) point out, the effective environmental protection component of these expenditures appears quite limited.

There are two implications that follow from this analysis: First, significant fiscal stimulus programs among developing countries have been developed mainly by countries that were able to finance such programs with their own resources such as China, Malaysia, Mexico, Chile and a few others. Fiscal stimulus however does not necessarily imply that it will be accompanied by a green stimulus and it appears that some countries have even used the opportunity to further expand subsidies that are deemed environmentally perverse.

Summary. The taxonomy separating countries that have saved and therefore can implement fiscal stimulus during the crisis financed out of their own savings versus countries that did not save and now face big fiscal deficits that they cannot finance with their own resources is a useful tool to direct policy advice and support. The emphasis on cutting environmentally perverse subsidies is more likely to be successful on the latter countries, while the emphasis on using part of the fiscal stimulus on green expenditures may have greater probability of success in the former countries, though the ultimate effects on the environment are uncertain and may be limited.
2. Regulatory frameworks for natural resources and the environment, and the impacts of the crisis

Among developing countries there are significant disparities in the scope of the regulatory framework and particularly in the extent by which it is enforced. A key issue is that countries with more effective environmental and natural resource regulations are able to impose binding constraints on pollution levels and natural resource degradation in normal circumstances, while in those without such effective regulation such constraints are not binding.

The pollution implications of the crisis can be opposite in the two cases. With more binding pollution constraints, a potential response to the crisis is a de facto relaxation of the enforcement of such constraints as a means to reduce costs for firms and mitigate the employment effects of the crisis. Thus, in that case we would have two opposite effects: the (contracting) output scale effect which reduces pollution, and the pollution intensity effect (i.e., the level of pollution per unit of output or consumption) that increases it. The net effect is ambiguous, but the point here is that it may be positive despite the decline in economic activity and employment. By contrast, in countries already without strongly binding pollution constraints, air and water pollution is likely to decline with economic activity because the scale effect may not be countered by a pollution intensity effect. That is, in this case we only have the scale effect of the crisis but not the pollution intensity effect as occurs in the countries that effectively regulate but respond to the crisis by relaxing environmental regulation.

Thus we have the following hypothesis: crises can tend to worsen pollution in countries that have more binding regulatory frameworks, if the constraints are weakened; while they tend to reduce pollution in countries where the regulatory framework is weak. Similar arguments can apply to natural resources where the role of regulation is to limit over-exploitation through, e.g. open access to forests for timber harvests. To be sure, empirical scrutiny of these hypotheses is complicated by the fact that countries rarely announce that they are de facto relaxing environmental and natural resource constraints as a crisis response. Moreover, for local air pollution in particular, impacts will occur through changes in the composition of output and fuel use, as well as through macro-
economic channels. In the next three sub-sections we consider some evidence bearing on these hypotheses, drawing on the experiences of the 1997 Asia-originated crisis and the 1995 Mexico-originated crisis. The goal is not to establish or refute the hypotheses indicated above, but rather to provide enough evidence to underscore the importance of their further study.

3. Pressures on forests and other rural natural resources

Forest and related ecosystems are affected by two types of forces which are likely to behave in opposite directions during crises: (i) pressures from the poor and subsistence producers. Forests are generally the last social protection against poverty. When poverty increases there are much greater pressures by subsistence producers on forests which may be translated into more deforestation and more forest burning. (ii) Pressures from the commercial interests. Forest clearing by large commercial interests linked to agriculture, mining or energy is likely to decline as the crisis reduces commodity prices and, therefore, diminishes the rate of return to such commercial operations.

Thus, while the net effect of the crisis on deforestation is in general ambiguous we can distinguish conditions under which the factors (i) and (ii) above are made weaker or stronger. The larger and poorer the country’s population, the more likely the subsistence forces of deforestation dominate the for-profit motives. That is, the more likely the crisis worsens deforestation and increase resource degradation. Studies using remote sensing and survey forest data have found that increasing poverty, especially in a context of high population density, intensifies forest pressures and increases deforestation (Deininger and Minten, 2002; Barbier, 2004). Similarly, a study by Kerr et.al (2004) found that in Costa Rica poorer areas are cleared more rapidly than richer areas suggesting that poverty increases deforestation and Son (2003) shows that poverty is a factor of deforestation in Vietnam.

Middle income, low population density countries

In countries where population density and poverty are low, effect (ii) (i.e., the commercial interest effect) may dominate. In middle income countries for example, it appears that crises in the past have reduced commercial resource extraction activities as
well as reduced agricultural expansion. A study by López and Galinato (2005) found that deforestation in Brazil— a middle income country with relatively low population density and moderate poverty levels— falls significantly during economic slowdowns. The main reason is the contraction of commercial agriculture that is often associated with declining commodity prices.

There are two main forces that may reduce the impact of the crisis on the profitability of domestic resource extraction activities: (a) Exchange rate devaluation. An important effect of the crises is that developing country currencies suffer significant devaluations. Since most primary commodities are tradable currencies devaluation imply an incentive to expanding resource extraction especially by commercial interests. However, since in crisis time international commodity prices fall as a consequence of reduced demand for commodities from the developed world especially, the net effect on domestic commodity prices is ambiguous. The World Bank (1999) cites a vast literature showing that currency devaluation, ceteris paribus, increases deforestation and in general increases environmentally damaging resource extraction. However, their analysis of the 1997 Asia crisis also shows that the net effect of the crisis in some countries has been to negatively affect the profitability of logging as well as of other commercial resource extracting activities.

(b) Government subsidies. The fall in the profitability of resource extractive activities and hence the amelioration of forest pressure from commercial interests can also be mitigated by governments resorting to subsidies and other distortive policies to compensate commercial or for-profit natural resource enterprises for the fall in commodity prices. Ironically, these undesirable government subsidies may be more feasible in cases where governments have been able to save during the boom times as they will have more financial resources to implement such policies.

Exchange rate devaluation and governments’ subsidies fomenting resource extraction activities may at least partially mitigate the effect of the crisis on deforestation but these factors are rarely large enough to fully reverse the decrease in extractive commercial

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15 Arcand et. al. (2008) econometrically corroborates this finding using a pooled sample of 101 countries over a 25 year period. Wunder (2005) also finds that real exchange rate devaluation significantly increase deforestation by promoting greater timber exports.
activities caused by economic slowdowns (López and Galinato, 2005). That is, the net effect of the crisis is likely to reduce deforestation and forest carbon emissions during crisis times in middle income countries with lower population densities such as Perú, Brazil or Chile. Brazil appears to have a pro-cyclical pattern of deforestation: the high growth periods 1977-88 and 1993-94 coincide with high forest losses and deforestation has slowed down in periods of severe economic crises (Wunder, 2005). A reason for the reduction of deforestation during economic crises is that public projects such as road building and dam construction have to be postponed and agricultural subsidies reduced as a consequence of the fiscal squeeze. This may be a typical pattern of middle income developing countries where most of the resource degradation is associated to commercial exploitation and only a minor part of it is due to subsistence activities by the poor.

**Poor, high population density countries**

Among the Asian countries on which we have focused poverty (poverty line: US$1.25 per day) affects a large portion of the population in India (44% of the rural population), China (26%), Indonesia (24%), The Philippines (23%) and Vietnam (21%)

\[16\] In addition some of these countries have a very high population density, most prominently India (305 habitants per square km), The Philippines (224) and Vietnam (219). One would thus predict that in countries that combine high poverty levels with dense populations such as these three the effect of the crisis could trigger very significant additional pressures on rural natural resources, including forest habitats, originated in subsistence households. Unfortunately there are not many aggregate studies on deforestation in Asia based on real data as opposed to the commonly used FAO data which is mostly based on interpolations. Below we provide case studies that illustrate the hypothesis that forest pressures increase in crisis times in poor, highly populated countries.

In general, most empirical studies have concluded that the Asia crisis has led to a drastic fall in economic activity in the urban economy which has been in part compensated by increased activity in rural areas. In part this is a spontaneous response of those becoming unemployed in urban areas which return to rural areas where they can subsist as self employed or temporary workers living with their extended families. This also responds to deliberate government policies which encourage greater access to natural resources.

\[16\] These data are circa 2005 taken from Chen and Ravallion (year and citation in bibliography missing).
including forest activities, mining and fishing during crisis times. For example, the share of the primary sectors in total GDP significantly increased during the crisis in Indonesia from 25% to 31%.

Below we focus on case studies using detailed forest and other country data particularly emphasizing the case of Indonesia. Indonesia is the most studied case and is the country where the impact of the crisis was strongest. According to Aswicahyono, Bird and Hill (2009) Indonesia suffered a 13% fall in GDP in 1998, by far the largest decrease among the four East Asia countries directly affected by the crisis. The focus on Indonesia is also convenient because, as discussed earlier, the magnitude of the current 2008 crisis is such that its impact on developing countries is likely to be greater than any previous crisis in modern times since the Great Depression. The size of the impact in the developing world is likely to be as large as or perhaps even worse than Indonesia 1998. For this reason the analysis of the Indonesia experience might be much more relevant to evaluate the possible future impact of the current crisis in poor developing countries than that of most other developing countries in previous crises.

Dauvergne (1999) concludes that the 1997 crisis in Indonesia caused a large expansion of agriculture associated with a significant increase in part-time agricultural workers. The same is true for mining; in 1997 there was a 25% increase in the total stock of existing contracts awarded by the government to mine gold, diamonds, coal, and nickel. The government also promoted the commercial fishing industry and illegal fishing by poor households increased dramatically. The author also documented that wildlife conservation suffered dramatically as a consequence of increased illegal hunting.

Sunderlin et.al. (2001) found that the crisis caused a large increase of forest clearing by commercial interest to expand exports of rubber and other tree crops. In addition the authors also found a notable increase in forest clearing by small holders. Pagiola (2001) reaches similar though more nuanced conclusions; deforestation did not increase homogeneously in all regions in Indonesia, and in fact in some areas deforestation may have fallen during the crisis. Gaveau et. al. (2009) using detailed survey data showed that the 1997-98 crisis caused a significant reversal in law enforcement efforts in the Indonesian area studied (Bukit Barisan Selatan). The authors highlight how the weakening of the environmental law enforcement in conjunction with the increases in
real domestic commodity prices caused significant losses of “protected” forests and biodiversity.

Thus, it appears that in the case of Indonesia the crisis caused a massive expansion of deforestation and resource extraction. Possible causes of this seemingly strong effect is that Indonesia, being at the epicenter of the crisis, was affected by a particularly large devaluation of its currency (Table 7) which allowed commercial resource extractive activities to increase its relative profitability, and increased pressures on forested areas by the large segment of the population that became subsistence producers.

The magnitude of the devaluation was such that it apparently more than offset the fall of international commodity prices leading to an increase in the domestic commodity prices and hence the profitability of commodity resource extraction. The effects of the crisis on resource extraction in other Asian countries, however, were not as severe as in Indonesia (The World Bank, 1999). Pagiola (2001) found that pressure on forests did not significantly increase in Thailand or the Philippines. We note, however, that since the effect of the crisis on the Philippines was relatively mild compared to the impact on Indonesia (Datt and Hoogeveen, 2003) the finding that forest pressures did not increase in this country might be simply due to the fact that the quantitative impact on forests was harder to identify.

Apart from the world commodity prices-cum-exchange rate devaluation factor there are other important factors that affect the impact of the crises on the natural resources. A crucial one is the public expenditure response to the crisis. A study by Vincent et. al. (2002) showed that the 1997-98 crisis resulted in drastic cuts in environmental protection expenditures in all East Asian countries directed by the crisis with the only exception of Malaysia. Also, Kittirapras (2002) reports deep cuts in both social services and environmental protection in Thailand during the crisis. In general the cuts were much deeper in rural environmental expenditures than in urban ones. This means that the impact of the crisis was even stronger in the mostly rural natural resources than in urban pollutants not only because of the reverse migration tendencies discussed earlier but also because environmental enforcement may have worsened more in rural than urban areas.
4. Global pollutants: greenhouse gases

At present, emissions of CO2 and other greenhouse gases are not subject to regulations in developing countries. Consistent with the hypothesis presented above, these emissions are likely to fall with the reduction of economic activity caused by crises, although under some conditions it is possible that a recession may induce changes in emissions due to shifts in the composition of fuel consumption if the crisis changes relative fuel prices. However, in countries with open-access or semi-open access forests, the crisis may induce increased deforestation and forest burning as noted above, and that is likely in turn to increase non-industrial carbon emissions. This mixed pattern of influences is reflected in the data.

5. Impacts on local air and water pollution

Table 5, reproduced from Esty and Porter (2001), shows an index of environmental regulatory strength for 71 countries of which about 50 are developing countries. The index is based on data for the late 1990s and thus relevant for the time frame we are considering. As can be seen, within the developing countries there are very large disparities in environmental regulatory effectiveness. For example, according to the index Uruguay is much closer to Japan than to the Philippines or the Dominican Republic in this respect. Among the countries that we analyze below we can distinguish Chile and Uruguay, and to a lesser extent Brazil, among those with the highest environmental effectiveness among developing countries; Korea, Malaysia, Thailand and China, with intermediate effectiveness; and Mexico, Argentina, India, the Philippines, Venezuela, Indonesia and Paraguay among those with the least effective environmental regulations. It is important to note that while most of the highest ranked countries correspond to high-income countries, the ranking is not completely driven by per capita income especially among developing countries. In fact, there are countries with similar per capita income (say Uruguay, Malaysia and Argentina) that are ranked very differently in terms of environmental regulations.

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17 For example, if coal becomes cheaper relative to oil, it is possible that the reduction of economic activity be accompanied by an increase in carbon emissions due to the fact that burning coal is generally much “dirtier” than burning oil.
18 Appendix B (located at: [http://faculty.arec.umd.edu/lopez/index.htm](http://faculty.arec.umd.edu/lopez/index.htm)) shows data on CO2 industrial emissions for some Asian and Latin American countries.
The hypothesis is corroborated by some micro case studies for water pollutants. For Indonesia, Afsah (1999) showed that while output of a large number of surveyed industrial plants declined by 18% during the 1997-98 crisis, water pollution due to organic waste in industrial effluents as measured by the biochemical oxygen demand (BOD) increased by 15%. This paper documents how environmental inspections declined during the crisis which in turn reduced abatement efforts by industrial plants. Similarly, Caffera (2005) documents how the political will to enforce environmental regulations in Uruguay in the aftermath of the Peso crisis was low. In fact during 1997-99 period the reported rate of violation of regulations was consistently above 40% and the number of fines imposed was extraordinarily low. In China, firms facing financial difficulties have greater bargaining power with regulators and pay smaller environmental fees (Dasgupta et.al., 2003). A study by Dauvergne (1999) shows a significant weakening of environmental enforcement in periods of slow growth in several East Asian countries.

Air pollution effects of the crisis: Strongly regulated versus weakly regulated countries

Air pollution concentration levels among countries vary quite significantly once we account for a per capita income norm. Table 6, also taken from Esty and Porter (2001), provides measures of the difference of sulfur dioxide (SO2) concentration between the actual and the expected levels obtained by using predictions based on regressing SO2 concentrations on per capita GDP for a large sample of developing and advanced countries19. As can be seen in Table 6, there are wide differences in this index as well. For example, India has concentrations below the per capita GDP norm, while China has concentrations well above the norm. Among the upper-middle-income countries, Chile has pollution levels below the norm while Mexico and Brazil widely exceed the norm. It is not clear whether or not the quality of the environmental regulatory framework explains a significant portion of the deviations from the norm, as there are other potentially important explanatory factors. For example, the significant differences in the

19 Throughout this discussion we use SO2 as a key indicator of air pollution because this is a pollutant for which data are available in many countries. It is often seen to be better measured than other pollutants, though the data do often reflect estimates based on emissions factors per unit of production rather than physical measurements.
speed of economic growth may explain why China is above the norm while India is below it, although China is ranked higher in the regulatory quality index. Over the 1990s China grew almost twice as fast as India. It is likely that the countries that grow very fast face serious difficulties in controlling pollution even if their regulatory framework is adequate.

In our sample of Latin American countries, those with the most effective environmental regulations, namely Chile, Uruguay and to some extent Brazil, appear to have increased SO2 emissions after the 1995 Mexico-originated crisis. Their emissions continued to increase all the way until 1999 when the Asia-originated crisis had subsided. Figure 13 shows the annual SO2 emissions for these countries: Prior to the 1995 Mexican peso crisis Chile had experienced negative rates of emission growth for almost 5 years despite rapid economic growth. This is an indication that its SO2 regulation controls were effective. However, starting in 1995, the first year in which the crisis took effect and continuing through 1999, emissions increased at a relatively fast pace. In 2000, once the effects of the two crises had passed, emissions began to decrease again. Emissions in Uruguay and Brazil, followed a similar path, i.e. pollution had been decreasing for some years prior to the peso crisis and then emission growth rates became positive over the crises years.

Thus, the cases of Chile, Uruguay and to some extent Brazil fit our prediction for countries that have effective regulations: During the crisis the regulations are relaxed, possibly as a deliberate effort to mitigate unemployment. In these cases the pollution intensity effect may dominate the potential output scale effects of the crisis. The patterns of pollution growth in Paraguay and Argentina, countries that have the least effective environmental regulation in the region, are quite different from Chile and Uruguay. In both cases the crises do not seem to have prompted significant increases in emissions.

The data for emissions in Asia show that SO2 concentrations fell significantly in most of the countries of the region, especially in 1998 and 1999, when the Asian crisis had its full impact (Figures 14 and 15). Given the magnitude of the crisis in most of these countries, it is possible that any potential pollution intensity effect in countries that had binding environmental regulation was dominated by a strong output contraction effect. In the case
of Korea, however, pollution concentrations continuously declined over the 1990s, and the effect of the crisis was a temporary interruption of the declining trend. This small and temporary change in trend in Korea contrasts with the more precipitous and longer lasting reductions of pollution in most of the other Asian countries that generally had weaker environmental regulation. According to Table 5, Korea had the highest ranking among Asian countries in the sample with respect to environmental regulatory effectiveness. One explanation then would be that the output effect dominated in other countries, while in Korea there may have been an effect from less vigorous implementation of environmental standards.\textsuperscript{20}

We have presented above some evidence based on case studies and aggregate data that one response to economic crises is to reduce environmental enforcement, when such regulations are initially binding. Where this occurs, it could be a deliberate decision by governments aimed at mitigating the effects of the crisis on production and employment. However, it could also be that environmental budgets are cut during crises as part of a more general reduction in discretionary government expenditures to offset shortfalls in public revenues. More research is needed to identify the strength of different explanations for the patterns observed.

This is especially true in the area of local air pollutants. We discussed above some evidence seeming to point in the direction of our hypothesis for SO2. However, other explanations can be identified based on changes in patterns of output and energy use prior to and during the crises that are not driven by regulatory practices.

### IV. Conclusion

Growing environmental scarcity is not entirely a new phenomenon despite that commodity prices only recently appear to have started to reflect it. In part because

\textsuperscript{20} Appendix A to the paper (available at: \url{http://faculty.arec.umd.edu/rlopez/index.htm}) shows the time trend of SO2 concentrations and the deviations from the trend in each year for several countries in Latin America and Asia. In general the figures show an important regularity: Countries which in the years prior to the crises experienced below trend concentrations tend to show above-trend rates during the crisis years (1995-99 for Latin America and 1997-99 for Asia). By contrast, in countries that were not implementing significant pollution controls prior to the crisis -which may include those where pollution was above the trend prior to the crisis- the output scale effect dominated and pollution rates fell below trend levels during the crisis.
commodity prices have not historically reflected this, ominous signs of environmental scarcity have been systematically and happily ignored by policy makers for several decades. In fact, while during the 20th Century the world supply of energy, agricultural goods, metals and other primary commodities has been amazingly responsive to rising commodity demand, the supply of these commodities has been increasingly reliant on more and more fragile ecosystems. With some important exceptions, the key underlying scarcity was not the exhaustion of raw materials underground but the increasing damage to ever more scarce ecosystems, over use and contamination of water resources, loss of biodiversity and the large emissions of climate change gases generated by the conversion of natural ecosystems to agriculture, petroleum exploitation, logging, mining and other resource extractive uses. Commodity supply appeared until recently to have been almost infinitely elastic because these ever increasing environmental costs have been allowed to be ignored by producers, especially, but not only, in developing countries.

It appears that this growing scarcity is finally beginning to be at least in part reckoned with, precisely at the time when world economic growth has become more commodity-intensive as a consequence of the awakening of the sleeping giant countries to the growth process and the lack of dematerialization of consumption in advances economies. The commodity supply curve has become steeper and demand shifts upwards more rapidly with growth. The result is obvious: Unlike in the times when growth was the privilege of an exclusive and small club, nowadays rapid world growth leads to increasing commodity prices. And increasing commodity prices are not consistent with price stability which forces monetary tightening when energy and other commodity prices rise in response to growth. This, in turn, tends to suffocate world economic growth making the world more crises prone.

The analysis of the natural environments in the South has shown that the impact of the current crisis is likely to degrade even more dramatically the environmental resources as a consequence of desperate efforts of some developing countries to mitigate at least in part the grave economic and social consequences of the crisis. This may exacerbate in an important way the underlying environmental long term resource scarcity in the South. It may compromise even further the ability of the South to respond to a growing demand for commodities in the future once economic growth reappears. The additional
environmental destruction that the crisis may create in parts of the South is likely to increase the damages so extensively that, once normal times return, governments will have even greater difficulties in ignoring demands to implement more serious environmental policies which in one way or another will have to consider restrictions on resource extraction. Thus, the increased environmental losses that the current crisis may trigger and the likely tightening of environmental policies over the long run that the growing scarcity of vital natural services may induce could make the commodity supply curve of commodities even steeper in the future. This may exacerbate the economic growth-commodity prices linkages over the medium term.

The key implication of this analysis is that sustaining positive rates of economic growth over the long run is likely to become more difficult than in the past. The irony of this is that this is in part the result of the fact that economic growth has become more inclusive, potentially accessible for the first time in history to the majority of the world population. Sustaining such inclusive economic growth may need, however, significant changes in the patterns of growth especially in the advanced countries. The increasing dematerialization of production in the advanced economies needs to be finally matched by a similar dematerialization of their consumption expenditures as well.

The prevailing incentives to continuous expansion of the consumption of material goods often supported by public policies that discriminate in favor of such consumption patterns must be ended (i.e., reduced taxes and more lenient environmental regulations benefiting the often monstrous so-called “sport utility vehicles” in the U.S.A. as well as certain tax policies that foment ever increasing housing size, and many others). Policies such as a carbon tax as well as several other consumption taxes that focus on material goods but exclude services would be steps in the right direction. A dematerialization of public expenditures by increasing the provision of public social goods including education, health, environmental protection, crime prevention, science and the arts, and concomitantly reducing the government’s provision of material goods (which are often a vehicle to subsidize the wealthier segments of society) would not only induce a lower material component of the aggregate demand but also would improve social equity.
References


Figure 1: Production of Services as % of GDP in the USA and Average Share of Household Expenditures on Services

Service expenditures are considered expenditures on Apparel Services, Healthcare, Entertainment, Personal Care, Reading and education, Religion and Charity and Miscellaneous
Production of Services consists of utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government.

Figure 1A: Sector composition of GDP in the USA

Source: US Bureau of Economic Analysis
Figure 1B. Evolution of selected material components of household consumption and consumers’ waste generation

SOURCES: For House Size: Median and Average Square Feet of Floor Area in New One-Family Houses Completed by Location (Medians and averages computed from unrounded figures), and U.S. Census Bureau, Current Population Reports. From Statistical Abstract of the United States, 2008; http://www.soflo.fau.edu/report/NAHBhousingfactsMarch2006.pdf
For Number of vehicles: US Department of Energy, Fact #577: June 29, 2009 Changes in Vehicles per Capita around the World
Figure 2: Share of Industrial Imports over Total Imports in the USA

Source: Bureau of Economic Analysis
Categories include: Fuel and lubricants, paper and paper base stocks, materials associated with nondurables, selected building materials, unfinished and finished metals associated with durables, nonmetals associated with durables.
Figure 3: Industrial and Manufacturing Imports over GDP in the USA

Source Feenstra et. al. (2001), http://www.internationaldata.org/

Categories Include: Mineral fuels, lubricants and related materials (3), chemicals and related products (5), manufactured goods (6), machinery and transport equipment (7), and other miscellaneous manufactured articles.
Figure 4: Metal Imports as a proportion of domestic production in the USA

Source: US Geological Survey
Components of the Producer Price Index for all commodities include:
Farm products, Processed foods and feeds, Textile products and apparel, Hides, skins, leather, and related products, Fuels and related products and power, Chemicals and allied products, Rubber and plastic products, Lumber and wood products, Pulp, paper, and allied products, Metals and metal products, Machinery and equipment, Furniture and household durables, Nonmetallic mineral products, Transportation equipment, and Miscellaneous products

Figure 5A. Prices of Primary Commodities in the 21st Century

Source:

Figure 5B. Real quarterly Oil Prices (deflated by US CPI) and real quarterly US GDP per capita (2000-2010)

Source:
Figure 6: China and India Energy Consumption and Share in World Consumption

Left Axis: Energy Consumption in Quadrillion Btu
Right Axis: % of Total World Consumption
Source: Energy Information Administration (EIA)
Figure 7: China and India Petroleum Consumption and Share in World Consumption

Right Axis: unit - % over World Consumption
Left Axis: unit – Thousands Barrels per day
Source: Energy Information Administration (EIA)
Figure 8: Wheat Consumption by India and China and Share in total World Consumption

Source: USDA
Figure 9: China and India Carbon Dioxide Emissions

Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels (Million Metric Tons of CO2)

Left Axis: Million Metric Tons of CO2
Right Axis: % of Total World CO2 Emissions
Source: Energy Information Administration
Figure 10: Gasoline Subsidies in Indonesia

Estimated gasoline subsidy on premium gasoline in Indonesia, 1997-98

Source: Environmental Implications of the Economic Crisis and Adjustment in East Asia (1999), East Asia Environment and Social Development Unity, World Bank
Figure 11: Comparison of Government Spending in Environment and Input Subsidies in Indonesia

Core Environmental Expenditure in the National Development Budget (Own Resources) Compared with Total Input Subsidies (Index: FY1994/95 = 1)

Source: Vincent et.al. (2002)
Figure 12: Government Spending in Indonesia

*Sum of Development Expenditure (Own Resources) and Routine Expenditure in Sector 10 (Environment and Spatial Planning) of the National Budget (Rp billion, constant 1993/94 prices)*

Source: Vincent *et.al.* (2002)
Figure 13: SO2 Emissions, Latin America

Figure 14: SO2 Emissions, China and India


Figure 15: SO2 Emissions, East Asia

Table 1: Real GDP Growth Rate

<table>
<thead>
<tr>
<th>Decade</th>
<th>China and India</th>
<th>Advanced Economies</th>
<th>Rest of the World</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-2007</td>
<td>6.8</td>
<td>3.4</td>
<td>2.7</td>
<td>3.4</td>
</tr>
<tr>
<td>1961-1990</td>
<td>5.6</td>
<td>4.2</td>
<td>2.7</td>
<td>3.9</td>
</tr>
<tr>
<td>1991-2009</td>
<td>8.4</td>
<td>2.5</td>
<td>3.3</td>
<td>2.9</td>
</tr>
<tr>
<td>1961-1969</td>
<td>3.9</td>
<td>5.4</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>1970-1979</td>
<td>4.4</td>
<td>4.0</td>
<td>3.1</td>
<td>3.8</td>
</tr>
<tr>
<td>1980-1989</td>
<td>8.2</td>
<td>3.3</td>
<td>2.5</td>
<td>3.2</td>
</tr>
<tr>
<td>1990-1999</td>
<td>8.9</td>
<td>2.5</td>
<td>2.6</td>
<td>2.8</td>
</tr>
<tr>
<td>2000-2007</td>
<td>9.2</td>
<td>2.3</td>
<td>4.4</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Source: WDI, World Bank
Advanced Country List: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, UK, USA

Table 2: Annual Change in World Real GDP (in millions US dollars of 2000)

<table>
<thead>
<tr>
<th>Decade</th>
<th>China and India</th>
<th>Advanced Economies</th>
<th>Rest of the World</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-1969</td>
<td>5,154</td>
<td>366,333</td>
<td>120,100</td>
<td>491,587</td>
</tr>
<tr>
<td>1970-1979</td>
<td>12,198</td>
<td>514,740</td>
<td>47,150</td>
<td>574,088</td>
</tr>
<tr>
<td>1980-1989</td>
<td>36,740</td>
<td>472,160</td>
<td>94,735</td>
<td>603,635</td>
</tr>
<tr>
<td>1990-1999</td>
<td>86,310</td>
<td>519,200</td>
<td>116,040</td>
<td>721,550</td>
</tr>
<tr>
<td>2000-2007</td>
<td>201,375</td>
<td>618,875</td>
<td>274,525</td>
<td>1,094,775</td>
</tr>
</tbody>
</table>

Source: WDI, World Bank
Advanced Country List: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Taiwan, UK, USA
### Table 3: Government Spending in Environmental Activities in Indonesia

**Expenditures on Environmental Activities in the Routine Budgets of the Industrial Zone and Environment Division, the Mining Inspectorate and the Environmental Agencies in Sector 10**

(Rp million, constant 1993/94 prices)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Industrial Zone and Environment Division&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Mining Inspectorate&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Environmental Agencies, Sector 10&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994/95</td>
<td>858</td>
<td>457</td>
<td>3,330</td>
</tr>
<tr>
<td>1995/96</td>
<td>666</td>
<td>364</td>
<td>3,630</td>
</tr>
<tr>
<td>1996/97</td>
<td>704</td>
<td>415</td>
<td>5,406</td>
</tr>
<tr>
<td>1997/98</td>
<td>606</td>
<td>271</td>
<td>4,630</td>
</tr>
<tr>
<td>1998/99</td>
<td>163</td>
<td>56</td>
<td>4,167</td>
</tr>
</tbody>
</table>

<sup>a</sup> Planned expenditures.

<sup>b</sup> Actual expenditures.

Source: Vincent et.al (2002)

### Table 4: Environmental Expenditures in Asian Countries

**Environmental Expenditures in Asian Countries Affected by the Financial Crisis**

<table>
<thead>
<tr>
<th>Country</th>
<th>Share of Government Expenditure (%)</th>
<th>Share of GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>0.163</td>
<td>0.030</td>
</tr>
<tr>
<td>1997</td>
<td>0.079</td>
<td>0.017</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.067</td>
<td>0.015</td>
</tr>
<tr>
<td>1997</td>
<td>0.070</td>
<td>0.016</td>
</tr>
<tr>
<td>Thailand</td>
<td>1.19</td>
<td>0.22</td>
</tr>
<tr>
<td>1997</td>
<td>0.98</td>
<td>0.18</td>
</tr>
<tr>
<td>Korea</td>
<td>1.56</td>
<td>0.27</td>
</tr>
<tr>
<td>1997</td>
<td>1.38</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Source: Vincent et.al (2002)
<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Finland</td>
<td>2.203</td>
</tr>
<tr>
<td>2</td>
<td>Sweden</td>
<td>1.772</td>
</tr>
<tr>
<td>3</td>
<td>Singapore</td>
<td>1.771</td>
</tr>
<tr>
<td>4</td>
<td>Netherlands</td>
<td>1.747</td>
</tr>
<tr>
<td>5</td>
<td>Austria</td>
<td>1.641</td>
</tr>
<tr>
<td>6</td>
<td>Switzerland</td>
<td>1.631</td>
</tr>
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<td>7</td>
<td>Germany</td>
<td>1.522</td>
</tr>
<tr>
<td>8</td>
<td>France</td>
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<tr>
<td>9</td>
<td>Denmark</td>
<td>1.384</td>
</tr>
<tr>
<td>10</td>
<td>Iceland</td>
<td>1.354</td>
</tr>
<tr>
<td>11</td>
<td>New Zealand</td>
<td>1.299</td>
</tr>
<tr>
<td>12</td>
<td>Canada</td>
<td>1.297</td>
</tr>
<tr>
<td>13</td>
<td>United Kingdom</td>
<td>1.165</td>
</tr>
<tr>
<td>14</td>
<td>United States</td>
<td>1.184</td>
</tr>
<tr>
<td>15</td>
<td>Belgium</td>
<td>1.159</td>
</tr>
<tr>
<td>16</td>
<td>Australia</td>
<td>1.140</td>
</tr>
<tr>
<td>17</td>
<td>Japan</td>
<td>1.057</td>
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<tr>
<td>18</td>
<td>Norway</td>
<td>1.045</td>
</tr>
<tr>
<td>19</td>
<td>Ireland</td>
<td>0.548</td>
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<tr>
<td>20</td>
<td>Italy</td>
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<tr>
<td>21</td>
<td>Spain</td>
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<td>22</td>
<td>Estonia</td>
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<tr>
<td>23</td>
<td>Hungary</td>
<td>0.283</td>
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<tr>
<td>24</td>
<td>Slovenia</td>
<td>0.205</td>
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<tr>
<td>25</td>
<td>Chile</td>
<td>0.177</td>
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<tr>
<td>26</td>
<td>Czech Republic</td>
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<tr>
<td>27</td>
<td>Uruguay</td>
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<tr>
<td>28</td>
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<tr>
<td>29</td>
<td>Poland</td>
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</tr>
<tr>
<td>30</td>
<td>Jordan</td>
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<tr>
<td>31</td>
<td>Portugal</td>
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<tr>
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<td>South Africa</td>
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<tr>
<td>33</td>
<td>Latvia</td>
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<tr>
<td>34</td>
<td>Jamaica</td>
<td>0.037</td>
</tr>
<tr>
<td>35</td>
<td>Brazil</td>
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<tr>
<td>36</td>
<td>Costa Rica</td>
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<tr>
<td>37</td>
<td>Korea</td>
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<tr>
<td>38</td>
<td>Malaysia</td>
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<tr>
<td>39</td>
<td>Lithuania</td>
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<tr>
<td>40</td>
<td>Slovak Republic</td>
<td>0.177</td>
</tr>
<tr>
<td>41</td>
<td>Egypt</td>
<td>0.224</td>
</tr>
<tr>
<td>42</td>
<td>Panama</td>
<td>0.242</td>
</tr>
<tr>
<td>43</td>
<td>Mauritius</td>
<td>0.250</td>
</tr>
<tr>
<td>44</td>
<td>China</td>
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</tr>
<tr>
<td>45</td>
<td>Thailand</td>
<td>0.399</td>
</tr>
<tr>
<td>46</td>
<td>Colombia</td>
<td>0.416</td>
</tr>
<tr>
<td>47</td>
<td>Bulgaria</td>
<td>0.534</td>
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<tr>
<td>48</td>
<td>Mexico</td>
<td>0.632</td>
</tr>
<tr>
<td>49</td>
<td>Greece</td>
<td>0.618</td>
</tr>
<tr>
<td>50</td>
<td>Peru</td>
<td>0.727</td>
</tr>
<tr>
<td>51</td>
<td>Argentina</td>
<td>0.732</td>
</tr>
<tr>
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<td>Zimbabwe</td>
<td>0.732</td>
</tr>
<tr>
<td>53</td>
<td>Bolivia</td>
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<tr>
<td>54</td>
<td>Indonesia</td>
<td>0.756</td>
</tr>
<tr>
<td>55</td>
<td>India</td>
<td>0.759</td>
</tr>
<tr>
<td>56</td>
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</tr>
<tr>
<td>57</td>
<td>Russia</td>
<td>0.695</td>
</tr>
<tr>
<td>58</td>
<td>Sri Lanka</td>
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<tr>
<td>59</td>
<td>Philippines</td>
<td>1.014</td>
</tr>
<tr>
<td>60</td>
<td>Dominican Republic</td>
<td>1.014</td>
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<tr>
<td>61</td>
<td>Venezuela</td>
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</tr>
<tr>
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<td>63</td>
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<td>64</td>
<td>Romania</td>
<td>1.258</td>
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<td>65</td>
<td>Ukraine</td>
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<tr>
<td>66</td>
<td>Honduras</td>
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<td>67</td>
<td>Nigeria</td>
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<td>68</td>
<td>Bangladesh</td>
<td>1.331</td>
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<tr>
<td>69</td>
<td>Guatemala</td>
<td>1.352</td>
</tr>
<tr>
<td>70</td>
<td>Ecuador</td>
<td>1.616</td>
</tr>
<tr>
<td>71</td>
<td>Paraguay</td>
<td>1.740</td>
</tr>
</tbody>
</table>

Source: Esty and Porter (2001)
Table 6: Difference of SO2 concentration between the actual and the expected levels, given per capita GDP

Urban $SO_2$ concentration relative to expected given GDP per capita, listed by income groups

<table>
<thead>
<tr>
<th>Low-income Countries (≤ $36,500)</th>
<th>Middle-income Countries ($36,500–$220,000)</th>
<th>High-income Countries (≥ $220,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank</td>
<td>Country</td>
<td>Residual</td>
</tr>
<tr>
<td>1</td>
<td>Ecuador</td>
<td>-28.49</td>
</tr>
<tr>
<td>2</td>
<td>Romania</td>
<td>-28.10</td>
</tr>
<tr>
<td>3</td>
<td>Thailand</td>
<td>-26.69</td>
</tr>
<tr>
<td>4</td>
<td>India</td>
<td>-26.41</td>
</tr>
<tr>
<td>5</td>
<td>Philippines</td>
<td>-12.81</td>
</tr>
<tr>
<td>6</td>
<td>Venezuela</td>
<td>-6.84</td>
</tr>
<tr>
<td>7</td>
<td>Bulgaria</td>
<td>11.96</td>
</tr>
<tr>
<td>8</td>
<td>Egypt</td>
<td>21.04</td>
</tr>
<tr>
<td>9</td>
<td>China</td>
<td>51.25</td>
</tr>
</tbody>
</table>

* Net all data were available for all countries.

Source: Esty and Porter (2001)

Table 7: Asian Financial Crisis Currency Depreciation

<table>
<thead>
<tr>
<th>Country</th>
<th>Asian Crisis - Forex Markets vs. US$</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>-84%</td>
<td>July-97 to July-98</td>
</tr>
<tr>
<td>Thailand</td>
<td>-53%</td>
<td>July-97 to July-98</td>
</tr>
<tr>
<td>Korea</td>
<td>-51%</td>
<td>July-97 to July-98</td>
</tr>
<tr>
<td>Malaysia</td>
<td>-47%</td>
<td>July-97 to July-98</td>
</tr>
<tr>
<td>Philippines</td>
<td>-40%</td>
<td>July-97 to July-98</td>
</tr>
</tbody>
</table>

Source: World Bank Crisis Talk