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**The Great Financial Crisis, Commodity Prices and  
Environmental Limits**

*by*

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## **Abstract**

This paper examines how certain new structural factors have contributed to the latest great financial crisis and world recession of 2008-09. We focus on three of these structural factors: (i) the incorporation of highly populated countries into the growth process; (ii) The increasing scarcity of the environment and certain natural resources; (iii) the unprecedented concentration of wealth and income in the advanced economies over the last three decades. These structural changes have significantly tightened the links between world growth and commodity prices, have made the world commodity supply to become increasingly inelastic, and have made growth to become more dependent on lax monetary policies, respectively. All this may make the recovery from the current crisis much more difficult, implying a deeper and more protracted crisis than most previous crises. With this framework in mind we focus on the likely affect of the financial crisis upon the natural resources in the developing world, by drawing implications from the 1995 Mexico-originated Peso crisis and the 1998-99 Asia crises. We find that the impact of the current crisis is likely to degrade further the environmental resources and the tightening of environmental policies in response to such degradation may make the commodity supply curve of commodities even steeper in the future.

## **I. Introduction**

This paper examines how certain new structural factors have affected the emergence and nature of the latest great financial crisis and world recession of 2008-09. We focus on three of these structural factors: (i) 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; (ii) 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 even some poor countries; (iii) the unprecedented concentration of wealth and income in the advanced economies that has taken place over the last three decades. These structural changes have significantly tightened the links between world growth and commodity prices due to the fact that growth has become more commodity-intensive and that the world commodity supply curve is finally becoming increasingly less elastic. In addition, they have caused an

increasing dependence of economic growth on lax monetary policies as an instrument to allow consumers easy access to credit at low interest rates. These two features, closer growth-commodity price linkages and higher dependence of growth on lax monetary policies, are likely to make fast economic growth with price stability much harder to achieve in the future. In addition, we show that they will make the economic recovery from the current crisis much more difficult, which may imply a crisis that is deeper and more protracted than most previous crises with the exception perhaps of the 1930s depression.

With this framework in mind we analyze various conditions which are likely to affect the impact of the financial crisis on the developing world particularly focusing on the impact upon the natural resources. 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 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 allow us to provide in principle testable hypotheses about the direction and potential 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 instead examine certain effects of two previous crises episodes, the 1995 Mexico-originated Peso crisis and the 1998-99 Asia crisis, which have been evaluated in the literature.

Part II below provides an in depth analysis of the emergence of the great recession within the context of the new economic order that the three structural factors listed in the first paragraph above have given rise to. This analysis encompasses a retrospective historical analysis of the articulation of the rich country-poor country world emphasizing how the role of the traditionally poor countries has evolved making economic growth increasingly less exclusive over time. Next we briefly examine the consequences of radical new policies in the advanced economies forcefully implemented by a series of conservative governments supported by a reinvented intellectual *lazes-faire* market ideology. This part concludes by showing how the nature and depth of the current crisis has been conditioned

by these developments. 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 origins of the Great Recession**

### *Retrospect*

For much of the 20<sup>th</sup> 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. 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 shrank as a share of total output. Figure 1 shows 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.

This dematerialization of production was not fully matched by a similar dematerialization of consumption in the North. 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 North continued to expand their demands for industrial goods, especially durables, at a pace that often exceeded growth of per capita GDP. Moreover, the decline of the consumption share of commodities was much less than the reduction of the share of commodities in domestic production. This divergence between structural changes in domestic production and consumption meant that the North became 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.

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 implies that the shifts in consumption towards services and away from material goods were probably 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 domestic industry value added. 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 2 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 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. The increasing demand for commodities from the North was matched by the continuous exploration and expansion of the enclave economy thus developed in the South. In a context of resource abundance in the South and no effective regulations limiting resource extraction environmental damages, the long run supply curve of commodities was for a long time essentially flat (López and Stocking, 2009). This meant that the North could grow with the luxury of constant and even at times declining commodity prices for many decades. As has been well documented by several studies, these enclaves 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*

Things started to change in the 1970s with the emergence of a few countries 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 efficient 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 eighties 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<sup>1</sup>.

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<sup>1</sup> 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 began 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).



The nineties brought 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 dramatic policy reforms in these countries. These new policies included pro-market reforms, export promotion through exchange rate policies and other incentives, strengthening of property rights, 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. Both the NIC and NIG based their development on the rapid expansion of industrial exports which was made possible by undervalued exchange rates<sup>2</sup>. This, in turn, meant enormous accumulation of foreign exchange which was recycled into the North (Figure 6). 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, feedback 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 (China, India, Russia and Brazil) 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

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<sup>2</sup>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.

about \$1.1 trillion. As can be seen in Table 2, the participation of 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.

The new North-NIG boom equilibrium of the second half of the 1990s and 2000s had one important difference with the early North-NIC equilibrium of the seventies, eighties and first half of the nineties: 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, hitherto inedited in history, the South itself became an important and rapidly growing consumer of primary commodities. Persistent economic growth ceased to be an exclusive attribute to a small portion of human kind to now, for the first time in history, become almost universal.

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 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 rate the enormous population size of the NIG caused their demand for commodities to reach a sizable portion of the total world demand as it is today (just China consumes more oil than the total production of Saudi Arabia, the biggest oil producer, and almost as much as the USA). Figures 10-12 and Table 3 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.

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 begun in 2002.

## *The new policies of the North*

By the early eighties the North started its own “structural change”. The view that the economy was being suffocated by excessive government intervention and too high taxes became quite accepted among policy makers and economists. It was thought that by acting on these issues it could be possible to increase economic efficiency and thus allow economic growth to speed up. Most countries in the North embarked in a far reaching policy experiment that was intended to significantly increase market incentives to investment and innovation.

The new structural change policies included various pro-market policies in conjunction with a pervasive process of extricating the government out of the economy. It included large cuts in taxes and in a broad spectrum of social spending as well as a vast financial deregulation. Even more important than the financial deregulation itself was the “de-supervision” that has occurred over the last two decades as a consequence of deliberate government actions to weaken the powers of the regulatory agencies by cutting their budgets, personnel, and attributions (Caprio et. al., 2008). In addition, structural change especially in the USA also included subtle policies and legislation directed to weakening labor unions. While some of these policies may have accelerated investments, especially financial ones, they also appear to have had some serious unintended consequences on income distribution.

The very policies that were intended to increase economic efficiency and continued economic growth in the North -most prominently, financial deregulation and de-supervision, major tax cuts for the wealthy, and concomitant public spending reduction, specially social spending, and the weakening of labor unions- were in part responsible for the massive concentration of income observed over the last three decades<sup>3</sup>. Figures 7

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<sup>3</sup> There is a vast literature that tries to explain the concentration of income mainly focusing on the distribution of wages among broad groups within the labor force (Autor, Katz and Kearney, 2006; Autor Levy and Murnane, 2003; Card and di Nardo, 2002). Most of them emphasize issues related to the implications of new technologies and increased levels of human capital for wage distribution. A study by Gordon and Dew-Becker (2007) has looked at consequences of decreased unionization of the labor force-a process that has accelerated precisely since the time of structural change- for wage polarization. Few studies have looked at the upper end of the wage distribution which appears to explain a high portion of wage concentration. Kaplan and Rauh (2009) does this showing that the amazing increases in executive compensation to investment bankers, hedge fund, private equity and mutual fund managers and traders as

and 8 give an idea of the large concentration of income that has taken place in the USA and UK, respectively, especially since the early eighties. In the US the middle class (which we define as the second, third and fourth quintiles of the household income distribution) continuously reduced its participation in national income from almost 54% in 1980 to 47% in 2006 while the poor (the bottom 20%) reduced its participation from 5% to 4%. Most of these reductions benefited the rich, the top 5% of the households, which increased their participation in national household income from 17% to 22.5% over the same period. Similarly, over the period 1980-2006 the share of the middle class in the UK fell from 55% to 50% and that of the poorest quintile also decreased from 10% to 8% over the period. Concomitantly, the share of the top 10% of the households increased from 20% to 27% of the total household income.

These figures reflect massive transfers of wealth from the middle class to the wealthy, which meant that the per capita income of the middle classes increased at a much slower pace than the national per capita income. This concentration of income meant that the mean real household income of the middle class in the USA barely increased over the last three decades, from \$48,000 in the early eighties to \$52,000 in 2007 (Figure 9). That is, while the annual per capita GDP in this period grew by more than 2% the annual household income growth of the middle class was about 0.3%. By contrast, the mean real household income of the top 5% of the population rose dramatically, from \$155,000 to \$290,000 over the same period at a much faster rate than per capita GDP.

### *Dilemmas and paradoxes*

The continuous process of income concentration represented a significant problem because for a long time the persistence of a high rate of economic growth has become highly dependent on equally rapid rates consumption growth. Consumption is in fact the key engine of growth and the backbone of mass consumption is the middle class. Economic growth needs a continuous and rapid expansion of consumption which only a

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well as other types of top executives in large corporations explain to a large extent the observed polarization of wage income. We postulate that the incredible rise of executive compensation benefiting perhaps no more than 1% of the labor force is due mainly to extreme financial deregulation and other structural adjustment policies initiated in the early eighties.

prosperous middle class can support<sup>4</sup>. But the middle class was increasing its income at a rate that was less than one eighth of the per capita GDP growth rate. So in principle the rate of growth of household income of the middle class was hardly sufficient to support the pace of growth in the economy's consumption that was needed to sustain economic growth in the North at its historical rates. Thus, the dilemma was how to persuade the middle class to expand its consumption at a sufficient rapid pace to sustain annual per capita GDP growth rates of the order of 2-2.5% despite that its real income was increasing at only 0.3%.

The required expansion of consumption could only occur if credit was plentiful and cheap and if the middle class was enticed to accept ever increasing levels of debt. This is where the growing flow of financial resources from the NIG and oil-exporter countries into the North and domestic "financial innovation" made possible by deregulation come into place. Cheap and plentiful credit was offered to almost anyone. Why did households bite so easily and so massively into the easy credit temptation? The massive inflow of capital from the NIG and oil-exporting countries in a context of almost complete effective financial deregulation created the last component of the miracle (or better mirage), the dramatic appreciation of all sort of assets mainly equities and real estate. Capital gains made the ordinary citizens feel richer despite that their income flow increased little as most of the income growth accrued to a very small minority of the population. Confounding necessarily short term capital gains with permanent income induced the middle class to cut savings-rapidly increasing consumption- and happily accept the easy credit that was offered to them.

While the dilemma of sustaining economic growth in the midst of a stagnated middle class was "solved" via easy credit and low interest rates it nonetheless embodies ominous implications. The model of growth requires ever increasing household debt in turn supported by ever increasing equity and real estate appreciation. Obviously not something that can be considered a permanent solution. Perhaps even worse, the high dependence of the middle class on debt and new borrowing made the consequences of

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<sup>4</sup> Another possible engine of growth was exports, but given the historically low weight of export value added in GDP, even rapid export expansion cannot give enough support to domestic growth. Investment, with less than 20% of GDP is also too small to make a significant difference for growth; also, investments are to a great extent driven by the consumer demand itself.

restricting the monetary policy potentially much more costly than in previous times when the economy's consumption and hence growth was not nearly as dependent on middle class borrowing as it is today. The phenomenal debt-income ratios reached over the last decade made consumers' income greatly sensitive to interest rate hikes that increase debt service. We return to these important issues below.

### *Commodity prices and the crisis*

Given the relatively low share of commodities in the consumer demand in the North at first the significant commodity price increases had little impact on inflation in the North. However, given the magnitude of the commodity demand increases that 8-10% annual growth rates in the NIG required, commodity prices continued increasing very rapidly. As commodity prices skyrocket in 2003-2004 they began to have an effect first in the overall consumer price index in the USA and many other countries which were not necessarily immediately internalized by the monetary authorities as long as they did not affect the so-called "core" inflation. However, core inflation was eventually affected (more than doubled in 2004) and by the third quarter of 2004 the Fed started a process of monetary restriction causing a steady rise of the effective federal fund rate from 1.25% in such quarter to more than 5% by the end of 2007. Figure 13 shows the connection between monetary policy and commodity prices in the USA: by the end of 2004 the oil price increases had spilled over into most other commodities and thus started to have an effect on the core CPI inflation. In fact, the core CPI more than doubled in a short period of time. It appears that this prompted the Fed to start a protracted period of monetary tightening as reflected by the large increases of the Fed Fund Rate during 2004-2007.

Given the increased dependence of growth on an ever expanding household debt and easy borrowing that the income squeeze of the middle class required to sustain growth, the tightening of monetary policy in the 2004-07 period was to have much more serious consequences than previous episodes of monetary restrictions<sup>5</sup>. In fact, it triggered the end of the economic boom and the beginning of the great recession. First the higher interest rates caused a concomitant increase in mortgage rates leading to the sudden

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<sup>5</sup> The financial and real estate bubble that was highly dependent on cheap credit was part of this same phenomenon.

collapse of the housing market. The fall of real estate value with the consequent evaporation of a significant part of earlier capital gains caused consumers to suddenly realize that they were not nearly as wealthy as they had been led to believe.

In addition, the drying up of credit made it increasingly difficult for the middle class to continue borrowing and, more important, the cost to consumers of servicing their accumulated debt went up significantly. The large debt-to-income ratio of consumers has made their income perhaps like never before greatly vulnerable to interest rate increases. All this prompted a first round of adjustment in household consumption. At the same time it caused widespread defaults in the housing sector which, in turn, led to the financial collapse inducing enormous capital losses to equity markets. The large capital losses in the equity markets, in turn, caused a second round impact on consumption (due to a wealth effect) which ultimately allowed the crisis to impact the real sector causing higher unemployment and great instability in the labor market. This appears to be inducing a third round effect on the income and consumption of the middle class, which we are experiencing today. In addition, the subsequent collapse of the world economy led to a significant fall in world commodity demands and their prices.

### *Policy Responses to the crisis*

The responses of governments to the crisis have been directed to: (i) a widespread bailing out process which entailed massive transfers of state resources to the large financial and later to non-financial corporations; (ii) a drastic relaxation of the monetary policy bringing short term interest rates to near zero levels and quantitative monetary intervention meaning that the central banks have effectively become direct lenders, especially to large financial institutions, at an unprecedented scale; (iii) Massive fiscal expansion which have created deficits rarely seen in the history of the advanced economies.

The deficit-financed new fiscal spending is expected to replace in part the large reduction of private expenditures and in the process stimulate a recovery in economic activity that may entice consumers once again to reignite their pace of consumption expenditures. The increased private consumption would be stimulated by the economic recovery that the

fiscal expansion would cause and by the near zero interest rates that the monetary policy would allow for. However, the fiscal deficits effectively imply huge new financial liabilities to ordinary citizens that sooner or later will have to be paid for either via higher taxes and/or inflation. That is, to the capital losses to consumers that the real estate and equity markets collapse caused, now one has to add the new potential capital liabilities generated by the fiscal deficits. In addition, the generous government aid to the financial firms and to other parts of the large corporate sector effectively means, once again, a massive transfer of resources from the average citizen to the wealthiest segments of society. This may thus worsen even further the wealth concentration which as we have seen is one of the fundamental factors behind the severity of the economic consequences that the tightening of the monetary policy induces.

Thus, while output growth in the North has become directly less dependent on commodities, paradoxically its income growth has indirectly become more dependent on commodities. This is so because world growth is now more intensive in commodities as a consequence of the incorporation of low income-highly populated countries into the growth process. Continued world economic growth is now more tightly linked to increased commodity price. While inflation in the advanced economies has become less influenced by commodity inflation, the persistent commodity price increases caused by rapid world growth eventually makes its way into the core inflation. This, in turn, leads to restricted monetary policies which as a consequence of the highly concentrated income distribution have now much more dramatic effects in the real sector of the economy than has historically been the case. The consequence: World economic growth may become much more difficult to sustain than in the past.

### *Environmental scarcity and more paradoxes*

The increased connection between commodity demand and economic growth that the incorporation of the NIG into the growth mode brought about has happened at the time when natural resources in the rest of the South are becoming less abundant and when the dire environmental consequences of the frenetic expansion of natural resource extraction are finally beginning to be taken seriously in the South. Even if the underground availability of most but not all raw materials may still be plentiful there are clear signs



that their supply must rely in increasingly more expensive sources; moreover, resource extraction has led to massive environmental costs affecting ever more crucial ecosystems, water quality, forests and many other increasingly scarce environments<sup>6</sup>. Under increasing pressures from international NGOs and part of the domestic civil society developing country governments are finally 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 callous resource extraction. These restrictions ultimately make the extraction of commodities more costly even in cases where the ground resources are plenty.

This means that now, perhaps for the first time in history, the long run supply curve of resource commodities has become relatively inelastic. The inherent fixity of the earth is finally translating into a more and more vertical supply of commodities. This phenomenon, in conjunction with the great expansion of the world's growth club into massively populated countries, explains the unusual response of commodity prices to fast world growth observed over the 2000s. The emergence of the NIG has meant that world economic growth has become more dependent on commodities at a time when commodity supply has become less elastic. Hence, like never before it appears that world economic growth and commodity prices are now intimately related.

Doubtless, the increasing scarcity of natural resources could be in part off-set with the development of appropriate resource-saving new technologies. New technologies could reduce such intimate 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 20<sup>th</sup> Century directed R&D to produce new technologies that were generally capital and energy intensive to save mainly labor. These new technologies were mostly

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<sup>6</sup> 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.

intensive users of the cheapest factors of production, the environment and the natural resources. While some internalization of the true cost of the environment were implemented in the North, environmental compliance costs are in fact extremely low even in the wealthiest countries and the low historical prices of commodities imply reduced incentives to produce technologies that saved commodities.

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, increasing commodity prices make the world economies more inflation vulnerable, as occurred in the years prior to the current crisis, which prompts central banks around the developed world to tighten monetary policies and raise interest rates as soon as commodity prices threaten their low inflation targets. But given the unprecedented concentration of wealth that policies in the North have caused, consumption –the engine of economic growth- has become extremely vulnerable to interest rates as a consequence of the protracted dependence of consumers on credit, in turn caused by the gradual plundering of the middle class. 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. 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 incentives to generate commodity-saving technical change.

### *Climate change*

In addition, there is climate change: The emergence of the NIG and the stubborn reluctance of the USA to participate even in the modest effective efforts of other advanced economies to mitigate greenhouse gas emissions have implied that such

emissions have continued at high levels. At the same time increasing evidence indicates that an impending climatic disaster may be avoided only if greenhouse gases are drastically reduced. The carbon emissions by the NIG constitute an increasing share of the total world emissions reaching more than 25% by 2006 (Figure 14); more importantly, the elasticity of emissions to growth in the NIG is very high which means that their continued economic growth will mean large increases in their emissions. Thus, world economic growth is now even more closely linked to carbon emissions than during the late 20<sup>th</sup> century. Even stabilizing world emissions at the current unsustainable levels will require much greater and costly efforts by the North to compensate for the increasing emissions from the NIG. Reducing the magnitude of climate change constitutes a new constraint on economic growth especially to the North which over the last decades has been in reality ignored. That is, an important yet hitherto effectively ignored limit to growth for the North has become even more serious with the advent of the NIG into one of the engines of world growth. Sooner or later this constraint will have to be reckoned with.

### *Summary*

The previous analysis suggests that despite that the North's output and to some extent consumption has become less directly dependent on commodities, the links between world economic growth and commodity prices have become stronger. This means that sustained growth of the NIG, by now a vital supplier of industrial goods and financial resources to support consumption in the North, is now inevitably associated with rapid increases in commodity prices. Despite the reduction of the importance of commodities in the consumption bundle of the North, given the increased sensitivity of commodity prices to world-wide growth, commodity price increases in a growing world are large enough to eventually impact CPI inflation in the North. This commodity-induced inflationary pressure, in turn, causes the monetary authorities in the North to tighten monetary policy thus reducing domestic demand and inducing financial disruptions. The financial implications of tighter monetary policies are now much more serious than in the past as a consequence of the high dependence on cheap credit that supporting aggregate demand in a context of a highly concentrated income distribution need.

## *Prospects*

It is of course extremely difficult to project the length and depth to which the on-going crisis can go. However, based on the above analysis we may expect that it will be very difficult to extricate the world from the current crisis over the next few years. It appears that unlike other recent economic crises, certain long term structural conditions that have been created over the last three decades may make considerably more difficult to return to normal growth conditions. These structural factors are mainly three: (i) a great concentration of income and wealth that have taken place in the advanced economies and elsewhere; (ii) the emergence of relative scarcity of natural resources and especially of the environment as a sink of the byproducts of economic growth; (iii) the incorporation of the NIG as important actors in the world economy making economic growth highly demanding of commodities and natural resources. Factor (i) implies that rekindling aggregate consumption as needed to restart economic growth may require the maintenance of easy credit and a lax monetary policy. Factors (ii) and (iii), in turn, imply that fast world growth and high and increasing commodity prices have become perhaps for the first time in history inextricable.

Currently, in response to the crisis, the world is seeing an unprecedented combination of massive fiscal stimulus and lax monetary policies with nominal interest rates reaching practically zero levels in most of the advanced economies. Public credit has come to take the slack left by the reduced private credit caused by the financial debacle. A new period of easy credit for all appears to have come with the only difference that the source of easy credit is now public instead of private credit. In addition, fiscal stimulus has meant gigantic fiscal deficits as governments have been generally reluctant to raise taxes on the rich-beyond some isolated token gestures-to finance at least in part the deficits. It appears that the anti-crisis policies have done nothing to ameliorate the structural problems discussed above which underlie the great recession and, moreover, in certain respects these policies may have actually worsen such structural factors.

In these conditions any incipient recovery of the world demand is likely to ignite again severe inflationary pressures; a phenomenon that would be aggravated if commodity prices were to retake its upward movement as is likely to be the case. In addition, given

the large fiscal imbalances any economic recovery would put large upward pressures on long-run interest rates. Inflationary pressures are likely to prompt governments to reverse monetary policy causing further increases in interest rates and to reduce fiscal deficits by increasing taxes. Moreover, the needed future tax increases almost surely will fall mainly into the middle class thus exacerbating the structural factor (i)<sup>7</sup>. The effect: the incipient growth is likely to be suffocated at birth.

Returning to sustained economic growth appears to require dealing with the underlying structural factors: there is a need to make aggregate demand less dependent on easy credit by forcefully addressing the concentration of wealth and income and there is a need to promote fast environmentally and commodity-saving technological change by accepting more restrictive environmental policies in both the North and the South so that world growth becomes less commodity and environmentally demanding. But these are changes that will require decisive policies and that would take some time to fructify. In the meantime, returning to rapid growth is likely to be difficult.

In the remainder of this paper we thus assume that the world growth slowdown will remain and that the advanced economies may remain stagnated perhaps *a la* Japan for a prolonged period of time. This assumption is important because the consequences for the natural resources and for poverty in the developing countries critically depend on the length of the global slowdown. If the current crisis is merely a bump in an otherwise smooth road of economic growth much of its effect on the natural resources and the poor is likely to be small and mainly transient. If, however, the current situation represents a new trend the consequences are obviously much more serious and may require significant “structural change” in the developing economies to face this new period. Needless to say, the required structural change is probably quite different from the standard structural change advice that the Washington consensus once was.

## **II. The crisis and the developing countries**

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<sup>7</sup> As this essay is being written the idea of a national sales tax in the USA is being increasingly regarded with enthusiasm by economists and policy makers. As is well known these taxes are highly regressive and would constitute yet another blow to the middle class. Indirect taxes are in fact an effective means to take the wealthiest groups out of the tax hook.

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. 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*

Most economic crises emerge from prolonged 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 high commodity prices which caused a great expansion of commodity exports. In addition, some countries especially middle income ones greatly benefited as a consequence of the rapid expansion of manufacturing exports. Also, most of the South was able to attract unprecedented levels of foreign investment both financial and non-financial. 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 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 fast 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. There is of course a trade-off in the short run between

growth and public saving. Some countries were able to increase growth and even reduce poverty rapidly in the short run by spending most or all the additional revenues during the boom period in increasing social programs, development expenditures and in many cases increasing public waste. In several cases the government over shoot expenditures by using the boom times as an opportunity to increase borrowing<sup>8</sup>.

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 and, in some cases, establishing sovereign investment funds. The accumulation of public savings during the boom times let these countries be better positioned to use countercyclical policies to face the subsequent crisis than those that did not save or even increased net public debt. Among countries that were able to increase public savings the most during the early 2000s boom times were China and India in Asia and Chile in Latin America.

Countries that have saved during boom times may be able to increase social benefits and implement pro-employment fiscal expenditure policies during the crisis. By contrast, those countries 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. The unemployment and poverty impact is likely to be magnified in the latter countries and mitigated in the former ones. This may imply very different impacts of the crisis for the poor and for the 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 need 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 is likely to be more limited among countries that saved in boom times than those that saved little.

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<sup>8</sup> Some of these countries instead wasted the additional revenues through increased inefficiency, corruption, and satisfying political clientele.

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).

## *2. Environmental regulatory framework and the environmental impact of the crisis*

Among the developing countries there are significant disparities in the scope of the regulatory framework and particularly in the extent by which it is enforced. The key issue is that countries with effective environmental regulation are able to impose binding constraints on pollution levels while in those without effective regulation such constraints are not binding. The pollution implications of the crisis can be opposite in the two cases: If there are binding pollution constraints, a likely response to the crisis is a relaxation of the enforcement of such constraints as a means to mitigate the employment effects of the crisis. Thus, in this case we 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 it may be positive despite the decline in economic activity and employment. By contrast, in countries without 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 tend to worsen pollution in countries that have binding regulatory frameworks while they tend to improve pollution in countries



where the regulatory framework is weak. Below we provide some evidence consistent with this hypothesis using the 1997 Asia-originated crisis and the 1995 Mexico-originated crisis experiences.

*Measures of environmental regulatory strength and pollution*

Table 4 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 early 2000s). As can be seen, within the developing countries there are very large disparities on the environmental regulatory effectiveness. For example, according to the index Uruguay is much closer to Japan than to the Philippines or Dominican Republic in this respect. Among the countries that we analyze below we can distinguish Chile, Uruguay and to some 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. Importantly, while most of the highest ranked countries correspond to rich ones, the ranking is not completely driven by per capita income especially among developing countries. In fact, among the three groups of countries mentioned we encounter countries with similar per capita income (say Uruguay, Malaysia and Argentina) that are ranked very differently in terms of environmental regulations.

Pollution concentration levels among countries vary quite significantly once we account for a per capita income norm. Table 5, also taken from Esty and Porter (2001) provides measures of the difference of sulfur dioxide (SO<sub>2</sub>) concentration between the actual and the expected levels given per capita GDP<sup>9</sup>. As can be seen in the Table 5, there are wide differences in this index as well. Among the poor countries, for example, it appears that while India has concentration below the per capita GDP norm, China has well above it. Among the middle income countries Chile has pollution levels below the norm while Mexico and Brazil exceed the norm by a wide range. It is not clear whether or not the measured quality of the environmental regulatory framework explains a reasonable

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<sup>9</sup> Throughout the remainder of this paper we use SO<sub>2</sub> as a key indicator of pollution because this is the most widely and best measured pollutant.

portion of the deviations from the norm. To be sure there are factors other than the regulatory framework that may explain such deviations as well. For example, the significant differences in the speed of economic growth may be a factor that explains why China is above the norm while India is below it despite that in the ranking of environmental policies China is above India. Over the nineties China grew almost twice as fast as India. It is likely that the countries that grow too fast encounter significant problems in catching up with pollution emissions even if their regulatory framework is adequate.

*Pollution effects of the crisis: Regulated versus unregulated countries*

In our sample of Latin American countries we have that the countries with most effective environmental regulation, Chile, Uruguay and Brazil, appear to all have increased their annual rates of SO<sub>2</sub> 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 15 shows the annual SO<sub>2</sub> emission changes 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 SO<sub>2</sub> regulation controls were effective. However, starting in 1995, the first year in which the crisis is felt and continuing into 1999, emissions started to increase 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, the other countries in the region with somewhat effective environmental regulation followed a similar path to that of Chile. Pollution had been decreasing for some years prior to the first crisis and then emission growth rates became positive over the crises years.

Thus, the cases of Chile, Uruguay and to some extent Brazil fit well with our prediction for countries that have effective regulation: During crisis time the regulations are relaxed possibly as a deliberate effort to mitigate the employment effects of the crisis. 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 emission growth.

The data for emissions in Asian countries show that SO<sub>2</sub> concentrations fell significantly in most of them, especially in 1998 and 1999, the years when the Asia crisis had its full impact (Figures 16 and 17). Given the magnitude of the crisis in most of these countries it is possible that any pollution intensity effect that could have taken place in those that had binding environmental regulation was dominated by the acute output contraction effect. The case of Korea, however, is illustrative: pollution concentrations continuously declined over the nineties and the effect of the crisis was a temporary interruption of the declining trend that can be attributed to an equally temporary relaxation of regulations to mitigate the economic effects of the crisis. This small (temporary) increase in pollution in Korea contrast with the more precipitous and longer lasting reductions of pollution in most of the other countries in Asia that generally had weaker environmental regulation. It happens that Korea was precisely the highest ranked Asian country in the sample with respect to environmental regulatory effectiveness (Table 4). The smaller pollution effect of the crisis in the country with the best environmental regulation is thus consistent with the hypothesis discussed earlier.

The previous results appear more clearly when we focus on pollution deviations from the country trend rather than the actual levels. Appendix A shows the time trend of SO<sub>2</sub> 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 crisis experienced below trend concentrations tend to show above trend rates during the crisis years (1995 to 1999 for Latin America and 1997-99 for Asia). That is, countries which presumably had somehow been able to implement binding pollution controls prior to the crisis-which may include those where pollution rates had become below the trend- reduce the intensity of such controls which meant that during the crisis years pollution rates became higher than the trend level. By contrast, in countries that were not implementing significant pollution controls prior to the crisis- which may include those where pollution was above trend prior to the crisis- the output scale effect of the crisis years dominated and pollution rates fell below trend levels. This pattern is of course consistent with the central hypothesis of this analysis.

The hypothesis presented earlier is also corroborated by some micro case studies for water pollutants as well. Afsah (1999), for example, showed that while output of a large number of industrial plants surveyed declined by 18% during the 1997-98 crisis period in Indonesia, water pollution due to organic waste in industrial effluents as measured by BOD concentration increased by 15%. This paper documents how environmental inspections declined during the crisis which in turn reduced abatement efforts by industrial plants. That is, a response to the crisis is to reduce environmental enforcement when such regulations are initially applied. This may be due to a deliberate decision by government to mitigate the effects of the crisis on production and employment. It may also be related to the need for the government to drastically cut environmental expenditures as a consequence of the fall of revenues caused by the crisis<sup>10</sup>. In times of fiscal crisis governments often cut mostly discretionary expenditures; environmental expenditures are usually considered discretionary.

### ***3. Pollutants that are not subject to regulation in developing countries***

Pollutants that are not subject to regulations in any developing country include most prominently industrial emissions of carbon dioxide (CO<sub>2</sub>) and other climate change gases. Consistent with the hypothesis presented in the previous section, these pollutants are likely to fall with the reduction of economic activity caused by the crisis, although under some conditions it is possible that the recession may induce changes in the composition of fuels if the crisis changes their relative prices<sup>11</sup>. Also, as we discuss below, in countries that still have open-access or semi-open access forests the crisis may induce increased deforestation and forest burning that is likely to increase non-industrial carbon emissions. Appendix B shows data on CO<sub>2</sub> industrial emissions for some Asian and Latin American countries. In general the patterns are not nearly as clear as in the case of SO<sub>2</sub>. In part this may reflect the fact that this data is essentially projected on the basis of output coefficients rather than corresponding to actual measures as is the case with SO<sub>2</sub> concentrations.

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<sup>10</sup> Linking this to our earlier discussion in 1 above about countries that saved and those that did not save during the pre-crisis years, it appears that Indonesia was among the latter. This meant that the crisis had a profound pro-cyclical impact on fiscal expenditures which spillover into the environmental budgets.

<sup>11</sup> 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.

In general we expect that industrial emissions of climate change gases are likely to fall, or their rate of growth to decline, as a consequence of the reduced levels of economic activity caused by the crisis. However, in countries that still have forests non-industrial CO<sub>2</sub> emissions may increase as a consequence of increased forest clearing that the crisis may under certain conditions induce. Thus, the net effect of the crisis on emissions is ambiguous. We now turn to issues associated with deforestation.

#### ***4. 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 is the country's population the more likely is that the subsistence forces of deforestation dominate the for-profit motives. That is, the more likely is that 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).

##### *Middle income, low population density countries*

In countries where population density and poverty are low the 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 natural resource commodities are tradable currency 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<sup>12</sup>. 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 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

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<sup>12</sup> 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.

crisis times in middle income countries with smaller populations such as Perú, Brazil or Chile.

*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% of the rural population), Indonesia (24%), The Philippines (23%) and Vietnam (21%)<sup>13</sup>. 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 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

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<sup>13</sup> These data are circa 2005 taken from Chen and Ravallion.

(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 would 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 6) which allow commercial resource extractive



activities to increase its relative profitability, and the 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 off-set the fall of international commodity prices leading to increase the domestic commodity prices and hence on 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 forest 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. (2001) showed that the 1997-98 crisis resulted in drastic cuts in environmental protection expenditures in all East Asian countries directed affected by the crisis with the only exception of Malaysia. Also, Kittiprapas (2002) reports deep cuts in both social services and environmental protection in Thailand during the crisis. In general the cuts were much deeper in regional 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 worsen more in rural than urban areas.

#### **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

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 the supply of energy, agricultural, metals and other commodities has been amazingly responsive to increasing commodity demand, the supply of these commodities was increasingly relying in 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, loses of biodiversity and the large air pollution generated by the conversion of natural ecosystems to agriculture, logging and other products. In addition, resource extraction is responsible for a significant portion of climate changing gas emissions. Commodity supply appears 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 reckoned with, precisely at the time when world economic growth has become more commodity-intensive as a consequence of the awakening to the growth process of the sleeping giant countries. The commodity supply curve has become steeper and demand shifts upwards very 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 every time that energy and other commodity prices rise in response to growth. This, in turn, in a world where the vast middle class consumer has been made worse off and consequently more and more dependent on easy credit, suffocates growth.

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. This may exacerbate in an important way the underlying environmental 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 the South is likely to increase the damages so much that, once normal times return, governments will have

increasing difficulties in ignoring demands to implement more serious environmental policies which in one way or another will have to consider restrictions on resource extraction. That is, the further environmental losses that the current crisis may trigger and the likely tightening of environmental policies 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.

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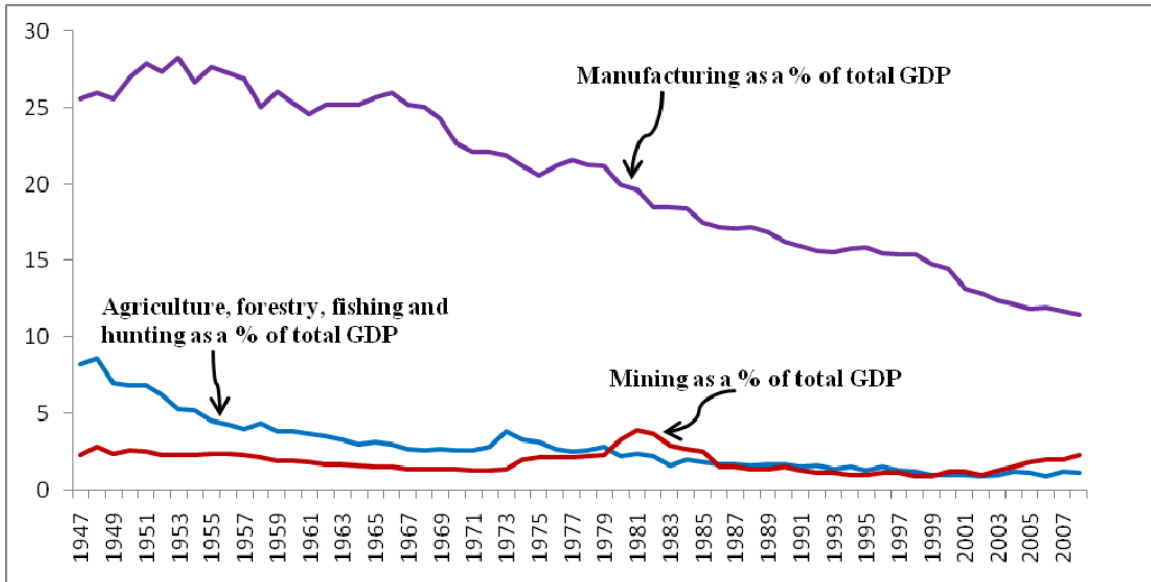
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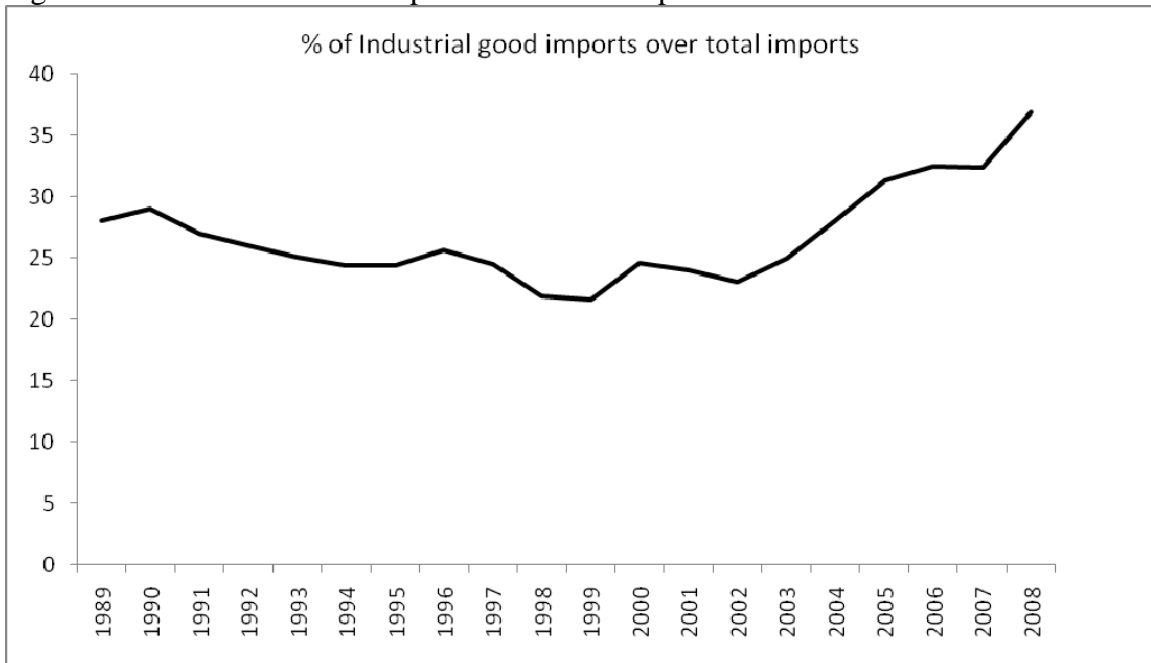
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Figure 1: Sector composition of GDP in the USA



Source: US Bureau of Economic Analysis

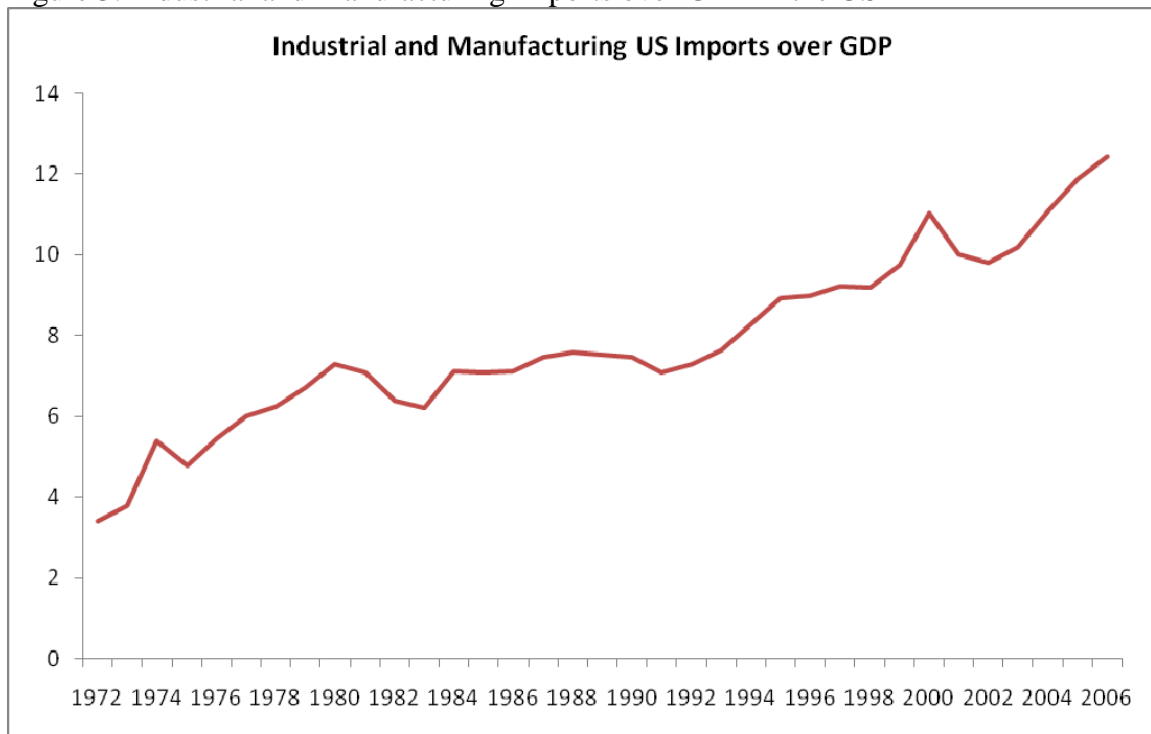
Figure 2: Share of Industrial Imports over Total Imports in the USA



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

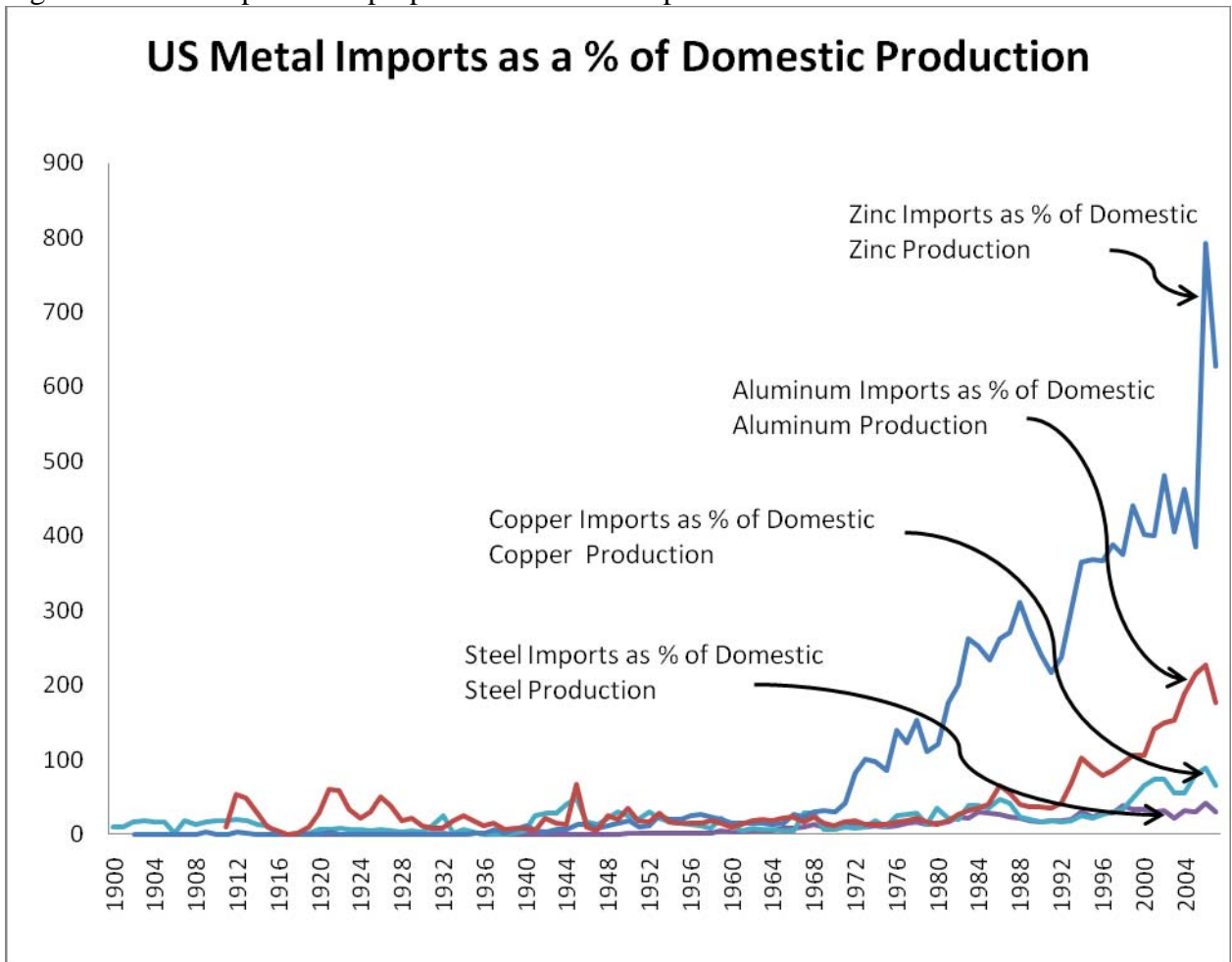


Source Feenstra et. al. (2001), <http://www.internationaldata.org/>

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.

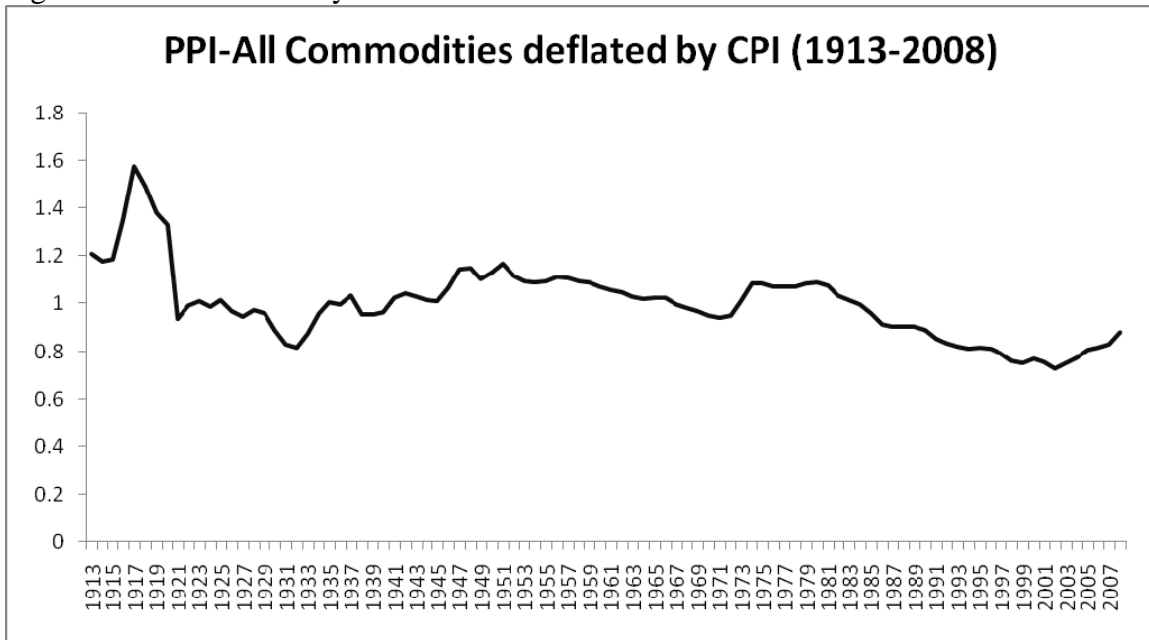


Figure 4: Metal Imports as a proportion of domestic production in the USA



Source: US Geological Survey

Figure 5: Real Commodity Price Trends: Producer Price Index – All Commodities

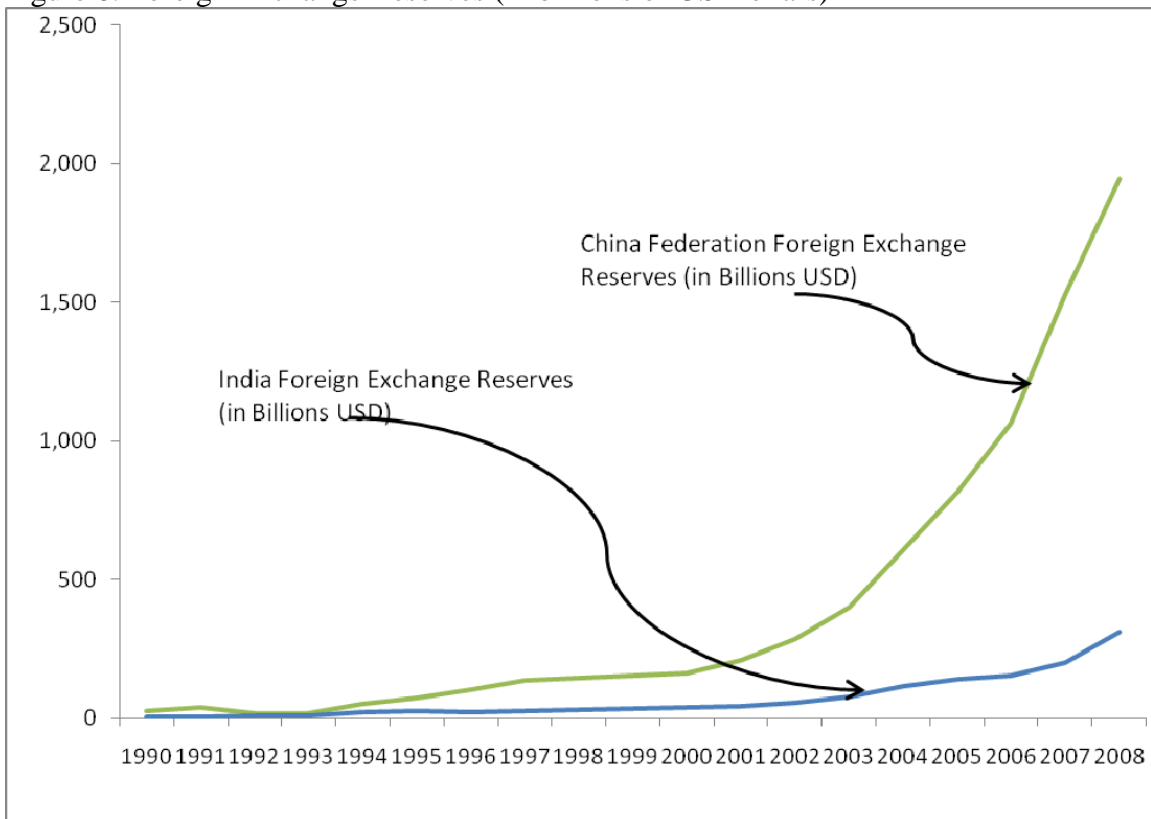


Source: US Bureau of Labor Statistics

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

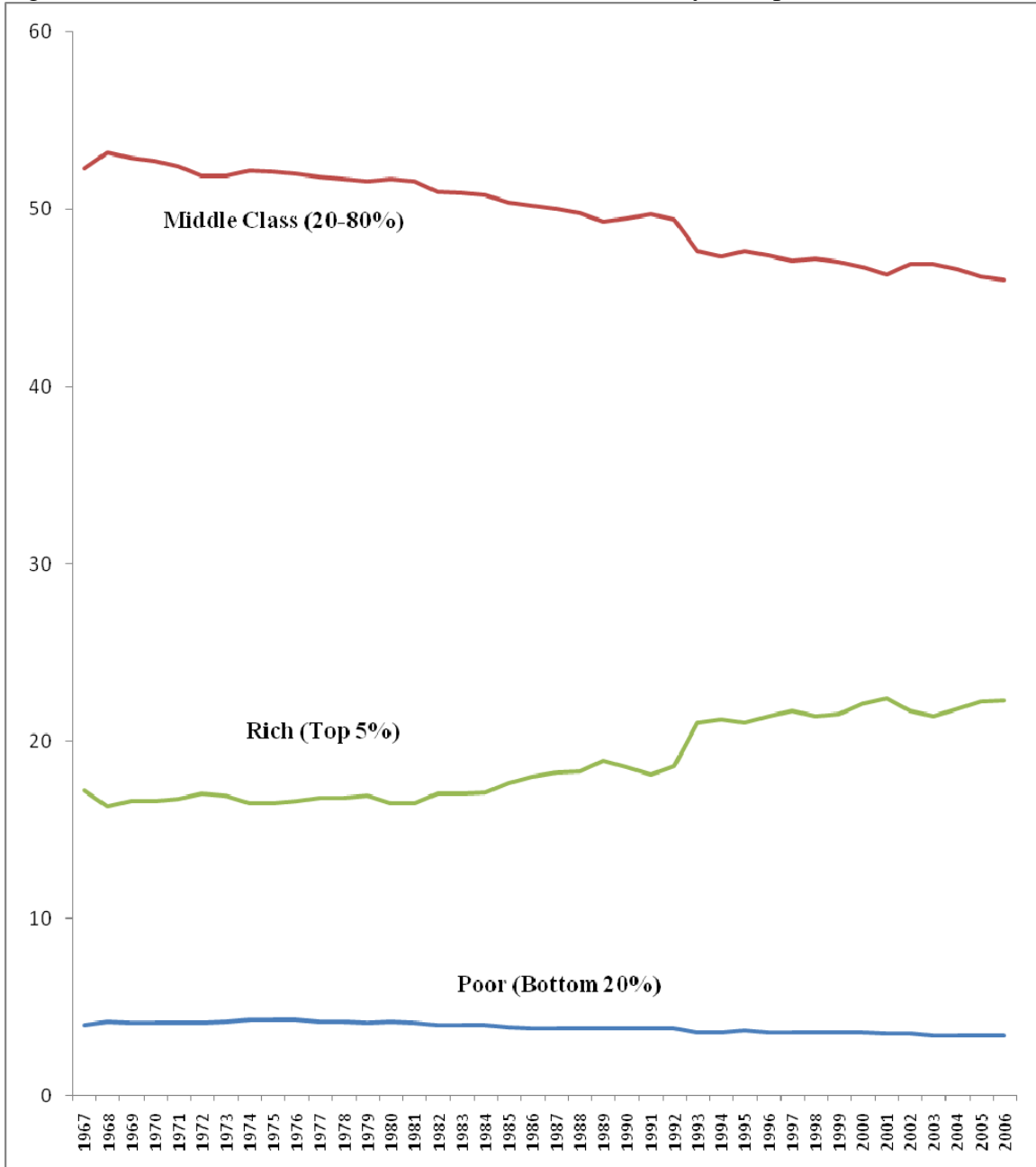
Figure 6: Foreign Exchange Reserves (in billions of US Dollars)



India Data Source: Bank of India,

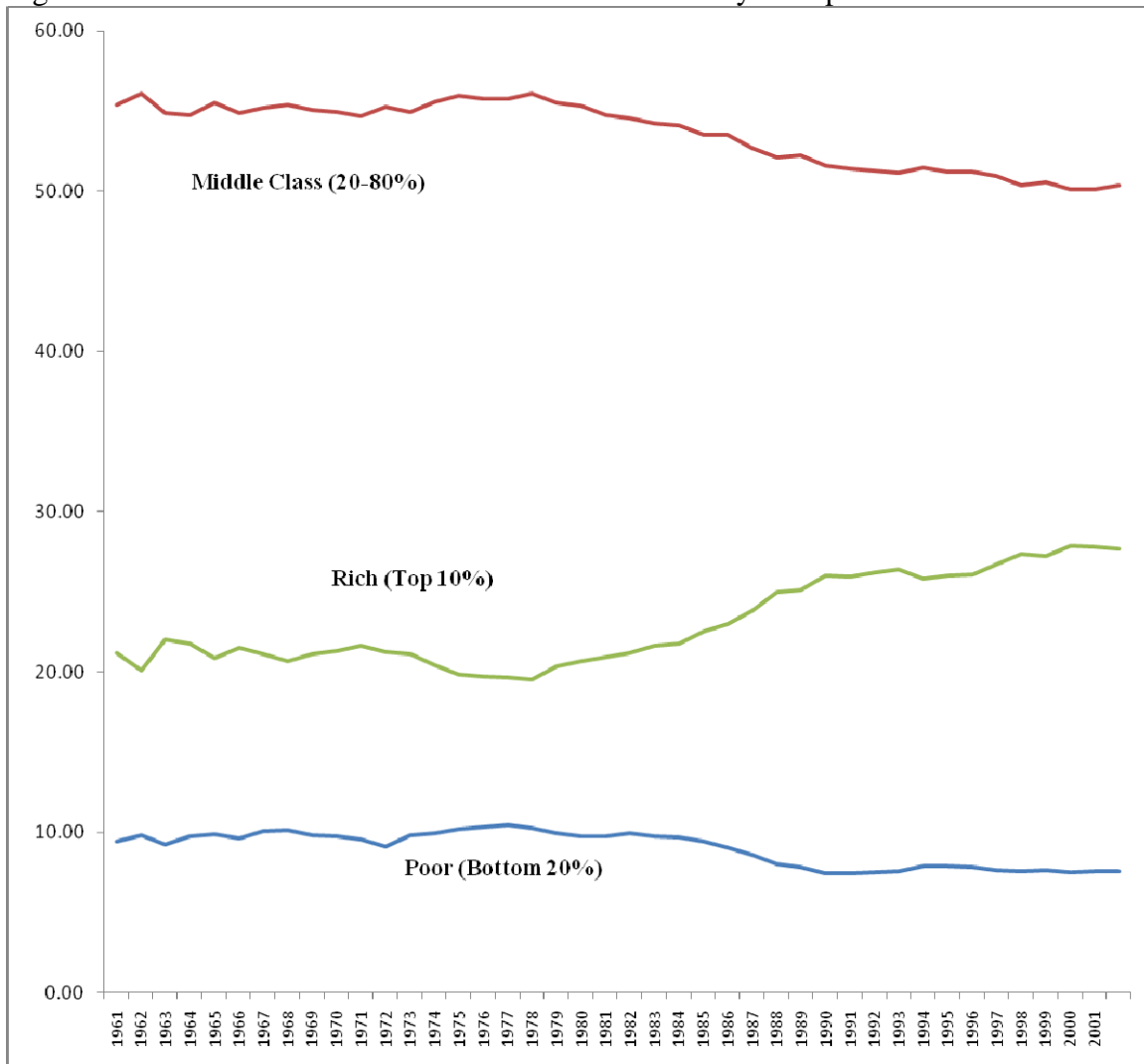
China Data Source: State Administration of Foreign Exchange, People's Republic of China.

Figure 7: Income Distribution in the USA: Income Shares by Groups



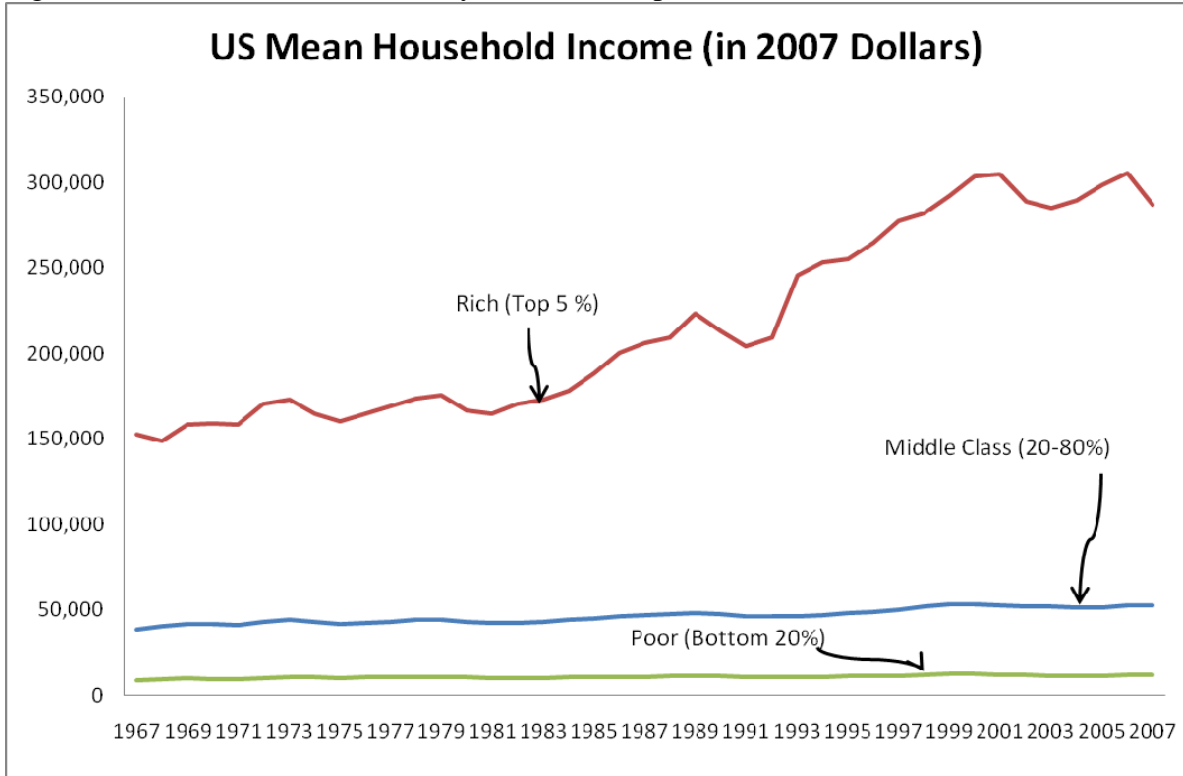
Source: US Census Bureau

Figure 8: Income Distribution in the UK: Income Share by Groups



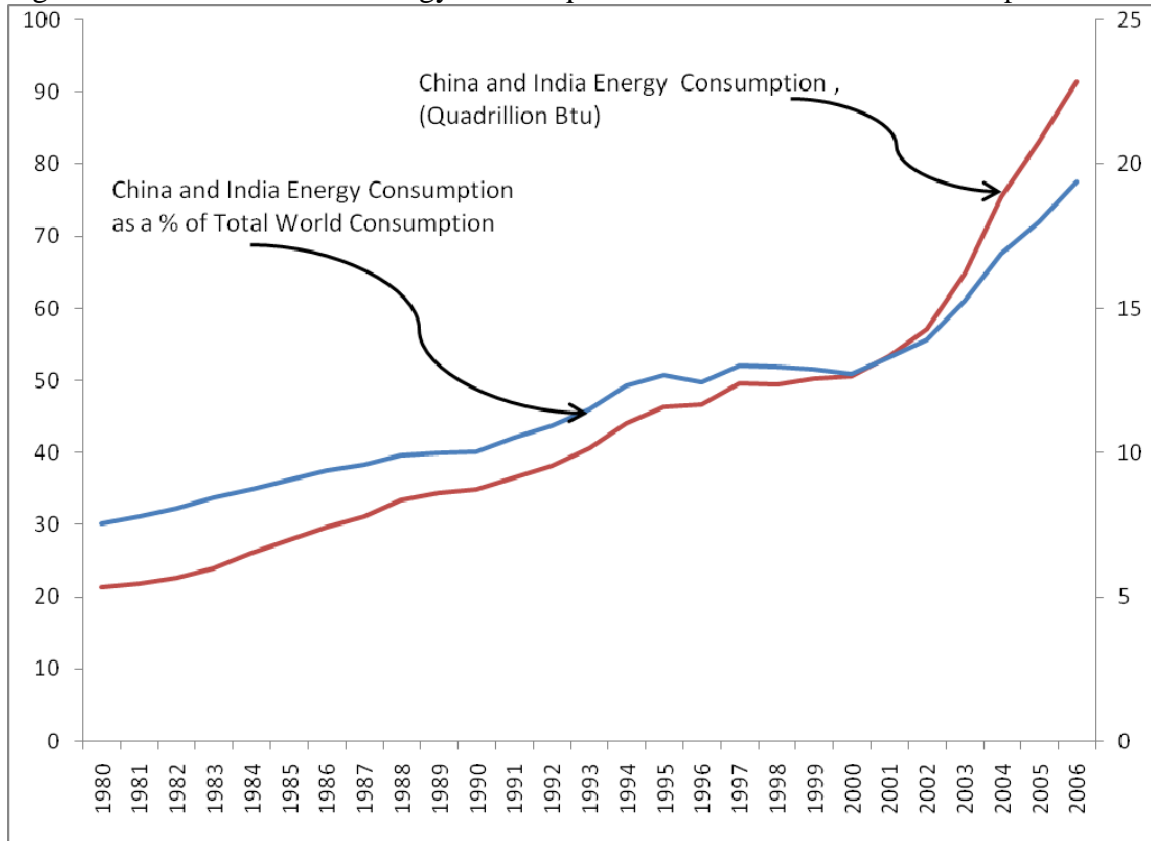
Source: World Income Inequality Database (WIID), United Nations University – World Institute for Development Economics Research (UNU – WIDER)

Figure 9: Real Household income by Income Groups in the USA



Source: US Census Bureau

Figure 10: China and India Energy Consumption and Share in World Consumption

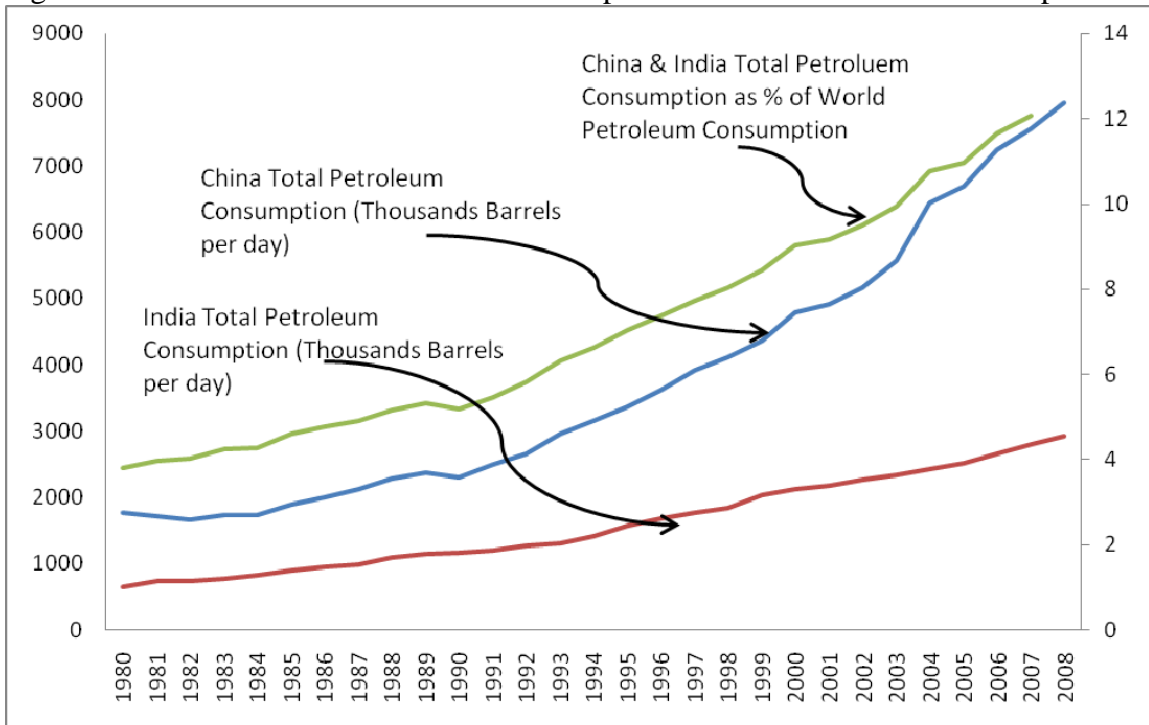


Left Axis: Energy Consumption in Quadrillion Btu

Right Axis: % of Total World Consumption

Source: Energy Information Administration (EIA)

Figure 11: China and India Petroleum Consumption and Share in World Consumption



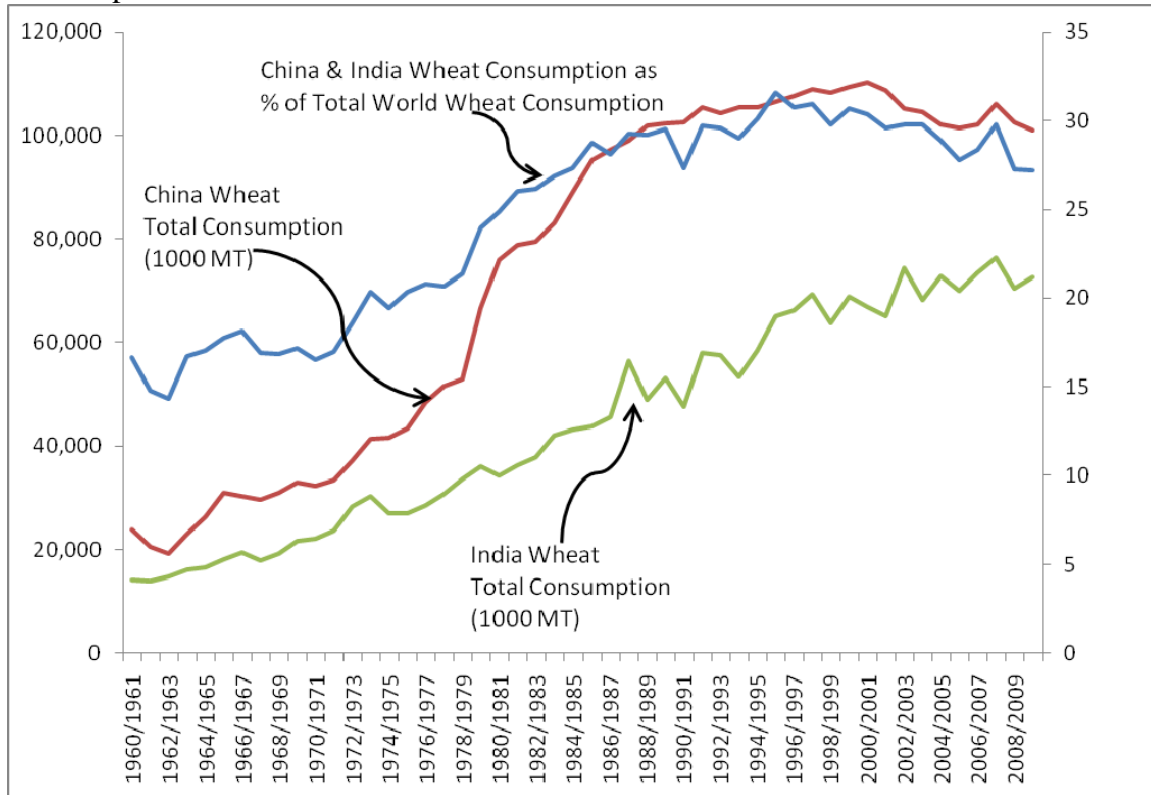
Right Axis: unit - % over World Consumption

Left Axis: unit – Thousands Barrels per day

Source: Energy Information Administration (EIA)

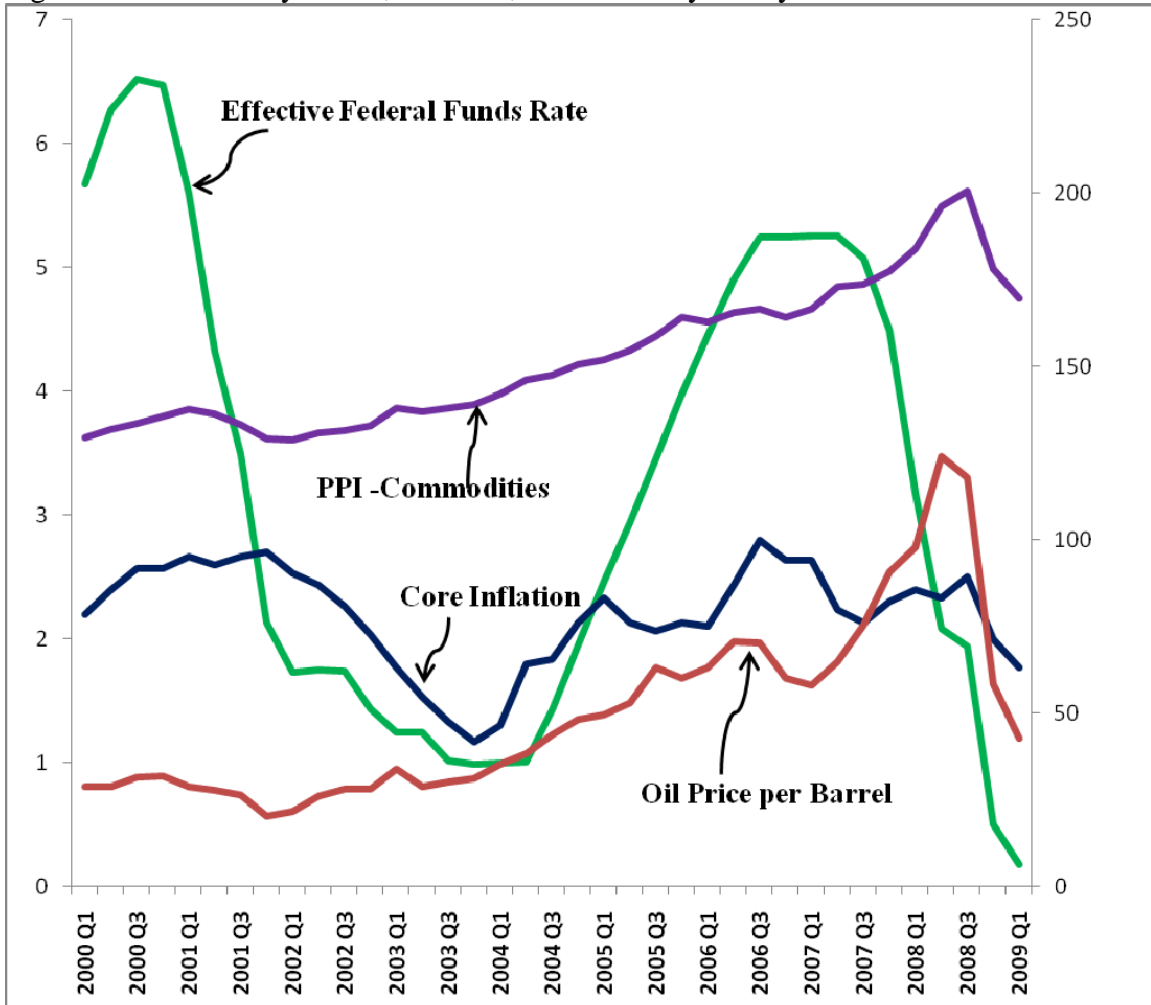


Figure 12: Wheat Consumption by India and China and Share in total World Consumption



Source: USDA

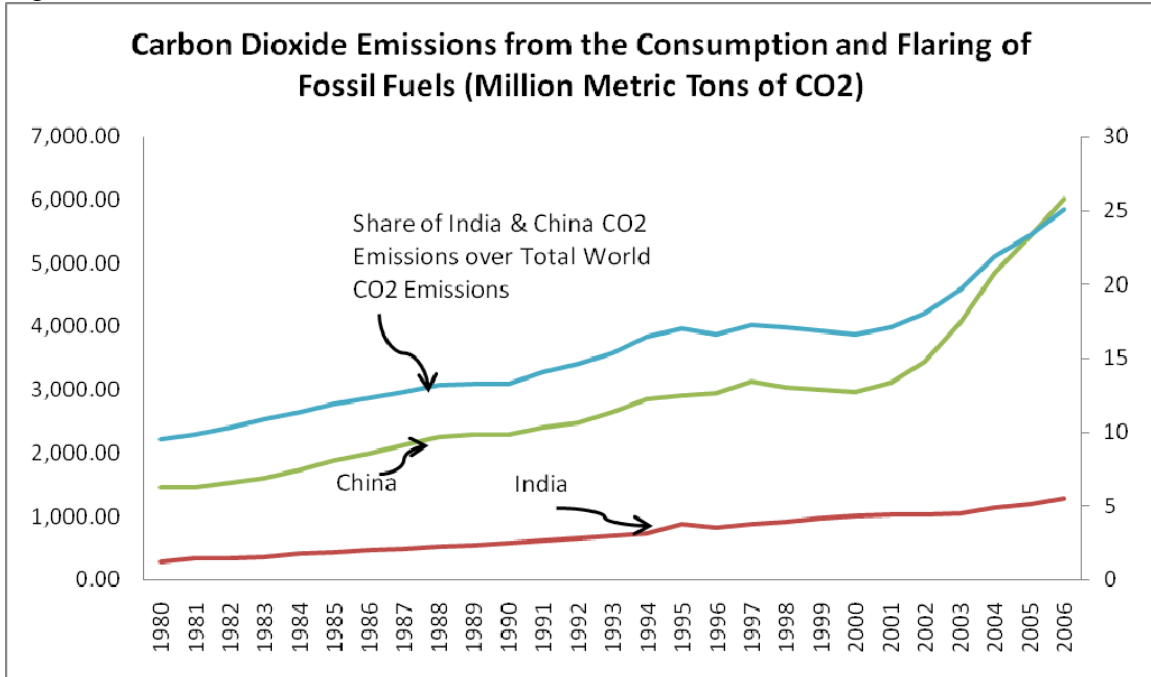
Figure 13: Commodity Prices, Inflation, and Monetary Policy in the USA



Left Axis: Oil Price per Barrel, PPI – Commodities  
 Right Axis: Core Inflation, Effective Federal Funds Rate

Source: US Bureau of Labor Statistics

Figure 14: China and India Carbon Dioxide Emissions

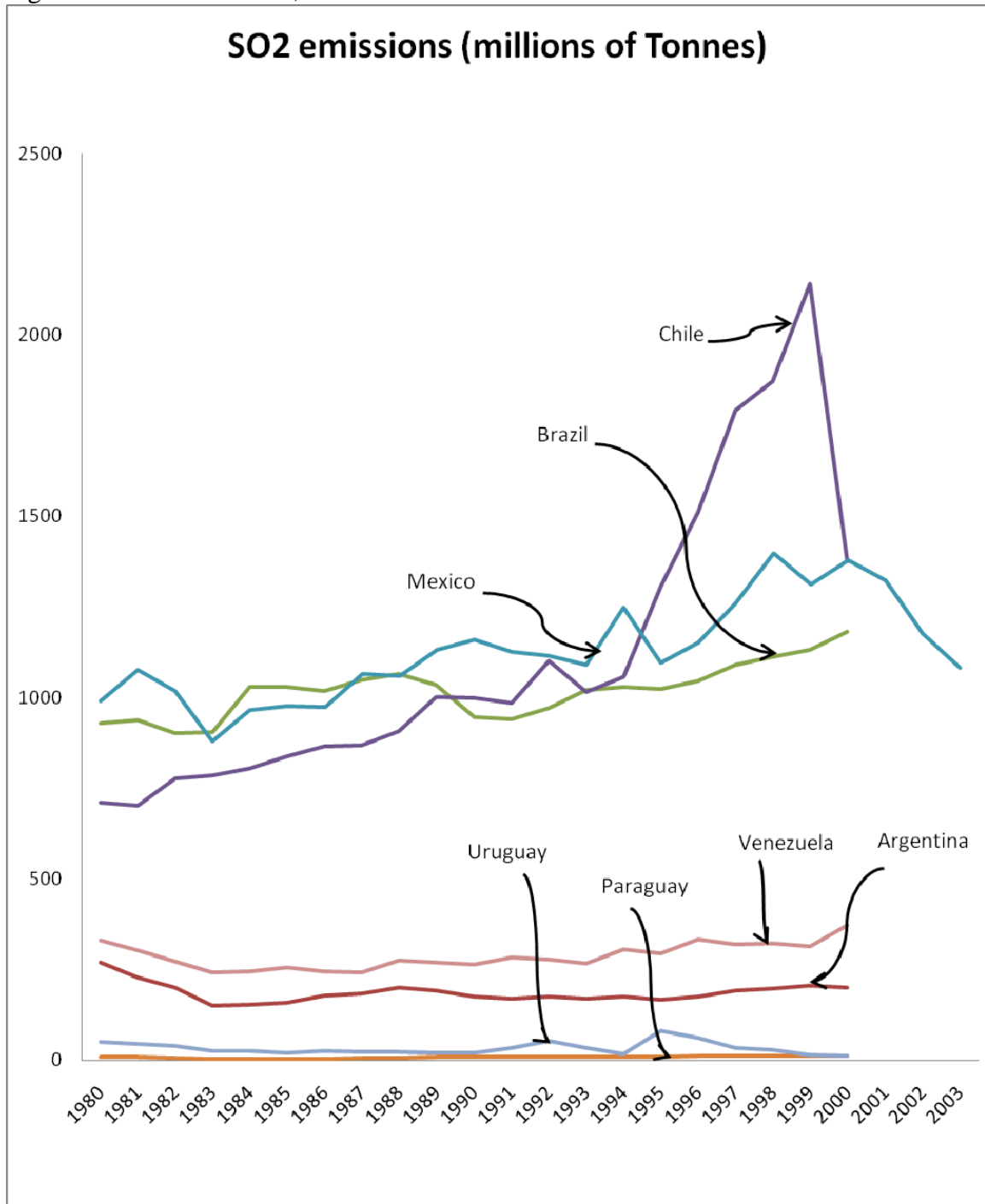


Left Axis: Million Metric Tons of CO2

Right Axis: % of Total World CO2 Emissions

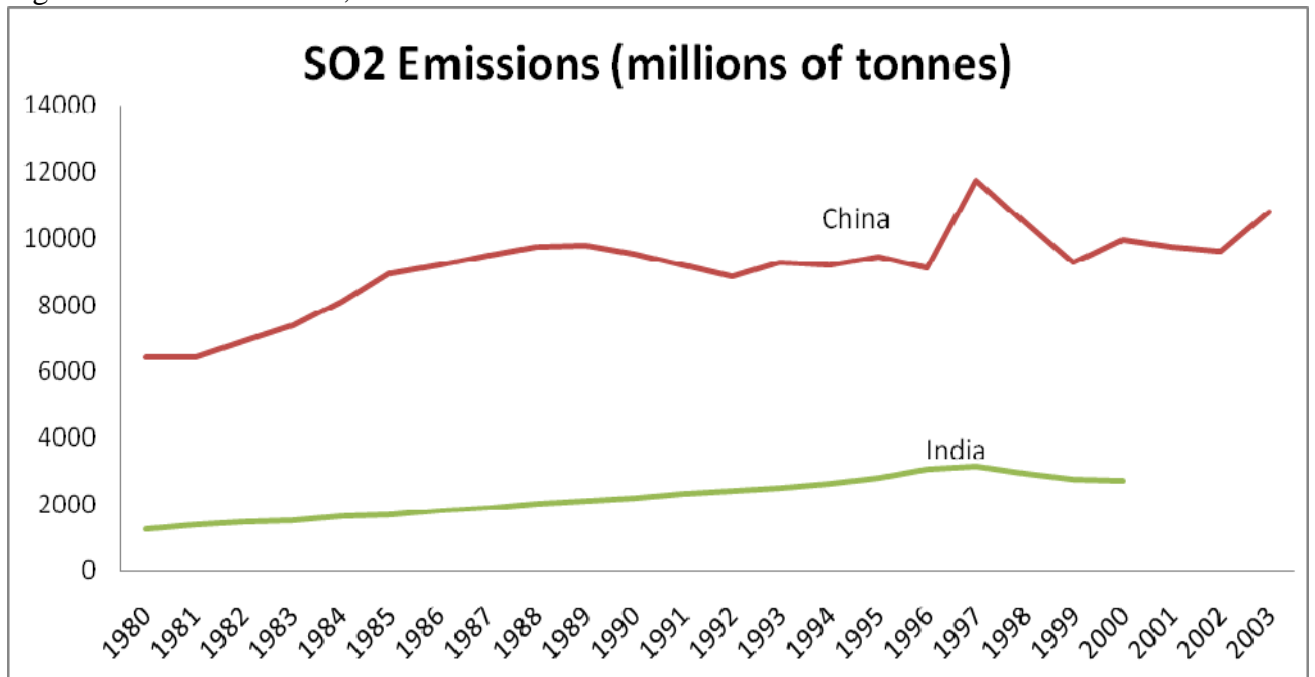
Source: Energy Information Administration

Figure 15: SO2 Emissions, Latin America



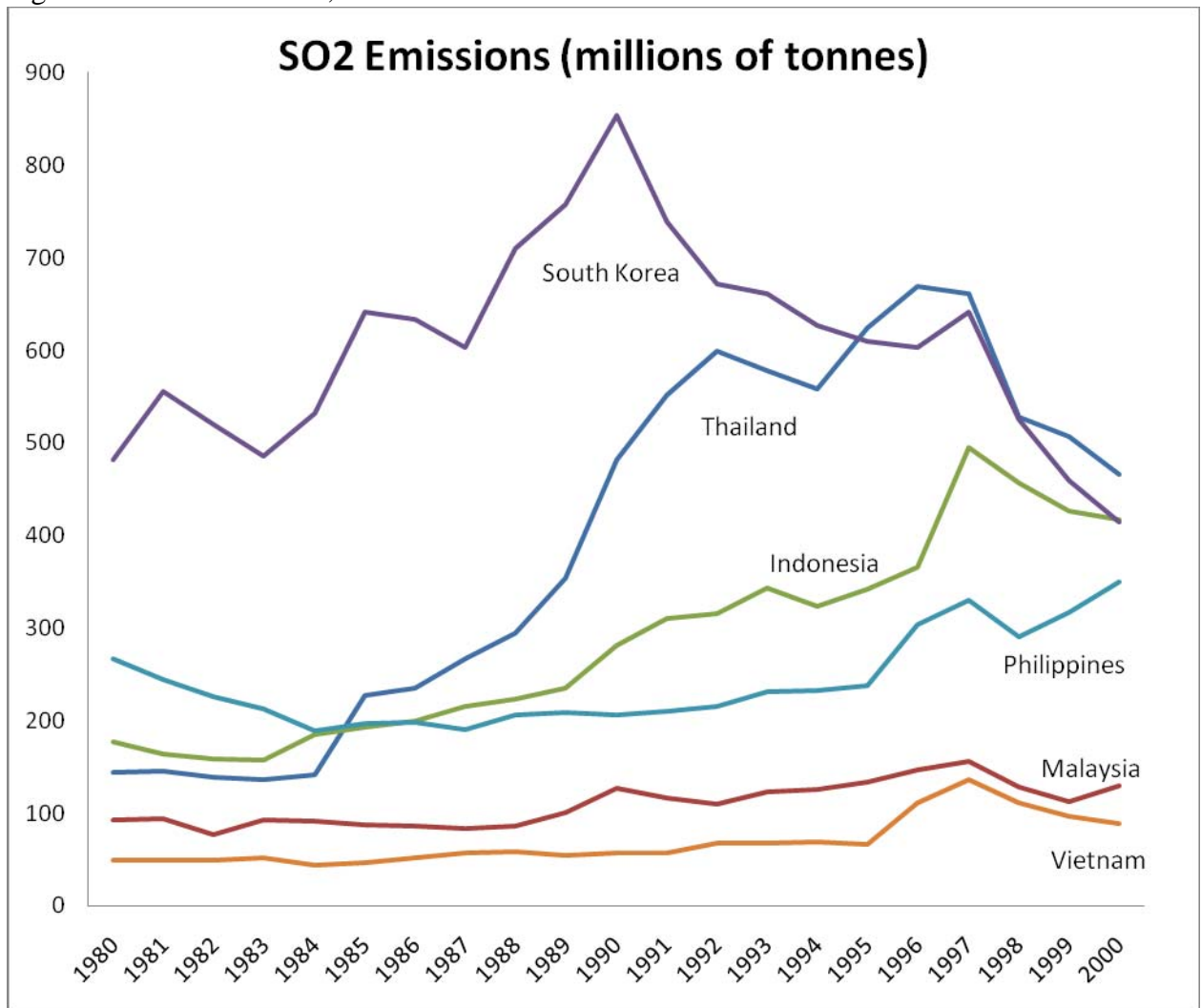
Source: Stern (2005) <http://www.sterndavidi.com/datasite.html>

Figure 16: SO2 Emissions, China and India



Source: Stern (2005) <http://www.sterndavidi.com/datasite.html>

Figure 17: SO2 Emissions, East Asia



Source: Stern (2005) <http://www.sterndavidi.com/datasite.html>

Table 1: Real GDP Growth Rate

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

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

World Bank Definitions of Low, Medium, and High Income countries: GNI per capita range (2007)

Low: \$935 or less

Middle: More than \$905 but less than \$11,116

High: \$11,456 or more.

Table 2: Contribution to Change in World Real GDP (in millions)

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

Source: WDI, World Bank

Table 3: Demand for Metals

**Cross-Country Shares in Global Increase in Metals Demand, 1996–2005<sup>1</sup>**

|                                       |  | Aluminum     | Copper       | Nickel       | Steel <sup>2</sup> |
|---------------------------------------|--|--------------|--------------|--------------|--------------------|
| <b>% change in global consumption</b> |  | <b>53.0%</b> | <b>35.2%</b> | <b>44.2%</b> | <b>44.4%</b>       |
| due to real GDP growth                |  | 68.8%        | 68.8%        | 68.8%        | 59.3%              |
| due to other                          |  | -15.7%       | -33.5%       | -24.5%       | -15.0%             |
| <b>Brazil</b>                         | <b>Share of global increase</b>        | <b>2.4%</b>  | <b>1.9%</b>  | <b>2.6%</b>  | <b>0.5%</b>        |
|                                       | due to GDP                             | 2.2%         | 2.8%         | 1.9%         | 2.0%               |
|                                       | due to other                           | 0.2%         | -0.9%        | 0.7%         | -1.6%              |
|                                       | due to growth in industrial activity   | 4.3%         | 5.3%         | 3.2%         | 4.1%               |
|                                       | due to commodity intensity in industry | -1.9%        | -3.4%        | -0.6%        | -3.6%              |
| <b>China</b>                          | <b>Share of global increase</b>        | <b>45.7%</b> | <b>59.4%</b> | <b>37.8%</b> | <b>68.7%</b>       |
|                                       | due to GDP                             | 31.6%        | 46.4%        | 18.7%        | 44.7%              |
|                                       | due to other                           | 14.1%        | 13.0%        | 19.1%        | 24.0%              |
|                                       | due to growth in industrial activity   | 31.6%        | 46.5%        | 18.7%        | 44.7%              |
|                                       | due to commodity intensity in industry | 14.1%        | 13.0%        | 19.1%        | 23.9%              |
| <b>India</b>                          | <b>Share of global increase</b>        | <b>3.4%</b>  | <b>6.2%</b>  | <b>-0.6%</b> | <b>4.7%</b>        |
|                                       | due to GDP                             | 5.7%         | 3.6%         | 4.9%         | 7.3%               |
|                                       | due to other                           | -2.3%        | 2.6%         | -5.5%        | -2.6%              |
|                                       | due to growth in industrial activity   | 5.6%         | 3.5%         | 4.3%         | 7.4%               |
|                                       | due to commodity intensity in industry | -2.2%        | 2.7%         | -5.0%        | -2.7%              |
| <b>United States</b>                  | <b>Share of global increase</b>        | <b>7.0%</b>  | <b>-8.1%</b> | <b>2.2%</b>  | <b>-3.1%</b>       |
|                                       | due to GDP                             | 29.0%        | 37.1%        | 14.9%        | 17.8%              |
|                                       | due to other                           | -21.9%       | -45.2%       | -12.7%       | -20.9%             |
|                                       | due to growth in industrial activity   | 20.5%        | 26.3%        | 10.7%        | 12.8%              |
|                                       | due to commodity intensity in industry | -13.5%       | -34.4%       | -8.5%        | -15.9%             |

1. This table breaks down the proportion of the increase in metals demand from a particular country that can be due to GDP growth (or industrial growth) and other factors. It assumes that, if nothing else in the economy changed, then metals consumption would have to increase one-for-one with GDP (or industrial) growth (assumes income elasticity of metals demand equals one). The residual, likely due to the metals intensity in industry, accounts for the unexplained portion.

2. The analysis for steel was for the period 1997–2005, in contrast to aluminum, copper, and nickel, which covered 1996–2005, due to data availability on steel demand.

Source: World Metals Yearbook, WDI, IMF (2008), and Bank of Canada staff calculations

Table and calculations from Francis and Winters (2008).



Table 4: Environmental Regulatory Regime Index by Country, Absolute Ranking

**Environmental Regulatory Regime Index**

| Rank | Country        | Score  | Rank | Country            | Score  |
|------|----------------|--------|------|--------------------|--------|
| 1    | Finland        | 2.303  | 37   | Korea              | -0.121 |
| 2    | Sweden         | 1.772  | 38   | Malaysia           | -0.127 |
| 3    | Singapore      | 1.771  | 39   | Lithuania          | -0.146 |
| 4    | Netherlands    | 1.747  | 40   | Slovak Republic    | -0.177 |
| 5    | Austria        | 1.641  | 41   | Egypt              | -0.224 |
| 6    | Switzerland    | 1.631  | 42   | Panama             | -0.242 |
| 7    | Germany        | 1.522  | 43   | Mauritius          | -0.290 |
| 8    | France         | 1.464  | 44   | China              | -0.348 |
| 9    | Denmark        | 1.384  | 45   | Thailand           | -0.389 |
| 10   | Iceland        | 1.354  | 46   | Colombia           | -0.416 |
| 11   | New Zealand    | 1.299  | 47   | Bulgaria           | -0.584 |
| 12   | Canada         | 1.297  | 48   | Mexico             | -0.602 |
| 13   | United Kingdom | 1.185  | 49   | Greece             | -0.619 |
| 14   | United States  | 1.184  | 50   | Peru               | -0.722 |
| 15   | Belgium        | 1.159  | 51   | Argentina          | -0.732 |
| 16   | Australia      | 1.083  | 52   | Zimbabwe           | -0.732 |
| 17   | Japan          | 1.057  | 53   | Bolivia            | -0.743 |
| 18   | Norway         | 1.045  | 54   | Indonesia          | -0.758 |
| 19   | Ireland        | 0.546  | 55   | India              | -0.759 |
| 20   | Italy          | 0.498  | 56   | Vietnam            | -0.770 |
| 21   | Spain          | 0.437  | 57   | Russia             | -0.895 |
| 22   | Estonia        | 0.296  | 58   | Sri Lanka          | -0.936 |
| 23   | Hungary        | 0.283  | 59   | Philippines        | -1.014 |
| 24   | Slovenia       | 0.209  | 60   | Dominican Republic | -1.014 |
| 25   | Chile          | 0.177  | 61   | Venezuela          | -1.079 |
| 26   | Czech Republic | 0.073  | 62   | Nicaragua          | -1.164 |
| 27   | Uruguay        | 0.059  | 63   | El Salvador        | -1.215 |
| 28   | Israel         | 0.021  | 64   | Romania            | -1.268 |
| 29   | Poland         | 0.005  | 65   | Ukraine            | -1.297 |
| 30   | Jordan         | 0.002  | 66   | Honduras           | -1.300 |
| 31   | Portugal       | -0.028 | 67   | Nigeria            | -1.314 |
| 32   | South Africa   | -0.029 | 68   | Bangladesh         | -1.331 |
| 33   | Latvia         | -0.036 | 69   | Guatemala          | -1.532 |
| 34   | Jamaica        | -0.037 | 70   | Ecuador            | -1.616 |
| 35   | Brazil         | -0.077 | 71   | Paraguay           | -1.743 |
| 36   | Costa Rica     | -0.078 |      |                    |        |

Source: Esty and Porter (2001)

Table 5: Difference of SO<sub>2</sub> concentration between the actual and the expected levels, given per capita GDP

**Urban SO<sub>2</sub> concentration relative to expected given GDP per capita, listed by income groups**

| Low-Income Countries (≤ \$6,500) |             |          | Middle-Income Countries (\$6,500–\$23,000) |                 |          | High-Income Countries (≥ \$23,000) |                |          |
|----------------------------------|-------------|----------|--|-----------------|----------|------------------------------------|----------------|----------|
| Rank                             | Country     | Residual | Rank                                       | Country         | Residual | Rank                               | Country        | Residual |
| 1                                | Ecuador     | -28.49   | 1  | Lithuania       | -34.29   | 1                                  | Finland        | -11.07   |
| 2                                | Romania     | -28.10   | 2  | Latvia          | -31.41   | 2                                  | Sweden         | -10.89   |
| 3                                | Thailand    | -26.69   | 3  | Argentina       | -26.04   | 3                                  | Iceland        | -7.81    |
| 4                                | India       | -26.49   | 4  | New Zealand     | -15.54   | 4                                  | Norway         | -7.16    |
| 5                                | Philippines | -12.81   | 5  | Portugal        | -12.63   | 5                                  | Denmark        | -7.02    |
| 6                                | Venezuela   | -6.84    | 6  | Malaysia        | -11.88   | 6                                  | Netherlands    | -4.97    |
| 7                                | Bulgaria    | 11.99    | 7  | South Africa    | -9.52    | 7                                  | Germany        | -2.60    |
| 8                                | Egypt       | 21.64    | 8  | Spain           | -8.72    | 8                                  | France         | -2.12    |
| 9                                | China       | 51.25    | 9  | Slovak Republic | -6.21    | 9                                  | Switzerland    | -1.85    |
|                                  |             |          | 10   | Chile           | -2.89    | 10                                 | Australia      | -1.70    |
|                                  |             |          | 11   | Czech Republic  | 2.07     | 11                                 | Austria        | -1.31    |
|                                  |             |          | 12   | Singapore       | 3.26     | 12                                 | Italy          | -0.97    |
|                                  |             |          | 13   | Costa Rica      | 7.03     | 13                                 | Canada         | -0.75    |
|                                  |             |          | 14   | Hungary         | 10.30    | 14                                 | Ireland        | 3.67     |
|                                  |             |          | 15   | Greece          | 11.60    | 15                                 | United States  | 5.09     |
|                                  |             |          | 16   | Poland          | 22.43    | 16                                 | United Kingdom | 5.37     |
|                                  |             |          | 17   | Korea           | 30.98    | 17                                 | Belgium        | 6.91     |
|                                  |             |          | 18   | Brazil          | 40.29    | 18                                 | Japan          | 9.49     |
|                                  |             |          | 19   | Mexico          | 41.61    |                                    |                |          |
|                                  |             |          | 20   | Russia          | 63.80    |                                    |                |          |

\* Not all data were available for all countries.

Source: Esty and Porter (2001)

Table 6: Asian Financial Crisis Currency Depreciation

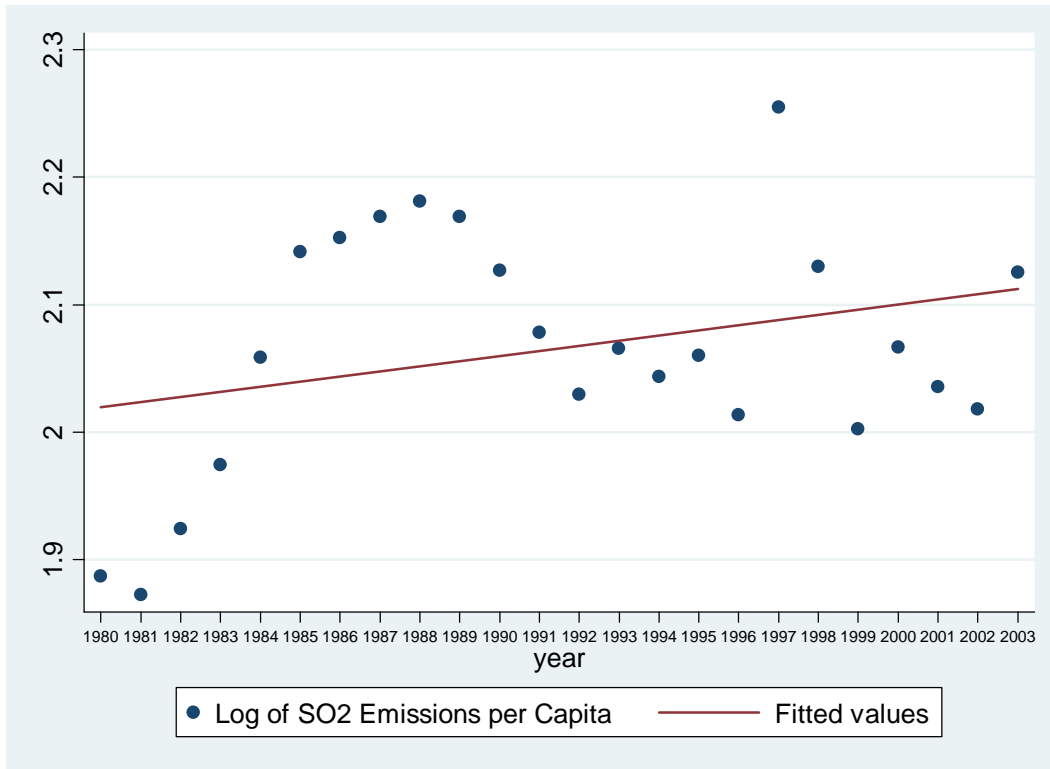
| Asian Crisis - Forex Markets vs. US\$ |              |                    |
|---------------------------------------|--------------|--------------------|
| Country                               | Depreciation | Period             |
| Indonesia                             | -84%         | July-97 to July-98 |
| Thailand                              | -53%         | July-97 to July-98 |
| Korea                                 | -51%         | July-97 to July-98 |
| Malaysia                              | -47%         | July-97 to July-98 |
| Philippines                           | -40%         | July-97 to July-98 |

Source: World Bank Crisis Talk

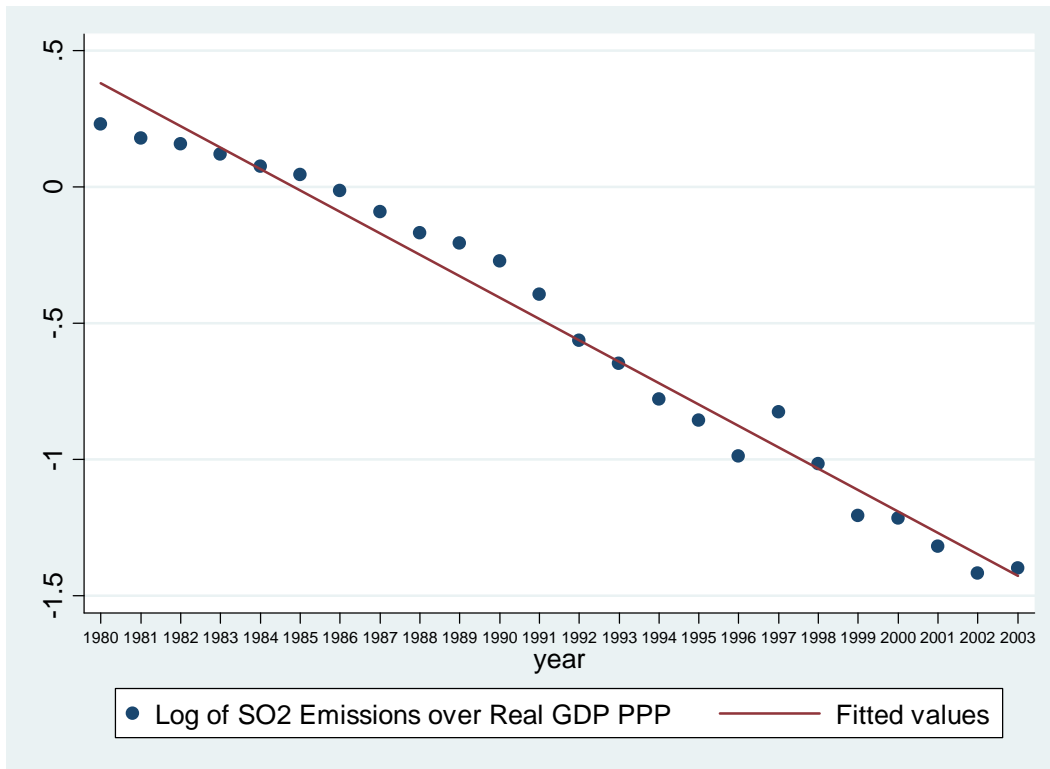
<http://crisistalk.worldbank.org/2008/10/currency-deprec.html>

## APPENDIX A: SO2 Emissions Deviation from Trend

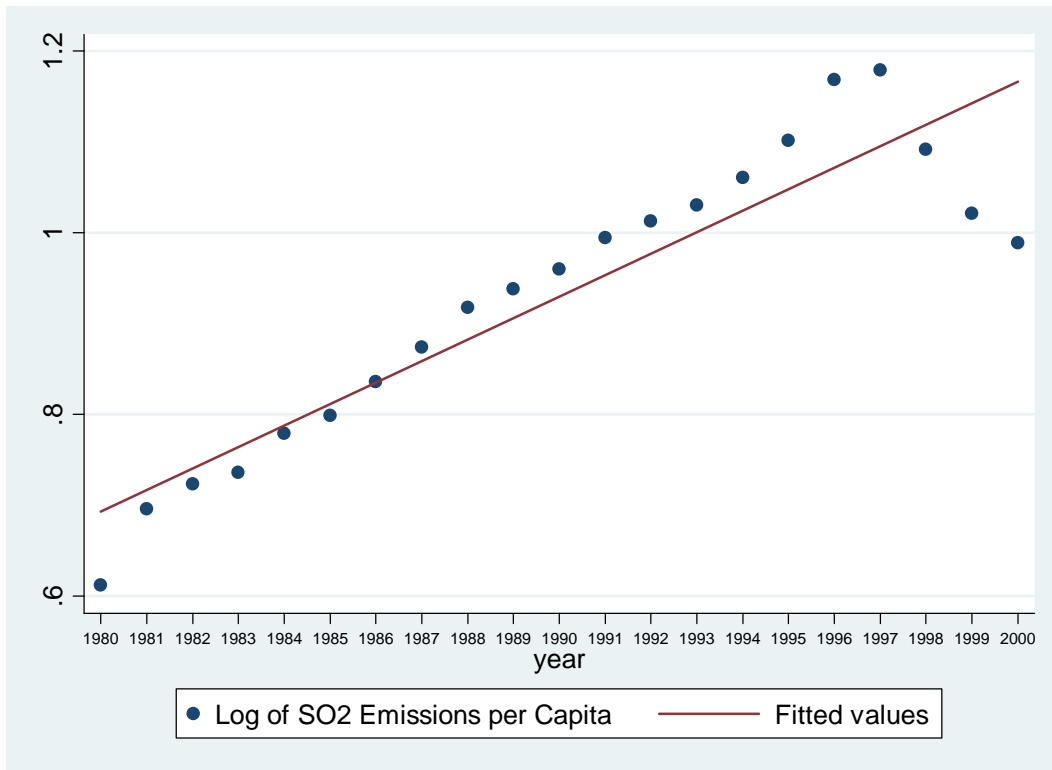
China



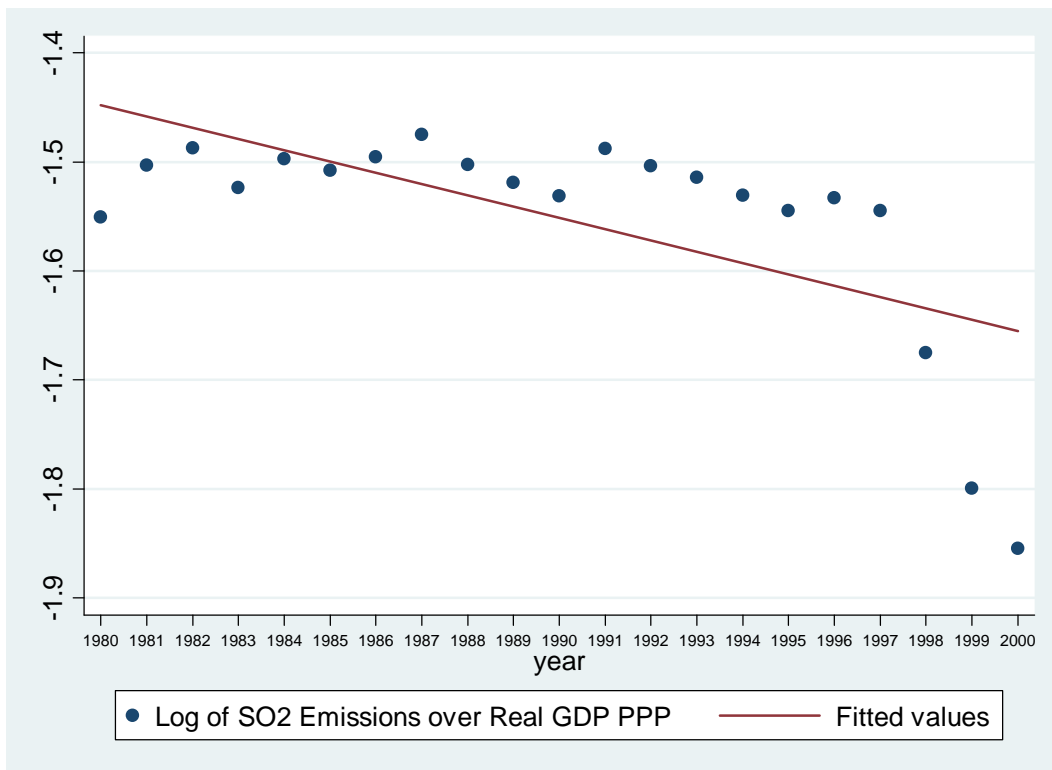
China



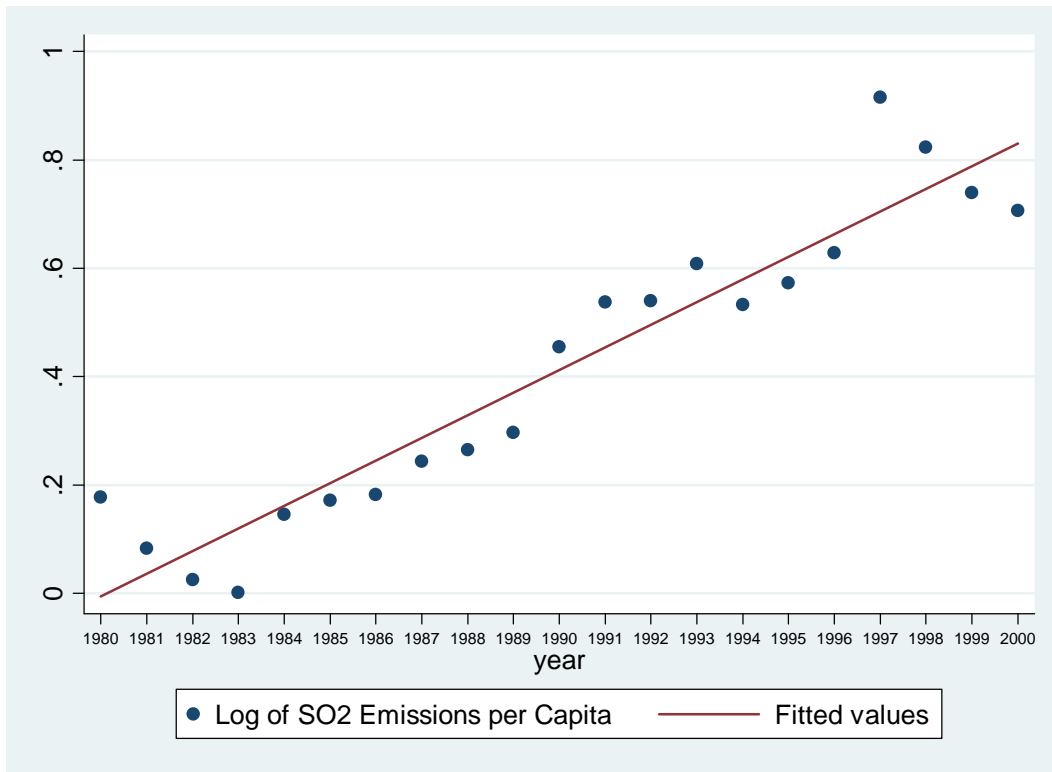
# India



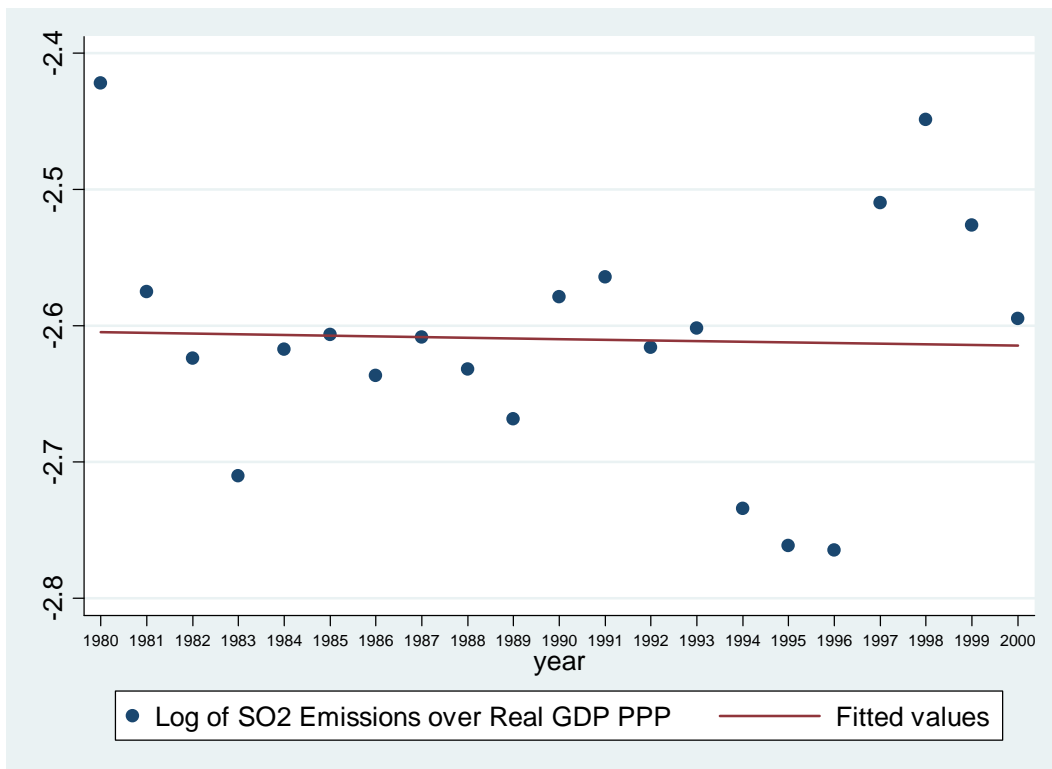
# India



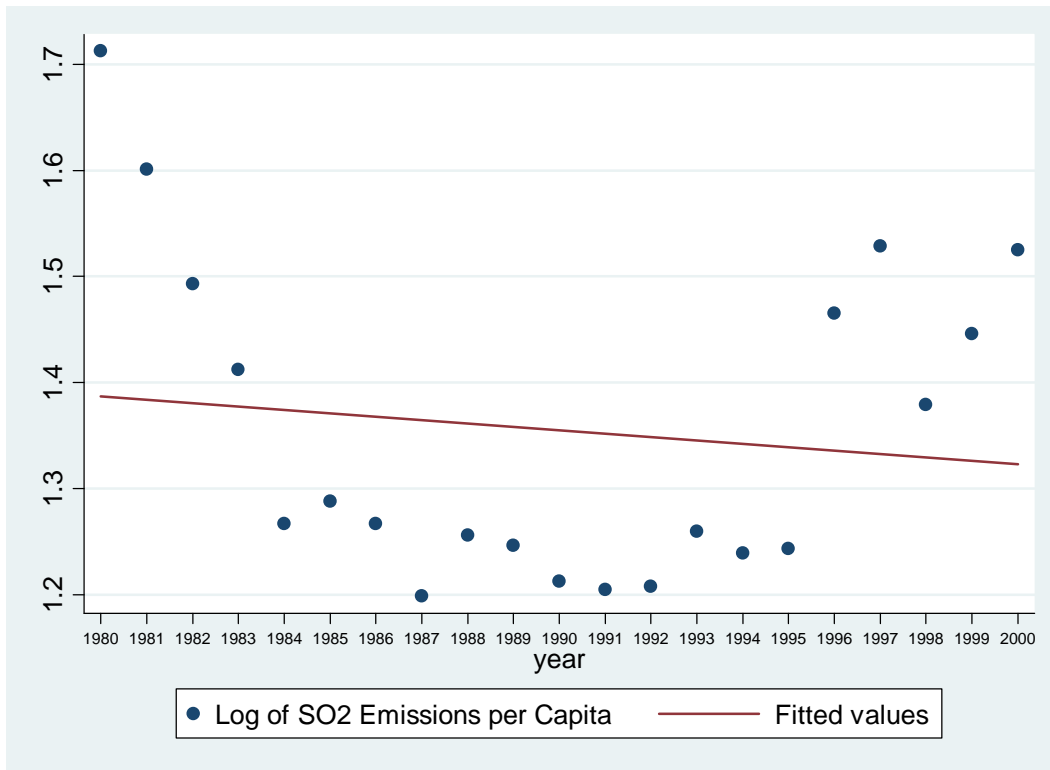
## Indonesia



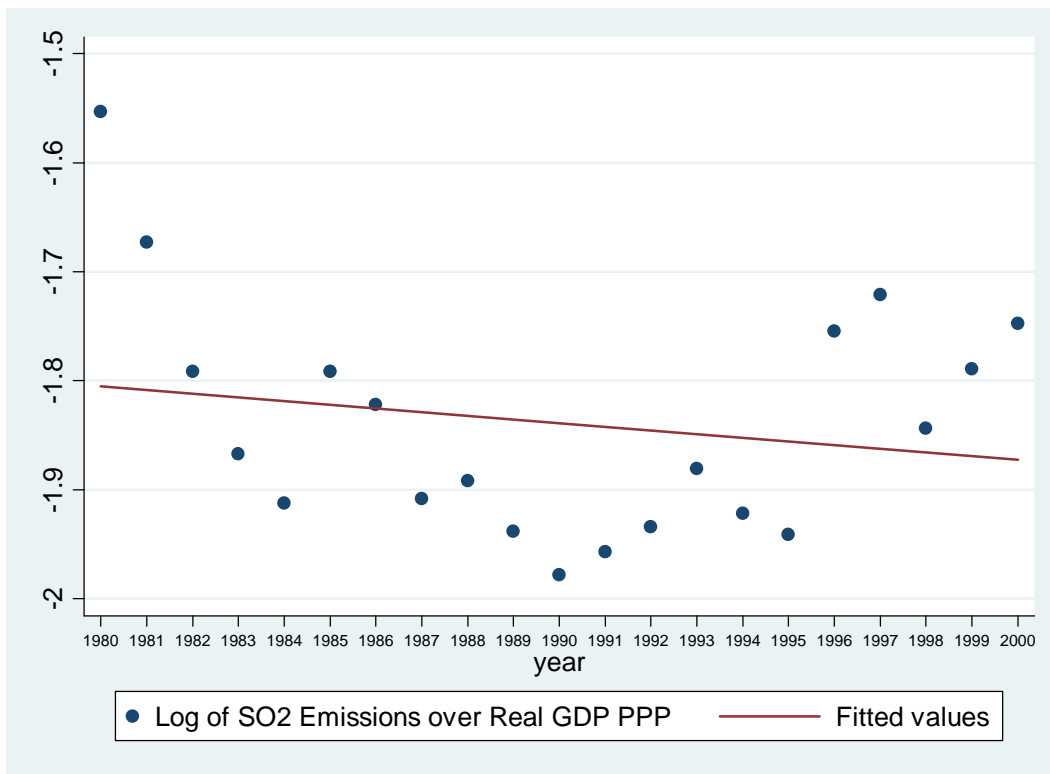
## Indonesia



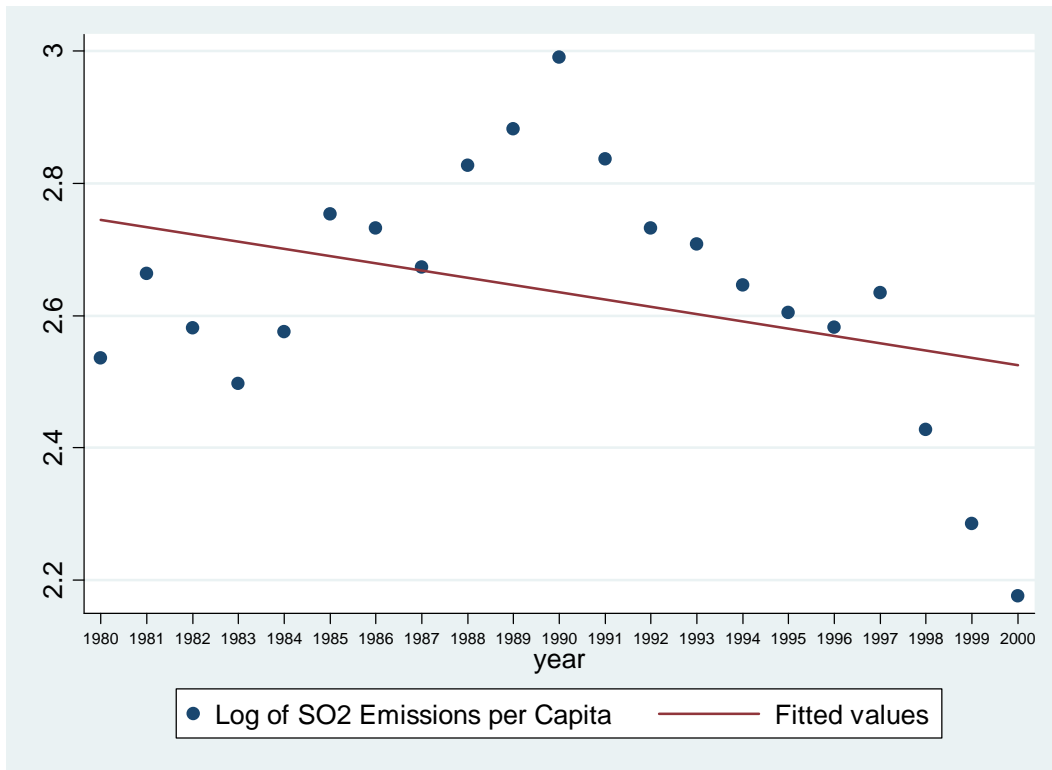
## Philippines



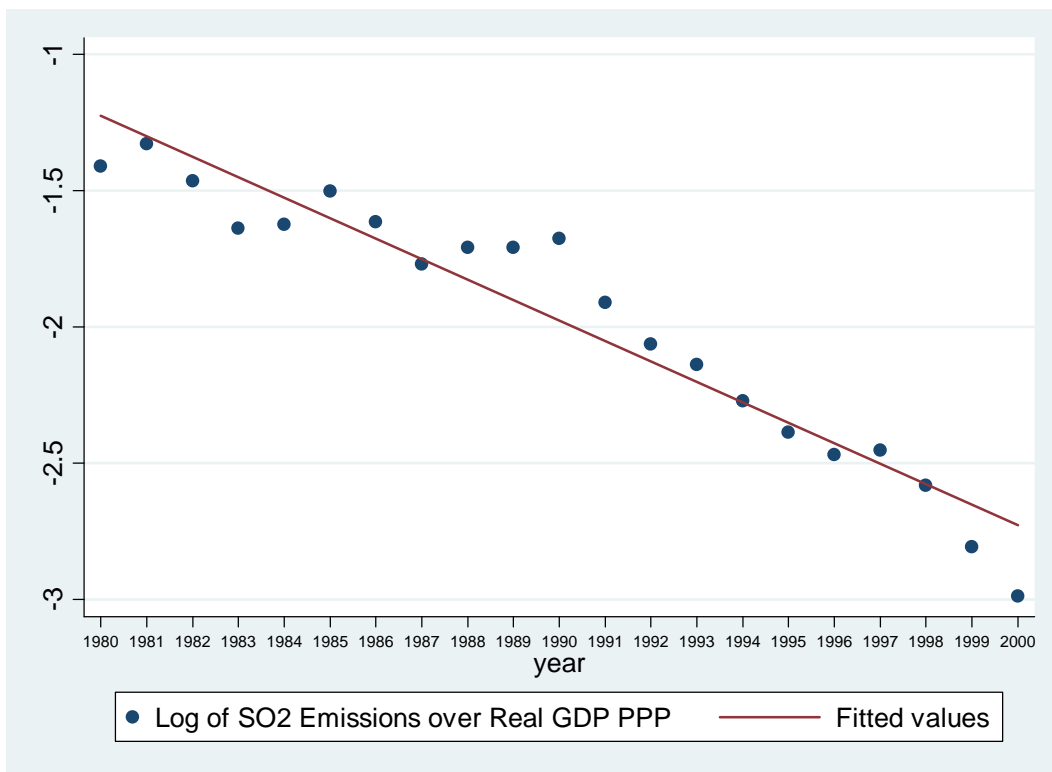
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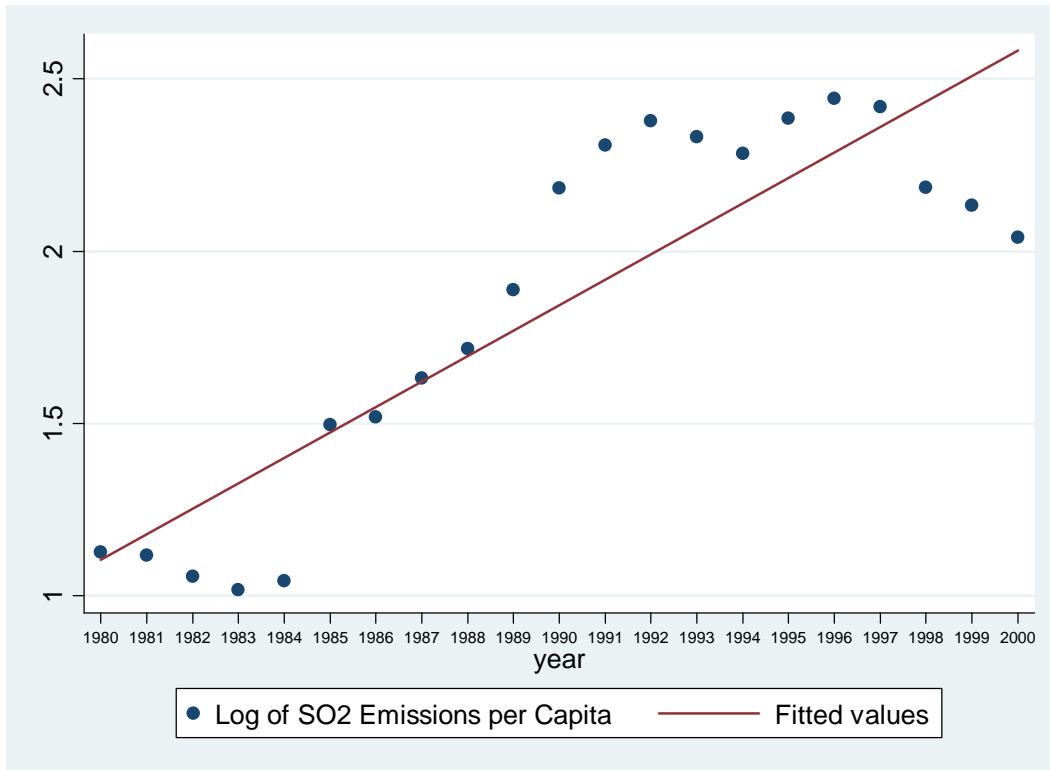
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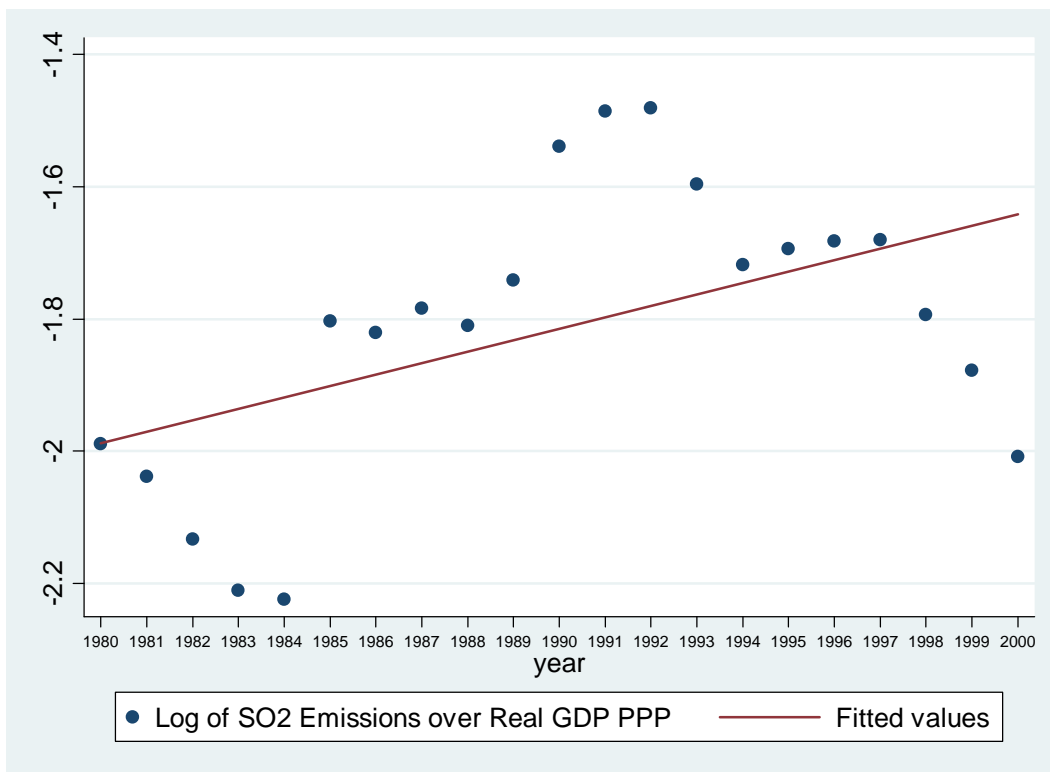
### South Korea



## Thailand

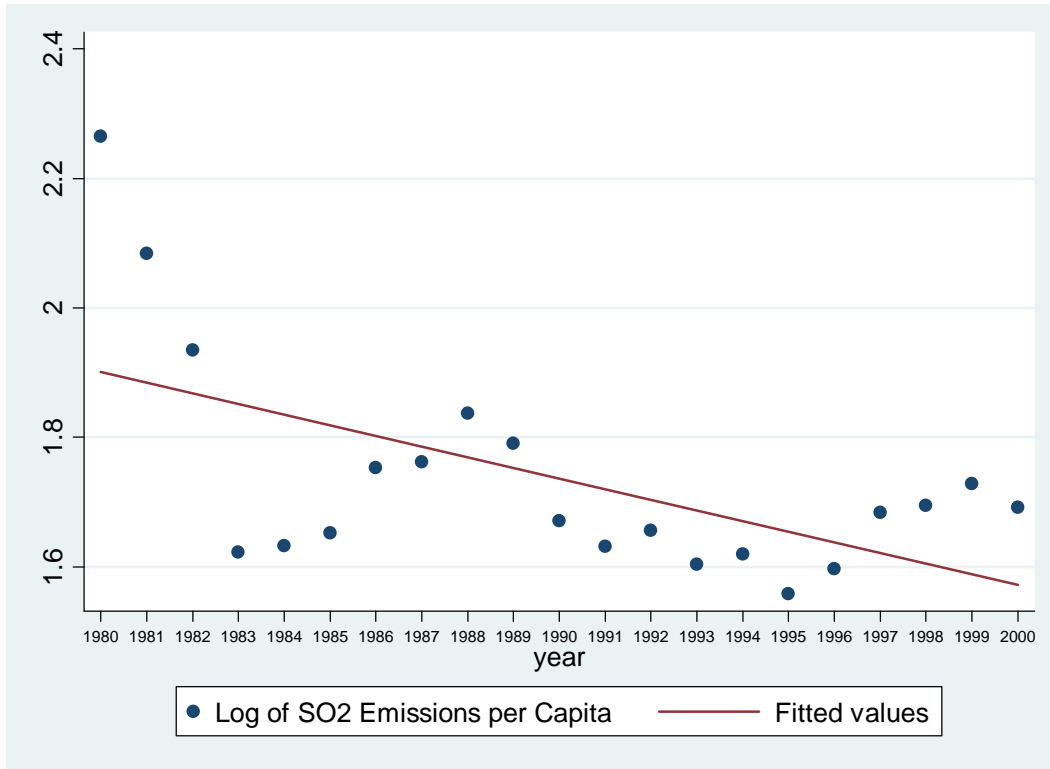


## Thailand

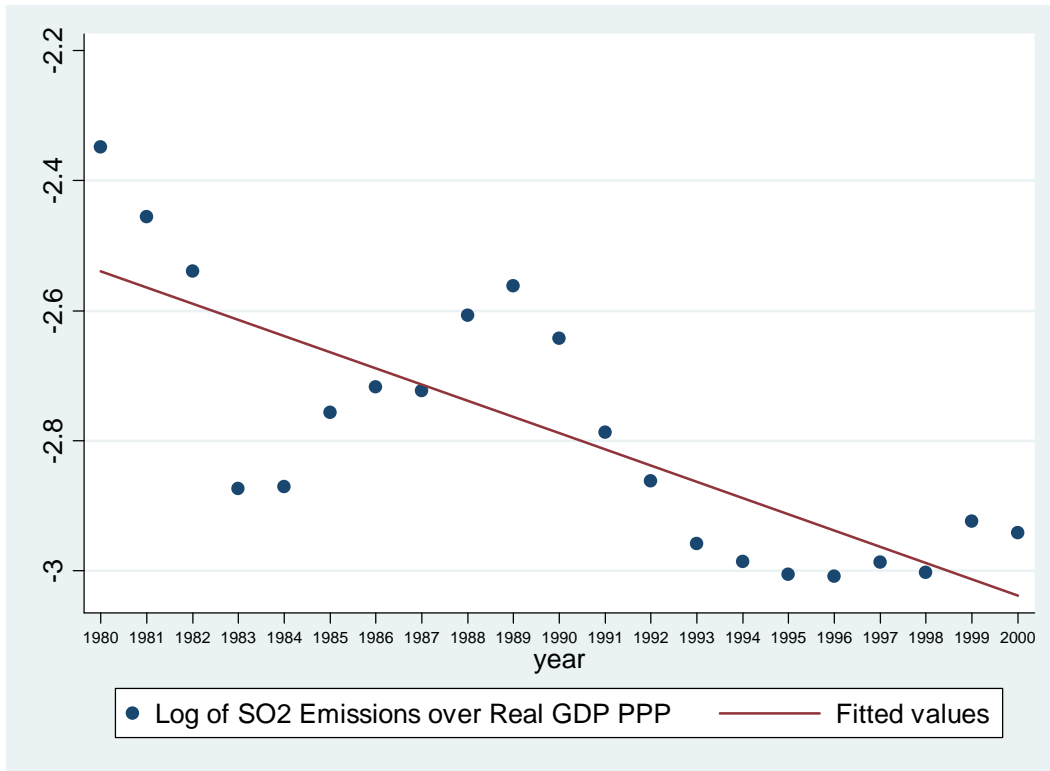




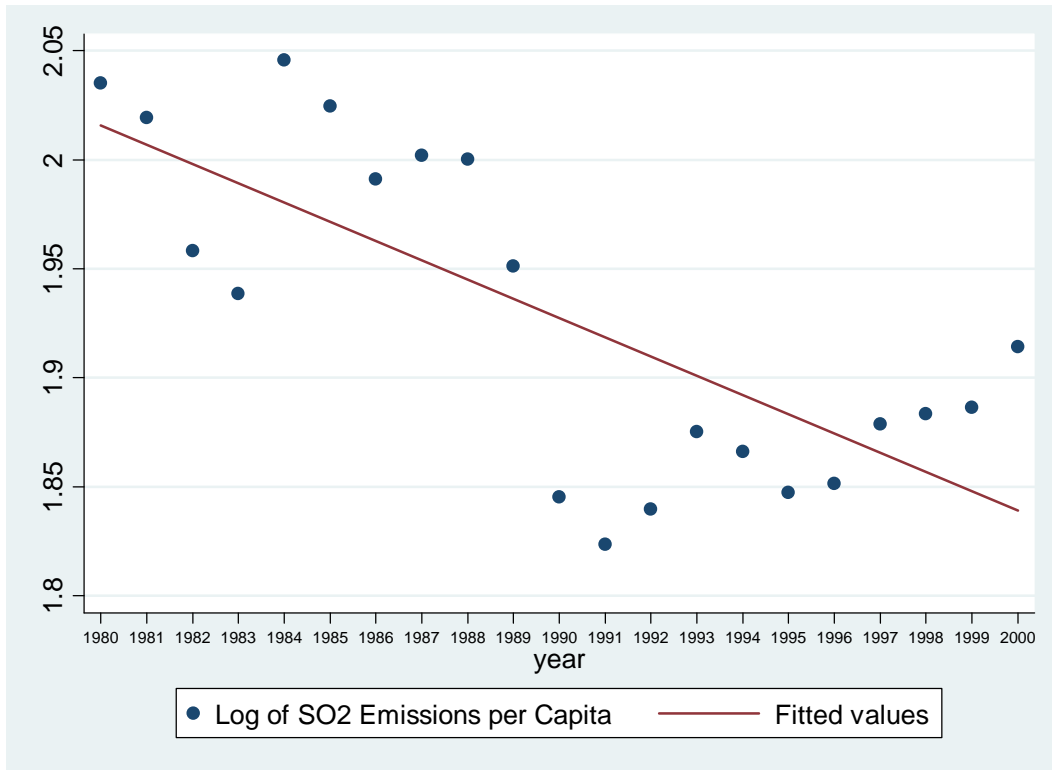
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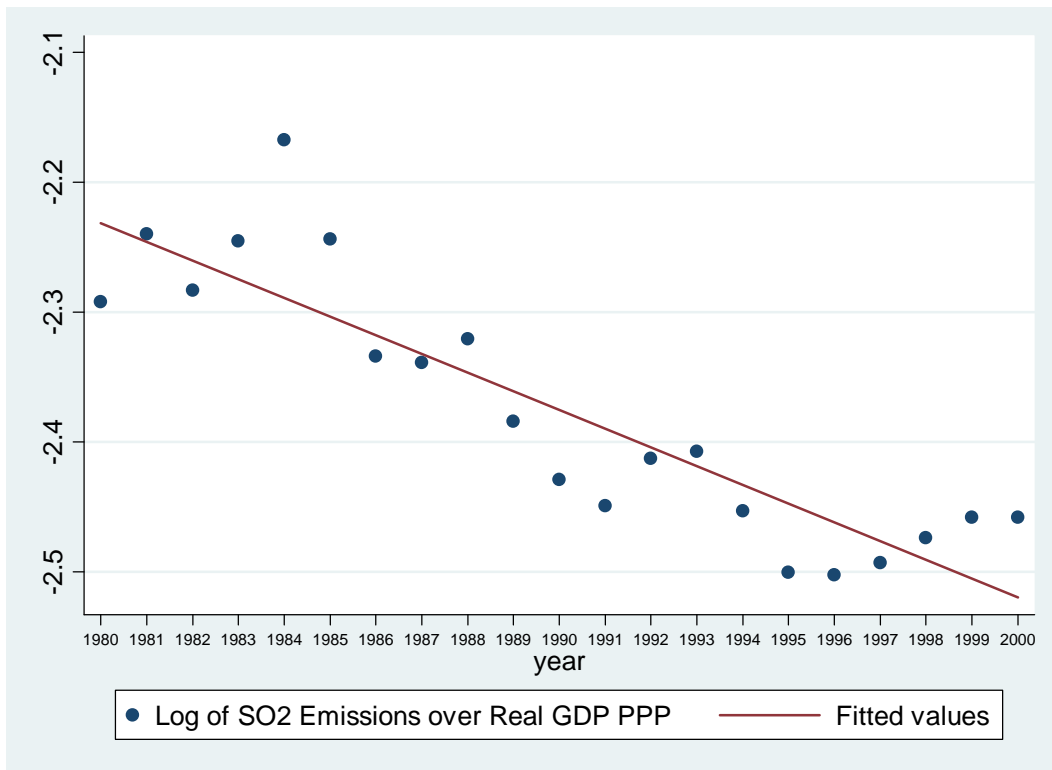
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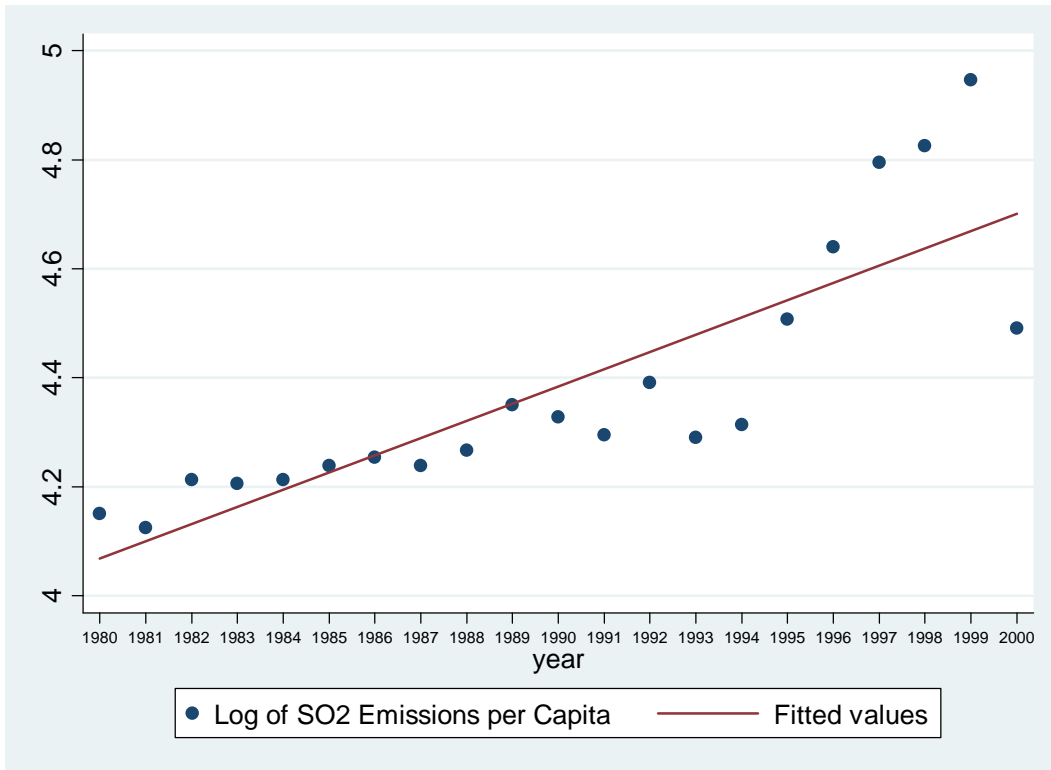
Brazil



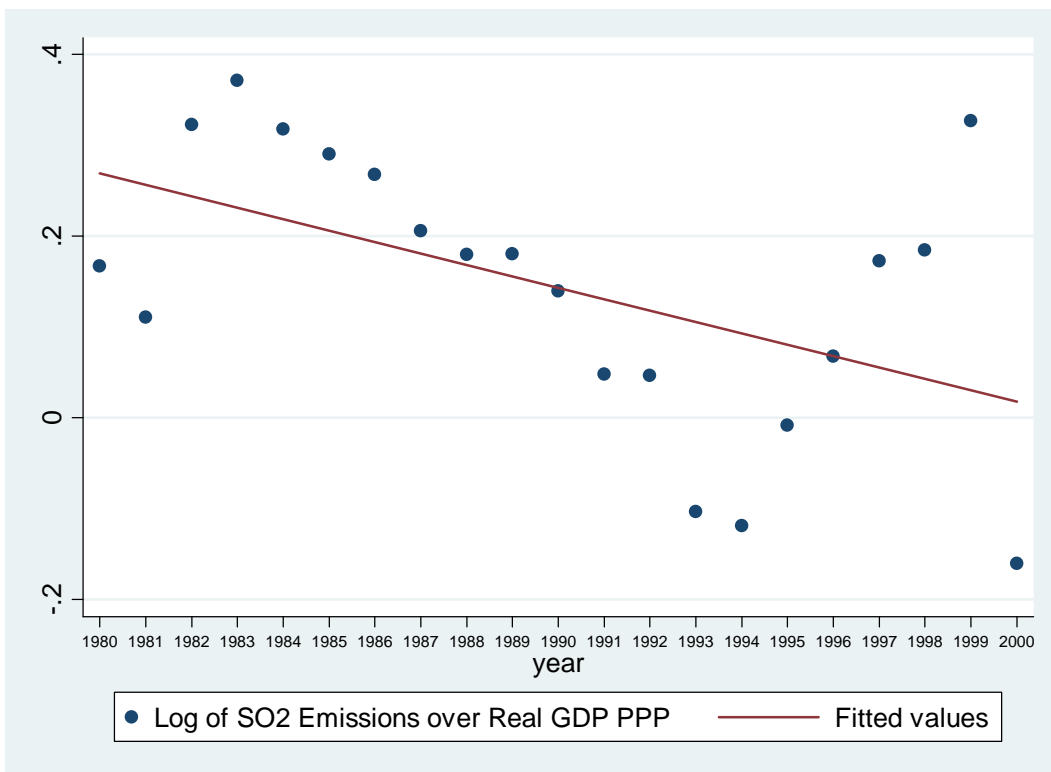
Brazil



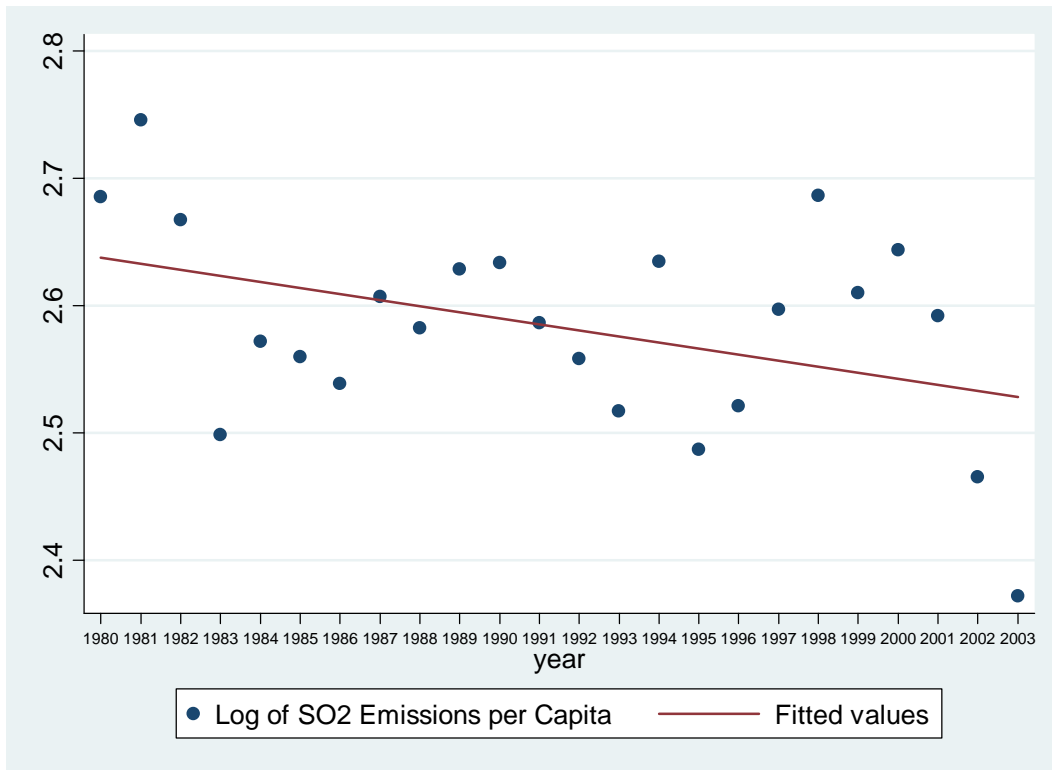
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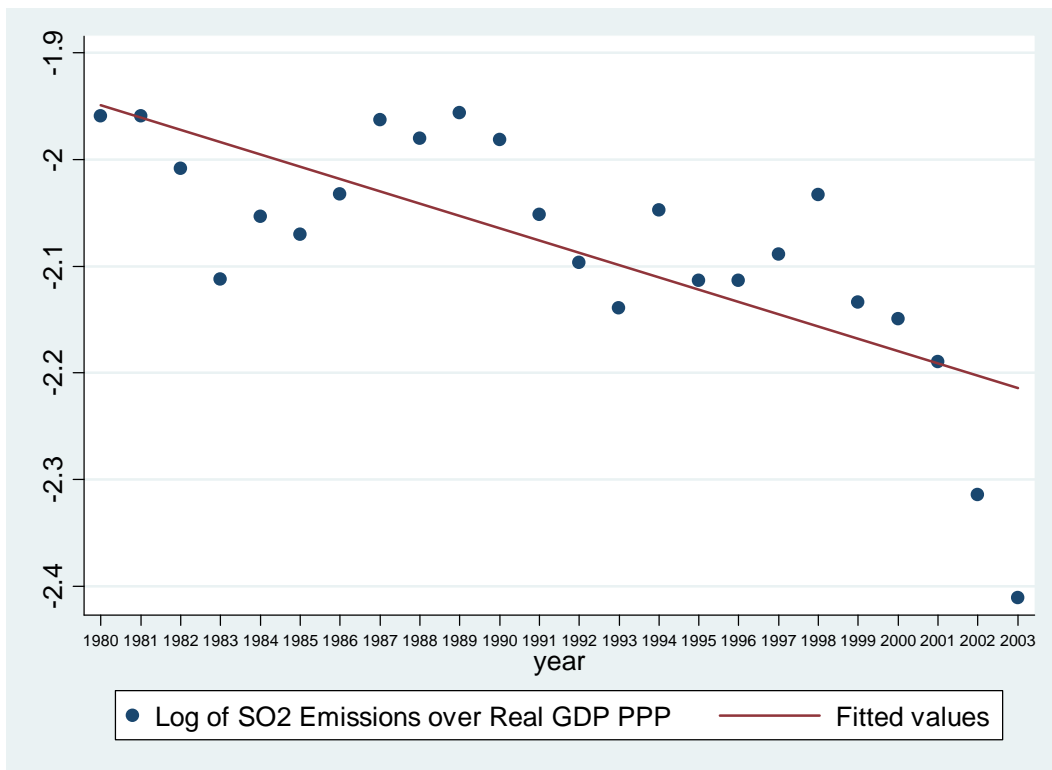
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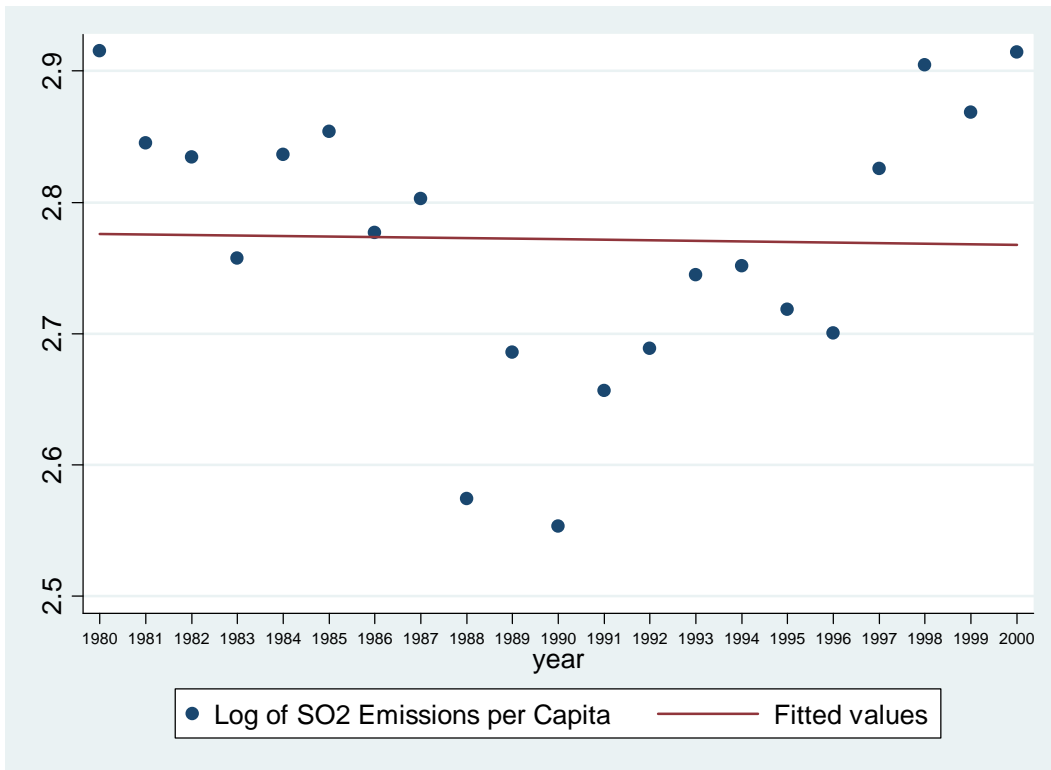
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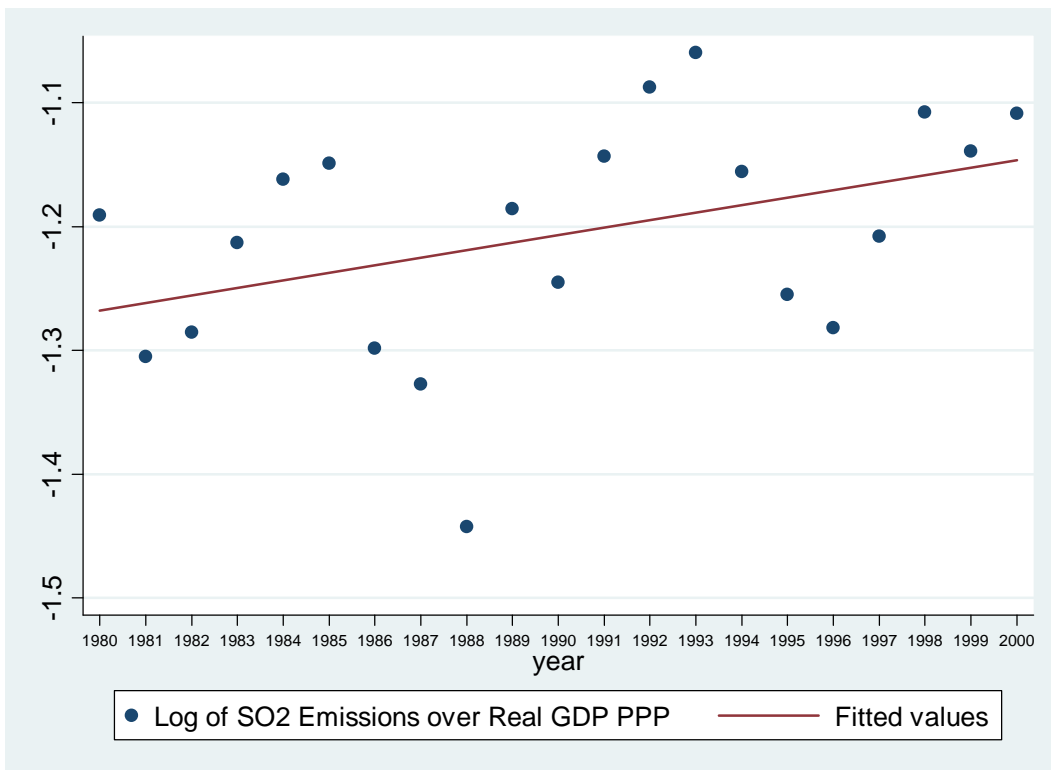
## Mexico



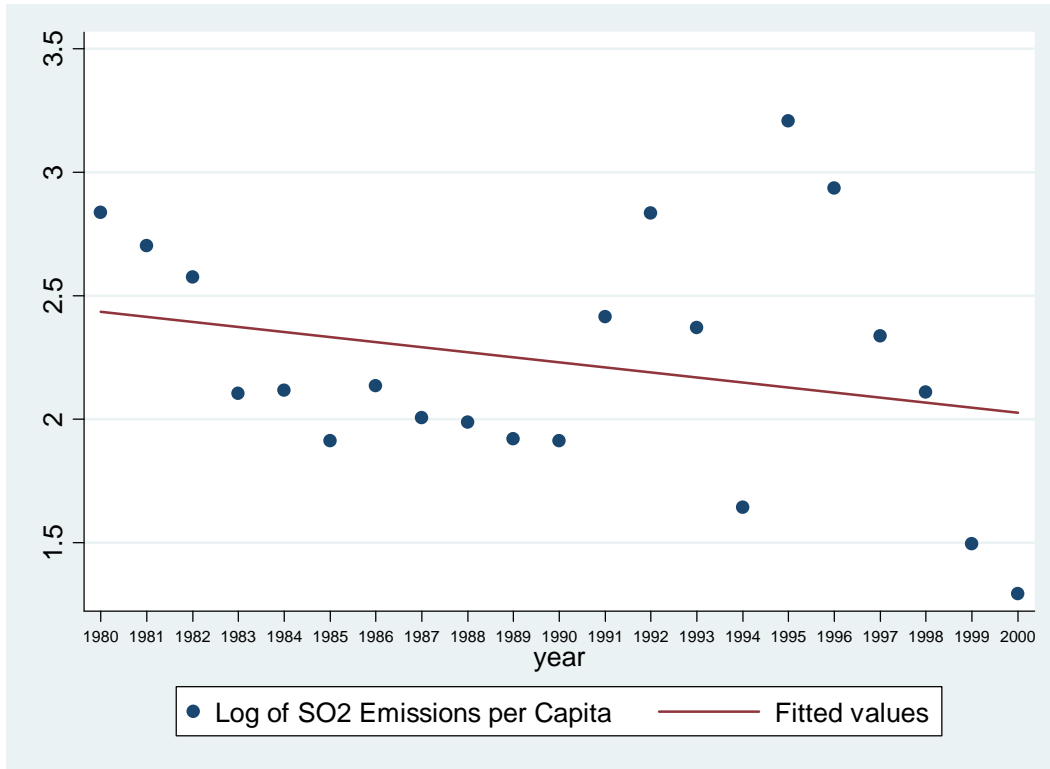
Peru



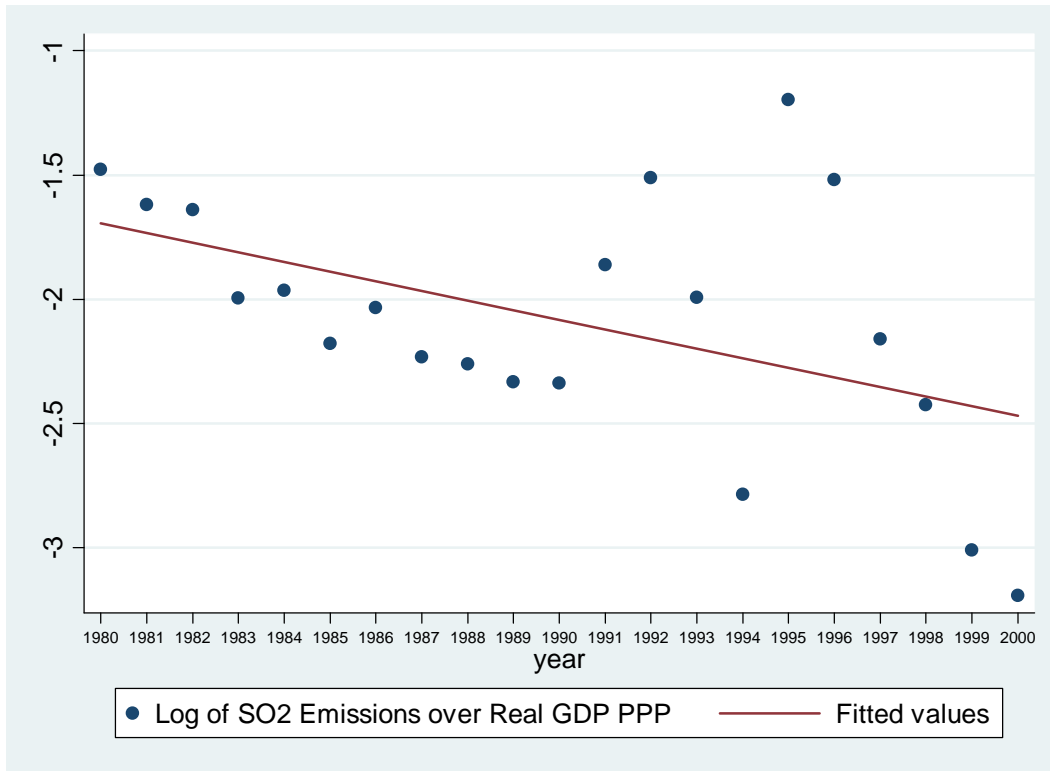
Peru



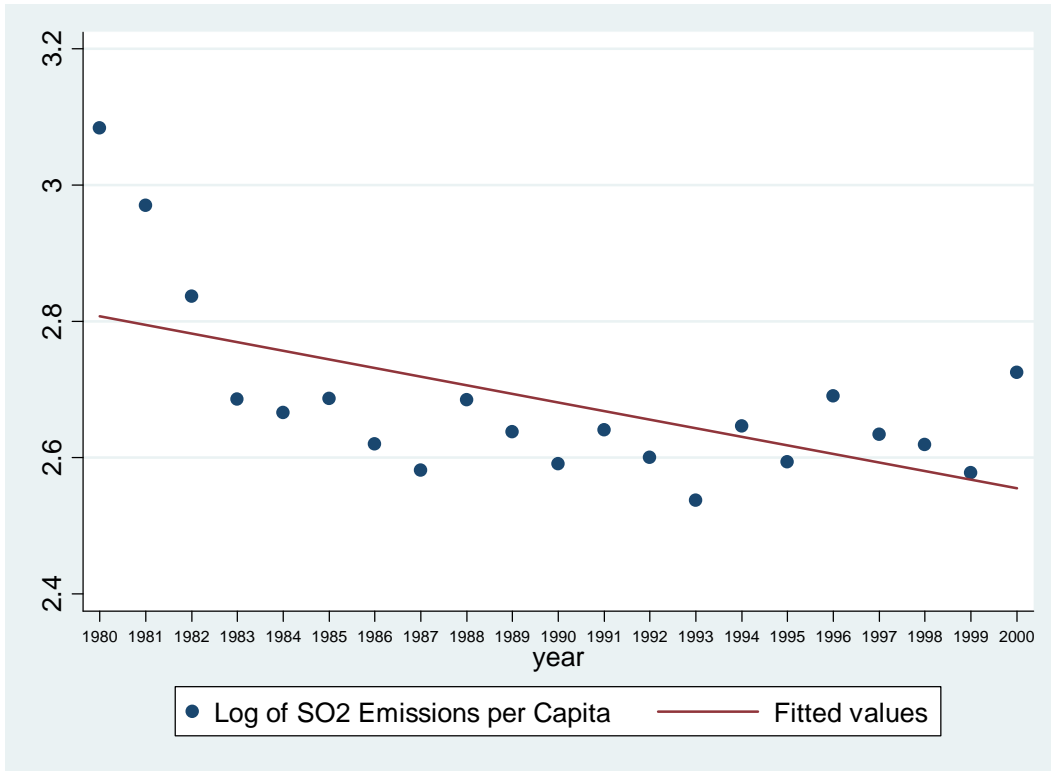
## Uruguay



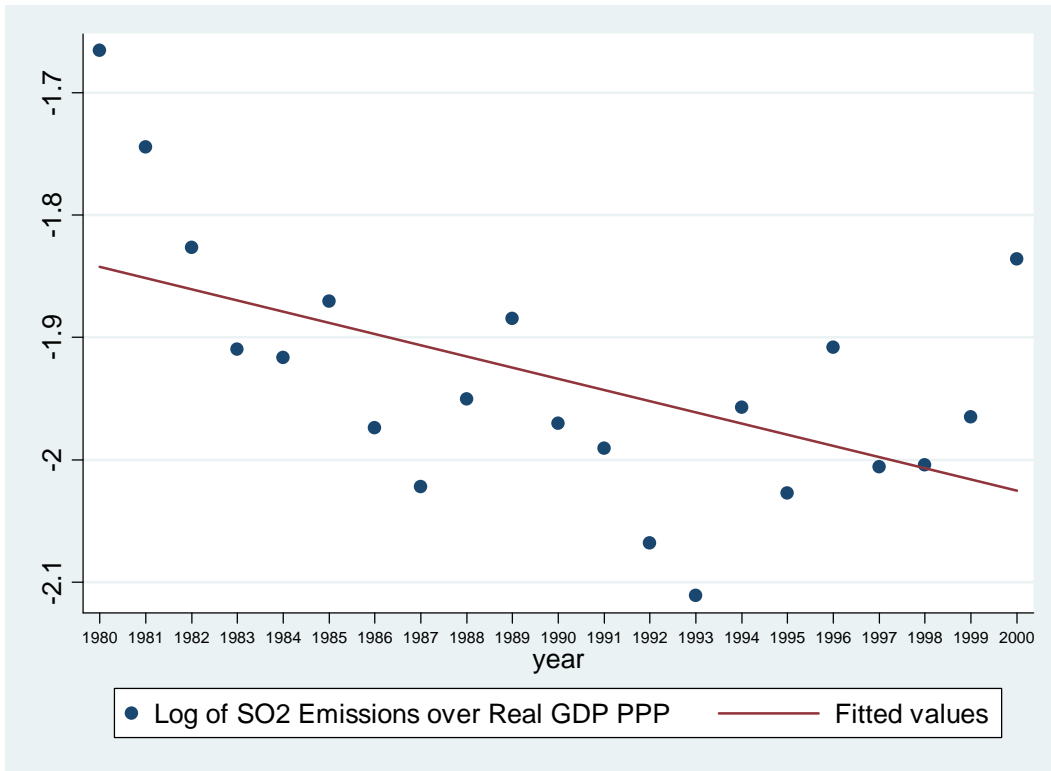
## Uruguay



Venezuela



Venezuela



**Appendix B: CO2 Emissions per Capita**

