JAPAN EARTHQUAKE:
IMPACTS ON GLOBAL ECONOMY AND CLIMATE CHANGE

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ABSTRACT

The recent 9 point magnitude earthquake that struck Japan's coasts and generated a violent tsunami will be reflected globally in four dimensions: (1) unusual volatility in the global financial markets; (2) it could affect the global economic recovery by the paralyzing the automotive and high-tech industry; (3) exert pressure on international oil prices; (4) serious effects on global warming of the earth.
The magnitude of economic losses caused by the natural phenomenon is not quantified yet, but general damages are estimated between two to three billion dollars, without considering the cost of Fukushima's nuclear reactors. It must be underscored that the electricity generated by 54 nuclear reactors in 2008, accounted for 24.9% of the total electricity used by this country.
Had this electricity been generated by fuel oil, about 376 million barrels of oil would have been burned and approximately 182 million tons of carbon dioxide (CO_2) equivalents would have been produced and sent into the atmosphere, with a very severe impact on global warming.

INTRODUCTION

Japan is the world's third largest economy, after the United States and China, which recently took away Japan's second place. This country's per capita gross domestic product amounts to US$38,177 annually. This economy has been characterized by maintaining a long term deflationary process; a low internal consumption stemming from the fact that consumption and investments have been postponed to decrease the country's debts, instead of acquiring goods and services in credit; very low interest rates; and an accelerated growth of the public debt. Hence, during the last twenty years, the dynamics of the Japanese economy has been different than that of the remainder of industrialized countries, affecting the growth rhythm of economic variables. Nonetheless, the rhythm of economic activity is associated to the development of nuclear industry. Besides the production of electricity, nuclear energy supposes large benefits in many fields and activities such as agriculture and food, medicine, and biology, among others.

Therefore, the nuclear accident at Fukushima – capital city of Fukushima Prefecture, Tōhoku, Japan- has left a deep imprint, not only on Japan, but also on the nuclear energy industry and world markets. Although the consequences of the accident still cannot be evaluated, it is fundamental to begin to estimate some of the most probable ones. For such reason, this analysis has been structured as follows:

The first part describes the evolution of Japan's most important economic variables, such as domestic consumption, interest rates, public debt, inflation, and deflation, emphasizing the economic recession this country experienced during the first quarter of 2011.

The second part analyzes the possible direct results of accident at the **Daiichi Nuclear Power Plant** and its consequences on the global nuclear development, such as the accelerated de-activation of reactors in key countries like Germany and Japan itself, and the decrease in the construction rate of new plants, especially in the United States, Western Europe, and some emerging countries.

The third part proposes that even with these negative consequences, nuclear energy will continue being a fundamental component in the world's future energy expansion, especially in regions of larger growth. Lastly, some conclusions resulting from the paper are presented.

FIRST PART
EVOLUTION OF JAPANESE ECONOMY

During the last twenty years, the dynamics of the Japanese economy has been different than that of the remainder of highly industrialized countries and has been characterized by: (1) a deflationary process, (2) a low domestic consumption, (3) a low interest rates, and (4) a growing public debt. Without a doubt, these factors have affected growth rates of economic variables in a negative way.

The new phenomenon that emerges in industrialized countries is deflation, which considers a negative annual inflation (price decrease) and is caused by new technologies and production processes. In other words, global competition in the automobile and high-tech industries has furthered the development of new production processes that have decreased the prices of these products, thus creating deflationary processes.

Another feature of the Japanese economy is the low domestic consumption resulting from the fact that families and economic agents have postponed consumption and investment to decrease their debts instead of acquiring goods and services on credit. Consequently, this has resulted in that companies geared toward domestic consumption maintain large idle capacities.

During the last years, an expansive monetary policy has been implemented whose effect has been a drastic interest rate decrease for the purpose of stimulating consumption and investment. Besides not achieving its objective, this policy has systematically caused the outflow of capitals of local companies that are looking for cheap resources to fund themselves and invest in other places in the world where profits are larger. In view of the inefficient monetary policy, the Japanese government has designed a costly tax policy which has caused the level of debt to exceed twofold the Gross Domestic Product (GDP). One of the advantages is that its liabilities are in the hands of domestic creditors.

It is important to highlight that during the nineties, Japan experienced a phenomenon called liquidity trap, term used in the melt-down of an expansive monetary policy that has taken interest rates to such low levels, close to zero, that there is no margin to decrease interest rates any further for the purpose of stimulating consumption and investment. The phenomenon called stagnation of economic activity by deflation, that is, a drop in production and price levels, occurred under such conditions. In view of this panorama, the Japanese government designed stringent structural reforms and an expansive tax policy, increasing public expenditure and tax incentives.

During the first years of this decade, Japanese economy registered positive tendencies to reactivate its economy; nevertheless, the global financial crisis that originated in the United States in 2008 was a hard blow for its economy, causing decreases in its production for seven consecutive quarters.

It must be recalled that Japan began to emerge from the global crisis with moderate growth rates, estimating a 1% growth rate for 2011 and now, with the havoc caused by the earthquake, *tsunami*, and nuclear crisis, its economic activity is expected to decrease once again, in the short run. The question to elucidate is if this earthquake – *tsunami* – nuclear crisis can cause an economic catastrophe. Despite that an image says more than a thousand words it can be asserted that the earthquake will not be an economic catastrophe. It is difficult not to be moved by the images of suffering and destruction that reach us from Japan and the serenity of the victims in view of the scenes of destruction and death is surprising. Japanese are different. One does not see scenes of panic, disorder or looting. On the contrary, we see long lines of people calmly waiting for medical care or purchasing food. The Japanese deserve the world's admiration and solidarity.

Financial markets also behave differently, but in their own way. These are betting on the recovery of the Japanese economy before anyone can foresee it, especially when the media show us an almost total destruction of areas important to Japanese economy. Furthermore, they are betting on that the financial impact on other countries will be lesser and that the long term economic effects will not be significant.

Less than a week after the earthquake and the *tsunami*, the nuclear plants still burning and almost on the brink of a large nuclear crisis and with a free-falling Japanese stock exchange, international investment funds specialized in purchasing Japanese company shares, in those days, received a record volume of funds: investors deposited 956 million dollars, despite the fact that during the week prior to the earthquake the total had amounted

to 180 million dollars. In one hand, investors, especially those of the speculative type, abandoned this stock market and other investors specialized in the purchase of company shares entered it, in the belief that these would increase their value in the short run. The same occurred to the Japanese currency. Days after the tragedy, the Yen reached its highest level – at an exchange rate of one dollar for 76.32 Yen - since the Second World War. The massive presence of dollars brought about the revaluation of the local currency or a massive demand of local currency caused its appreciation. It must be pointed out that a strong currency has negative effects on exports and causes multiple maladjustments at the international level. The foreign exchange war disappeared for a moment and the central banks of the seven richest countries intervened with great efficiency in the foreign exchange markets being able to stabilize the Japanese currency. This was also a novelty: the coordinated intervention of the central banks had not occurred for more than a decade.

The strengthening of the Yen is due to the fact that the markets anticipated a massive repatriation of Japanese capitals that had been deposited in United States and German sovereign or government bonds. Since these funds are returning to finance the reconstruction, they will boost an increased demand of local currency. Assuming this would increase the currency's value, speculators began purchasing Yen, but some lost in this case: the Japanese Minister of Economy and the parties accountable for the central banks of the G-7 countries (United Kingdom, France, Germany, Italy, Canada, the United States, and Japan) decided to conduct an arranged monetary intervention (the massive sale of Yen in the market) to curb the appreciation of the Japanese currency vis-à-vis the dollar.

The G-7 maneuver became a lifeguard for the Japanese foreign exchange market. At that meeting, the Yen experienced the worse fall against the dollar since 2008. Nonetheless, the Japanese currency still is 2% above the exchange rate it had vis-à-vis the dollar on the day prior to the occurrence of the natural disaster.

Before being backed by other nations, Tokyo already had been acting for its own account in the foreign exchange market. The Japanese government had seen the hand of the large speculative funds behind the Yen's rise. The market has interpreted the strengthening of the Yen in two ways: The first is that Japan would be forced to repatriate part of its savings in assets in other foreign currencies, mainly in the United States debt in order to finance the expense it would face for the repair of damages; the second is the carry trade practice (incur loans in Japan for its low interest rate in order to purchase assets in other markets) which also could have provided feedback to the Yen's strength, since upon this currency's appreciation, many would have unwound positions to limit losses.

On the other hand, the arranged intervention in the foreign exchange market also acted as a buffer for the Japanese stock exchange. The Nikkei index rose 2.72%; despite this rebound, the balance for Japanese variable yield securities recorded losses of 11.7%. The most punished securities in the Tokyo market were those of Tokyo Electric Power, Toshiba, and Japan Steel.

Those who probably will not lose are those who have bet on Japan's rapid recovery. Although this accident was devastating according to **World Bank Data**[1] (March 21, 2011), the highest estimate of costs amounts to 300 billion dollars and the lowest estimate places said costs at 200 billion dollars. The former figure is equal only to 4% of the Japanese economic activity and to 1% of the country's wealth; the latter represents 2% of the GDP. It must be recalled that in Japan, the world's financial crisis, had an impact equal to 10% of its economy, thus affecting a much larger number of Japanese.

Obviously, the tragedy has other negative effects, since the critical links of the chain of supply on which the world's industry depends are located there and now, these are stopped.

Insurance companies will suffer throughout this process due to the magnitude of the cost of the natural catastrophe and the future of the nuclear industry is at stake. Investors also bet on the latter. The price of uranium has dropped 30%.

SECOND PART
GLOBAL NUCLEAR DEVELOPMENT: POSSIBLE CONSEQUENCES

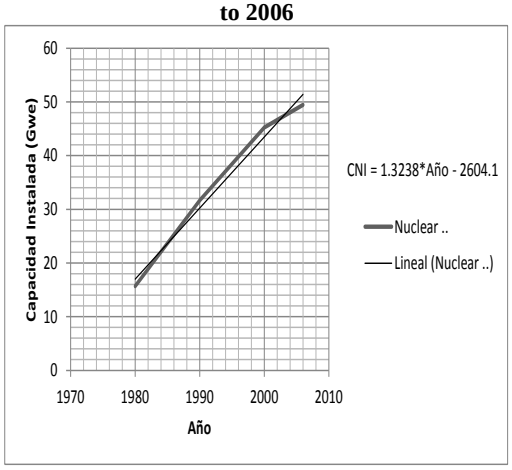
According to the **World Nuclear Association, (WNA)**[2] (2011) in 2008 Japan generated a

[1] Web site: http://data.worldbank.org/
[2] Web site: http://www.world-nuclear.org/

total of 1.085 billion megawatts hours[3] (MWh) of electricity. In regards to fuel type, 30% corresponded to coal, 25% to natural gas, and 24% to nuclear power, that is, 260.4 million MWh were generated with nuclear technology, a fact which meant not sending 182 million tons of greenhouse gases into the atmosphere, as would have been the case had this electricity been produced by fossil fuels, such as fuel oil. Such volume of greenhouse gases would have resulted in more global warming with catastrophic effects on the planet. In this sense, if the United States, the country with the largest number of nuclear reactors -104- under this assumption prevented producing almost four times this amount of greenhouse gases.

Particularly in Japan in the period comprised between 1980 and 2006, the installed nuclear capacity shows a clear trend; Figure 1 shows how this capacity grew 3.64% in the period from 1990 to 2000. The installed nuclear capacity grew from 15.7 megawatt electric[4] (MW_e) in 1980 to 49.5 en 2006[5].

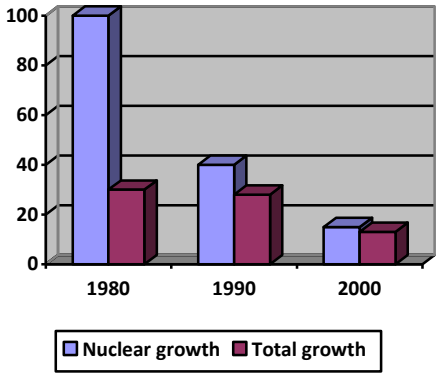
Figure 1.
Installed Nuclear Capacity in Japan from 1980 to 2006



Source: Own elaboration based on IAEA Data, 2010.

On the other hand, this rhythm, of growth looks even more dramatic when compared to the growth rate of the total installed capacity in that period. Figure 2 shows that while the installed capacity grew during the eighties at a rate of 36%, nuclear energy did so at a rate of 100%. In the decade from 1990 to 2000, the difference is no longer so drastic (43% as compared to 34%)[6]; indicating an increase in the number of other type of plants. It is worthwhile mentioning that the growth of other types of sources, particularly hydroelectric power, was of little significance. The weight on hydrocarbons once again was important.

Figure 2.
Comparison in the Growth Rate of Installed Nuclear Capacity and Total Installed Capacity



Source: Own elaboration based on IAEA Data, 2010.

Within this framework, prior to the Fukushima accident, throughout the world 60 more nuclear power plants were under construction with a capacity of 58,584 MW_e, which would represent a 15.64% increase in the current capacity and which concentrated in three countries, since almost 75% of this new capacity would be in China with 58,582 MW_e; in Russia with 9,153 MW_e, and in South Korea with 5,560 MW_e.

What would occur if this expansion of nuclear reactors stops and part of the installed capacity is stopped in advance?

In the case of Japan, a country with scarce raw materials and energy sources, where approximately 80% of the latter are imported, there would be a substantial increase of imports, which would strongly impact on fossil fuel prices and the depletion of their reserves and which, of course, would render non-viable its ambitious program to decrease the level of greenhouse gases 54% with respect to the level of 2000, by 2050 and 90% by 2100. At the worldwide level, under this scenario, the impact would multiply enormously. Besides its effect on climate change, it would require

[3] MWh is a unit of energy equal to 1000 watt hours.
[4] In the electric power industry, *megawatt electrical* (MW_e) is a term that refers to electric power.
[5] IAEA, CNPP (2010): http://wwwpub.iaea.org/MTCD/publications/PDF/CNPP2010_CD/countryprofiles/Japan/Japan2004.htm

[6] IAEA, CNPP (2010): http://wwwpub.iaea.org/MTCD/publications/PDF/CNPP2010_CD/countryprofiles/Japan/Japan2004.htm

financial investments for the construction of power plants with other technologies and these funds would be impossible to acquire.

The risk of applying other technologies also must be considered. In this respect, the same information source, WNA, reports the number of deaths occurred during the last four decades of the 20th century in the following two tables (see Table 1 and 2). Therefore, the fact that coal and natural gas are substantially more risky than nuclear energy and that these two sources generate most of the electrical power in Japan and the world would have to be highlighted.

In the case of Mexico, the recent accidents in coal mines in the state of Coahuila and the accident with gas pipelines must be recalled.

Table 1.
"Accidents in the Entire Energy Chain to Generate Electricity from 1960 to 2000"

	OECD		NON-OECD	
	DEATHS	***Deaths/TW year***	**DEATHS**	***Deaths/TW year***
Coal	*2259*	*157*	*18,000*	*597*
Natural Gas	*1043*	*85*	*1000*	*111*
Hydro electric	*14*	*3*	*30,000*	*10,285*
Nuclear	*0*	*0*	*31*	*48*

Source: Data by Paul Scherrer Institute in Organisation for Economic Co-operation and Development (OECD), 2010.

Table 2.
"Accidents in the Entire Energy Chain to Generate Electricity from 1960 to 2000"

	Immediate Deaths 1970-92	***Who?***	***by TW year****
Coal	*6400*	*Workers*	*342*
Natural Gas	*1200*	*Workers & Public*	*85*
Hydroelectric	*4000*	*Public*	*883*
Nuclear	*31*	*Workers*	*8*

Source: Ball, Roberts & Simpson, 1994; Hirschberg et al, Paul Scherrer Institute, 1996, in: IAEA 1997; Paul Scherrer Institut, 2001.

THIRD PART
WORLD'S FUTURE ENERGY EXPANSION

Social and economic reactions toward nuclear energy appeared as soon as the photographs of the chemical explosions (hydrogen combustion) in reactors 1, 2, and 3 of the **Daiichi Nuclear Power Plant** in Fukushima were released. Nonetheless, as weeks have elapsed since the accident, the recovery effort of the Japanese people has dulled the limited manifestations (although certainly important) in opposition to nuclear energy. A relevant factor for this behavior of the community is that the size of the installed nuclear capacity which was mentioned herein above became known simultaneously, as well as the role it has played in the economic development of Japan in recent decades.

We are not attempting to infer that the generation of electricity by nuclear means in Japan will not be affected. What is being suggested is that the cost to suppress said capacity of generation would lead this country into a recession that would prevent stanching the damages and consequences of the earthquake and *tsunami* of last March. Some countries, among them, Mexico -**Laguna Verde Nuclear Power Plant, Veracruz-**, already have announced a suspension of their nuclear plans.

Despite this, there is no perception that China and the other **BRIC**[7] countries (Brazil, Russia, and India) are willing to postpone their nuclear programs. In particular, Chinese experts have stated that nuclear development is necessary, because the provision of a stable energy source is required for good economic development and in order to comply with global goals of greenhouse gas emission reductions. In a recent G-8 meeting, although nuclear safety was questioned, the declaration is not geared to an immediate substitution of this type of energy. Anyway, the conclusions reached by the world meeting held in June by the member states of the **International Atomic Energy Agency (IAEA)**[8] to discuss the effects of the accident and new measures that will be taken to increase the safety of future nuclear plants will have to be awaited.

In the meantime, **Tokyo Electric Power Company (TEPCO)**[9] continues making efforts for IAEA safety standards, such as the prevention of reactor criticality, the removal of core decay heat, and the mitigation of the release of radioactivity into the environment, to be covered at the Daiichi plant. The world is waiting for this high level ministerial meeting called by the IAEA to be held, in order to analyze the teachings of Fukushima and evaluate its impacts and consequences. This

[7] An acronym for the economies of Brazil, Russia, India and China combined.
[8] Web site: http://www.iaea.org/
[9] Web site: http://www.tepco.co.jp/en/index-e.html

meeting also is expected to propose the strengthening of safety measures at nuclear plants. In this meeting to be held in Vienna from the 20th to the 24th of June, measures to be taken to strengthen the response capacity to nuclear emergencies and accidents will be suggested.

Lastly, by February 2012, the temperature of the reactors is expected to be stabilized at the normal 30 degree value. The plant, whose parts will be transferred and stored until its full decontamination, will begin as of that moment.

CONCLUSIONS

The impact of the earthquake, the *tsunami*, and the consequent nuclear accident at the **Fukushima Nuclear Power Plant** sunk the trust of investors, exports and domestic consumption, thus causing the Japanese economy to experience a recession phase which is technically defined as two consecutive quarters of Gross Domestic Product (GDP) contraction. This drop is expected to continue during the second quarter and for the recovery to occur in the third or fourth quarter of 2011.

Once of the results of the accident of the **Daiichi Nuclear Power Plant** is the accelerated deactivation of reactors in key countries such as Germany and Japan itself and a decrease in the construction rate of new plants, especially in the United States and Western Europe. Nevertheless, other countries, particularly the **BRIC** and some emerging countries, have not been so categorical.

In 2008, Japan generated 24% of its power through nuclear reactors, which prevented sending 82 million tons of greenhouse gases into the atmosphere that year. The possibly catastrophic effects had this power been produced by fossil fuels, such as fuel oil, would have resulted in greater global warming with catastrophic effects on the planet. Substituting this way to generate power for other traditional ones would entail a high economic cost for Japan which is impossible to quantify and world goals to decrease greenhouse gas emissions would be destroyed.

Nuclear energy will continue being a fundamental component in the world's energy expansion, headed by China, Russia, and South Korea, despite Japan's situation of tragic consequences, Surely, some of the conclusions reached by the **IAEA** minister meeting will be the design of more efficient nuclear energy plants with strengthened safety measures, and the design of programs increasing response capacity to nuclear emergencies and accidents.

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