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CHALLENGES OF GLOBALIZATION

**FEELING THE HEAT: FINANCIAL CRISES
AND THEIR IMPACT ON GLOBAL
CLIMATE CHANGE**

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Abstract: This interdisciplinary paper uses world-systems analysis as a theoretical framework to argue that both the 1870s, 1930's economic depressions reduced mean global temperatures. As global consumer demand fell, factories worldwide began producing less commodities and, as a result, emitted less greenhouse gasses. We find that in both instances there is evidence to support the hypothesis that financial crises lead to cooler temperatures.

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Purpose and overview

The paper addresses two very popular contemporary topics: the issue of global climate change and economic crises. We borrow from the fields of economics and the natural sciences to provide a preliminary investigation into possible connections between different financial crises (1870s and 1930s) and global climate change, specifically global warming. Our basic argument is that during financial crises consumer spending drops, causing industries to operate less, and thereby emit less greenhouse gases, specifically carbon dioxide (CO₂).

Review of literature and theoretical framework

One way to understand the global economy is the world-systemic perspective, which developed as a reaction to dependency theorists (Amin, 1976 and 1994; Kohler and Tausch, 2002; Yotopolous and Sawada, 2005; Giedraitis, 2007). During the 1970s, historical economic sociologists such as Wallerstein (1974) and Frank (1978) began to theorize an expanding European economic world-system, which could be used to explain the historical economic development (or lack thereof) of countries around the world. This model sees capitalist market relations as a means of wealth redistribution, from the poor peripheral countries to rich core countries, or from the global South to the global North (Arrighi, 1995; Turchin 2007).

One of the structural constants of the world-systemic perspective is the assumption of centuries old business cycles. This emphasis on 45 to 60 year Kondratiev business cycles have been criticized by some for not explaining the origins of the cycle, or Kondratiev waves as being simply economic

correlations rather than a cause of economic growth or depression (Solomou, 2004). Empirical evidence, however, indicates a correlation between the trough of a Kondratiev wave (e.g. 1870 and 1930), and economic depressions.

Schumpeter (1943) placed great emphasis on the role of Kondratiev waves in explaining the expansion of businesses through innovation. Rather than a condition of stagnation via Walrasian equilibrium, Schumpeter noted that innovators can breathe life into an economy through the introduction of new technologies and innovations (Giedraitis and Rasteniene, 2009). For example, Schumpeter noted that the steam engine as perfected by James Watt in the 1760s helped to bring about the Industrial Revolution.

However, with the arrival of the industrial revolution came an increase in emissions of greenhouse gases. Coal fueled steam power enabled the transition of a manual labor based economy to machine-based manufacturing. This resulted in a significant increase in production capacity. Further development of technologies, mainly heavy industry, ensured continuing economic growth. This, however, was harmful to environment, mostly because of rapidly increasing CO₂ and other greenhouse gas emissions.

There is a strong correlation between CO₂ concentrations in the atmosphere and economic situations which could be seen during recession periods, when industrial activity decreases. During the first significant financial crisis after the beginning of the industrial revolution, "The Panic of 1873", CO₂ emissions on a global scale reduced. The graph in Figure 1 represents an obvious growing trend in CO₂ concentrations, but in the year 1874 it reaches a bottom line (Figure 1).

Another example illustrating the link between CO₂ emission capacity and industrial activity level is the Great Depression of the 1930s. This recession had a bigger impact

on industry and lasted longer than The Panic of 1873, since industrial capacity was much greater. Therefore the correlation seen in Figure 2 is much more significant (Figure 2). It is important to emphasize that CO₂ concentrations since the beginning of the industrial revolution rises rapidly with very few fluctuations. Consequently, economic recessions not only decrease CO₂ emissions, but also prevent their increase. During both mentioned crises no

significant change in volcanic activity were recorded (volcanic eruptions cause much more sudden increase in atmospheric CO₂ concentrations than other natural events which alter the contents of atmosphere more gradually). Therefore we infer that a decrease in emissions during economic recessions is mostly caused because of anthropogenic factors rather than natural ones.

FIGURE 1: QUANTITY OF CO₂ EMITTED DURING CRISES

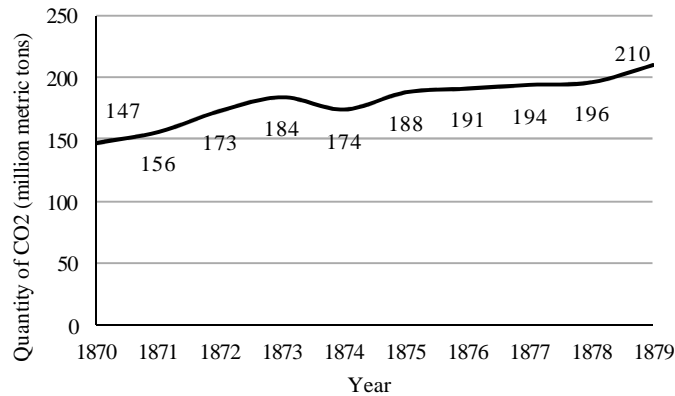


FIGURE 2: QUANTITY OF CO₂ EMITTED DURING 1930S DEPRESSION

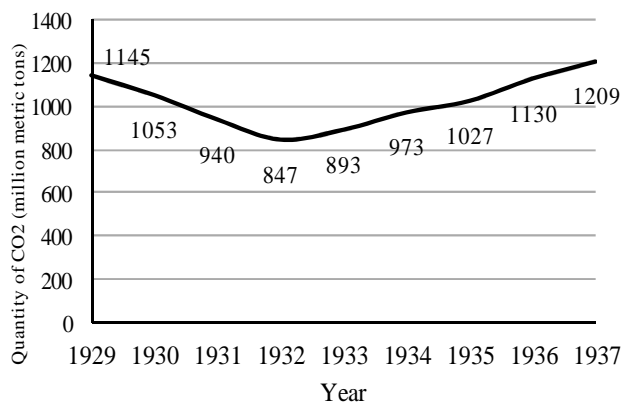
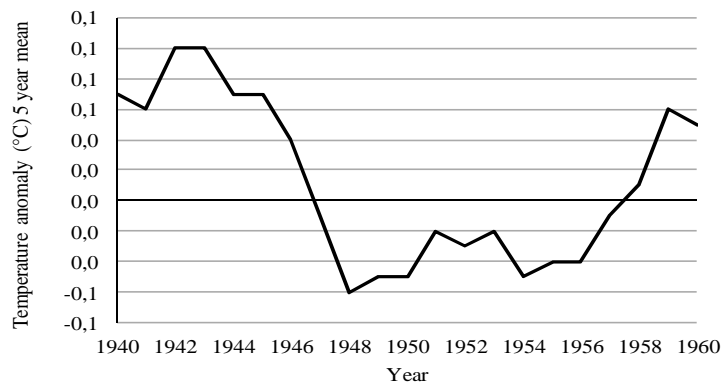


FIGURE 3. ANNUAL TEMPERATURE CHANGES IN YEAR 1940-1960



Even though there is a link between the economic climate and CO₂ concentrations, as Figures 1 and 2 show, no similar correlation could be found between reduced CO₂ emission capacity and decreased annual temperature. The atmospheric lifetime of CO₂ gas is approximately two years, because that is the average time needed for any CO₂ molecule to be incorporated into plants via photosynthesis, mix into ocean or leave the atmosphere by other processes. While the economic downturns in the 1870s and 1930s lasted from 2 to 4 years, this period of time is too short for all cumulative CO₂ to be removed from the atmosphere, therefore no significant decrease in annual temperature could be seen during economic crisis.

However, changes in economic situations do have a quite sudden and important impact on annual global temperature. A rapid economic recovery after a crisis stimulates intense increase in industrial activity, which leads to large pollution levels. Among those contaminants, sulfate aerosols including sulfur dioxide (SO₂), are the most important factors in changing annual global temperatures, because they have a significant cooling effect on the earth. The aerosols help form clouds with more water droplets, which reflect solar radiation more efficiently than clouds with fewer droplets. Therefore, the rise in sulphate aerosols due to a sudden increase in industrial activities cools the earth's temperature. For instance, in the first half of the 20th century a rapid economic recovery after the Great Depression and World War 2 resulted in large amounts of cumulative sulfate aerosols in the stratosphere. As Figure 3 shows, this led to the most significant cooling since the beginning of the industrial era. During this period of time, there again were no major volcanic eruptions which would emit large amounts of SO₂.

TABLE 1. CORRELATION BETWEEN VARIABLES

		GDP	CO2
GDP	Pearson Correlation	1.000	.478*
	Sig. (2-tailed)		0.012
	N	27.000	27
CO2	Pearson Correlation	.478*	1.000
	Sig. (2-tailed)	0.012	
	N	27	27.000

* Correlation is significant at the 0.05 level (2-tailed).

TABLE 2. MODEL FIT

Model	R	R Square	Adjusted R Square
	.478 ^a	0.228	0.197

a. Predictors: (Constant), CO2

In order to base our predictions about statistical relations between world gross domestic product (GDP) dynamics and

CO₂ emission level, we made simple calculations using statistical software. We gathered data from the International Monetary Fund database and CO₂ emissions from the Carbon Dioxide Information Analysis Centre during the period 1980 - 2006. We used 27 valid cases which we used to construct a statistical model, so these calculations should be understood not as a final model, but as a tool to check our predictions. We assumed that global GDP is the independent variable and global CO₂ emissions level is the dependent variable.

Firstly, we ran simple linear correlation, with results presented in Table 1. According to our calculations, there is a correlation between these two variables, but Pearson criteria indicates that it is not very strong. Thus, we infer that GDP growth leads to a higher CO₂ quantity in the earth's atmosphere. Also, as noted, we identify a clear relation between GDP and CO₂ emissions because we control for all natural activity, such as volcanic eruptions (Table 1).

Next, we ran more calculations to check the statistical model compatibility to the data. Results are shown in the Table 2. R² criteria is 0.228, which we interpret as a weak relation between our model and data. This could happen because of two reasons: there is not enough data to verify a strong correlation, or the time frame we analyzed is not an aggregate period of economic crisis, suggesting there is no evident overall decrease in global GDP.

When discussing the relation between world GDP and CO₂ emission levels, we must take into consideration a few aspects of criticism by Kolstad (2007). Firstly, scientist argue that one indicator (in most cases GDP and/or income per capita) does not reflect the development stage of and entire country's economy. What is more, we must also choose other indicators, which do not necessarily reflect the level of pollution. Secondly, almost every aspect of economic policy is influenced by the government. There is no way to avoid this impact. For instance, if the government objective is to improve economic performance, it will take no measures to reduce CO₂ emissions. Thirdly, in most cases a country's inhabitants must choose between a lower prices and higher pollution levels and higher prices and lower pollution levels. According to the classical economic approach, people tend to choose lower prices, because at the moment they do not see the consequences of higher pollution level, whereas the lower price effects is obvious. Fourth, marginal costs of reducing pollution must be considered. For the economies which rely on heavy industries, this is crucial solution, because reducing carbon dioxide emissions will demand a large cost, while for the economies which rely on the service sector, it will be cheaper to reduce pollution.

There are some conditions, under which the Environmental Kuznets Curve (EKC) could be applied to the economy (Deacon, 2006). The EKC essentially suggests that as GDP per capita increases along with industrial production, pollution increases, then begins to decrease. The EKC does not, however, hold for CO₂ emissions. There might be some countries, where there are no purely linear correlations between economic growth and CO₂ emission. In this paper we ran preliminary calculations (simple linear correlation), because our aim was not to construct an accurate statistical model, but to reveal basic tendencies.

Conclusion

These preliminary calculations indicated that we are on the right track and there is indeed a statistical relationship between global GDP dynamics and CO₂ emission levels. Moreover, we require more data and further calculations to identify a clear descriptive model of this relation. In our future work we plan to include more variables (such as temperature) and create predictive statistical model, which could be used as tool to predict future level of CO₂ emissions.

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