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**SHARED WINNER, CLIMATE CHANGE CATEGORY**

# The Embedded Carbon Valuation System: A Policy Concept to Address Climate Change

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***ABSTRACT:*** Current proposals to limit U.S. greenhouse gas (GHG) emissions will impose costs on U.S. industry without imposing similar costs on international competitors. The solution is to measure GHG emissions all along the marketing channel and impose the same burden on U.S. imports as is imposed on U.S. products with the same carbon content. Under the proposed policy, most U.S. agricultural exports would merit a subsidy rather than the tax that is currently proposed. This essay shows how to implement this alternative system.

All economic activities generate greenhouse gas (GHG) emissions. Until this fact is acknowledged, attempts to regulate GHG emissions will be inefficient and work to the detriment of U.S. agriculture. For example, under current regulatory and measurement systems—such as the IPCC Guidelines for GHG Inventories, California's Low Carbon Fuel Standard, and the Waxman-Markey Act—when crude oil is imported to the United States, its GHG emissions become the responsibility of the United States because this is where the GHG is released. However, when corn is exported from the United States, the GHG emissions associated with production of that corn are also assigned to the United States rather than to the country buying the corn for use as animal feed.
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Fundamental to the inefficiency of the current system is assignment of carbon burdens - generally in the form of monetary penalties or taxes—to the manufacturing facility rather than the manufactured product. This has the perverse effects of increasing manufacturing costs in countries that adopt carbon mitigation policies and moving the U.S. manufacturing base to countries with higher carbon intensities. Chinese and other foreign manufacturing will not have to pay this carbon burden and will, therefore, have a competitive advantage. This is inefficient because the U.S. manufacturing sector produces far less GHG emissions per unit of economic value than does China. A potential solution to this dilemma is to implement a system that acknowledges that carbon is "embedded" in goods and services[1] and accounts for the amount of GHG emissions accumulated along the value chain of a product's manufacture.

The Embedded Carbon Valuation System (ECVS) solves several of the problems presented by current systems. ECVS calculates the total GHG emissions per thousand dollars gross domestic product at each stage of the value chain for a particular product or service. A significant concern in many agricultural- and manufacturing-intensive economies is that, under most carbon regulation systems, it would be less expensive for GHG-emitting producers to outsource jobs to countries that do not regulate carbon. When used in conjunction with a carbon tax based on the product's lifecycle GHG emissions, the ECVS would reduce this incentive to outsource by taxing all imports from non-carbon-regulated economies at the same rate as domestically-produced products and services, based on the amount of emissions embedded in the product at the point of international transfer.

Under ECVS, U.S. corn exports would be assigned a net benefit because the corn that is exported contains carbon. The U.S. would tax Chinese manufactured imports at the border, based on the amount of GHG that was released in China when the products were manufactured. If the GHG emissions are measured at each point in the production system with the tax applied to the lifecycle GHG emissions, then the incentives to reduce GHG emissions would be aligned with U.S. and world interests, regardless of the

exporting country's policy. ECVS would be a means to effectively incentivize a decrease in GHG emissions on a world-wide basis.

The proposed ECVS would make domestic production competitive with foreign production without running afoul of General Agreement on Tariffs and Trade (GATT), which allows for taxes borne by the product to be imposed on the imports of like products.[2] It would be able to do this efficiently by calculating the emissions generated at each stage of the value chain, allowing for accurate calculations to be made for both raw materials and finished products. Since many of the traditional outsource destinations, such as China and India, utilize manufacturing processes that are not as energy-efficient as their U.S. counterparts, the tax they pay on their exports would increase until they improved their processes. The ultimate competitiveness of any product would depend on the efficiency of the associated production processes, encouraging reduction of emissions by all producers selling to the U.S. market, not just domestic producers.

A second concern with the current carbon regulatory systems is that they create a free-rider system, in that China and India can benefit from reductions elsewhere without the costs of imposing their own restrictions.[3] This problem would be solved by the tax on lifecycle emissions used in ECVS. The system would allow emissions to be calculated for all products and services imported to the United States, with the tax imposed at the border on those imports rather than just energy sources, placing them under the same constraints as domestically-produced products and services. A non-carbon-regulating country trading with a carbon-regulating country would effectively find its exports being regulated, removing any existing free-rider situation. This would not prove a hindrance to international trade, as the tax would be country-neutral and apply uniformly to both imports and domestic production.

A major shortcoming of current carbon regulating systems is they require the cooperation of the largest carbon-emitting countries to be effective. A crippling problem with current existing agreements, such as the Kyoto Protocols, is that countries not party to it have a strong incentive to remain non-members to maintain a trade advantage. The ECVS is

incentive-compatible in that it encourages producers in non-carbon-regulating countries to truthfully reveal the emissions associated with any product or service being exported to a carbon-regulating country. At best, it encourages them to become party to the agreement. The aforementioned ECVS tax structure would incorporate a default emissions calculation, with the burden resting on the exporter in a non-carbon-regulating country to produce evidence that the export's actual emissions were below that of the default. Carbon-regulating countries would have already imposed taxes or carbon prices on any exports, so no tax would be imposed at the U.S. border. If the carbon tax in the exporting country was the lower of the two, the United States could impose a tax equal to the difference.

Another problem with current carbon-regulating systems is their failure to provide a uniform measurement standard that can be applied to any carbon-emitting product or service. Four different measures are used, depending on the product characteristic being measured. The first—grams of carbon dioxide equivalent GHG emissions per megajoule of fuel energy (g $CO_2$e per MJ)—measures direct energy applications, such as transportation and power. While an efficient measure for transportation fuels, it fails to capture differences in the performance of various fuels and can only be used for transportation and power measurements.

The second measurement is grams of carbon dioxide equivalent GHG emissions per kilometer traveled (g $CO_2$e per km). This captures the differences in the performance of various fuels in different vehicle types, such as hybrids, battery electric, hydrogen fuel cell, and gasoline-powered, but can only be used to measure transportation fuel emissions, greatly limiting its use.

The third measurement is grams of carbon dioxide equivalent GHG emissions per kilogram of product (g $CO_2$e per kg). This measure evaluates emissions from products other than fuels, but is extremely limited. For example, while a comparison of the emissions associated with producing one kilogram of steel versus the emissions associated with producing one kilogram of corn chips would reveal a quantifiable

emissions amount, no practical purpose is served due to the inherent differences between the two products and the lack of a common denominator.

The final measurement—grams of carbon dioxide equivalent GHG emissions per gallon of fuel (g $CO_2$ per gal)—is of little use even when comparing different transportation fuels, given the differences in energy amounts in different fuels. For example, one gallon of ethanol contains less energy than one gallon of gasoline.

All four measurements do share one trait: none can be used to quantify the emissions associated with services in a way that can be compared with other services, let alone products. This is a notable omission since the service sector is responsible for 78% of the U.S. workforce[4] and one-third of U.S. industrial GHG emissions.[5] The ECVS would provide a common denominator by which emissions from service activities could be quantified and compared against one another, as well as against product emissions.

Perhaps the biggest flaw in the current carbon regulating systems is that they only regulate emissions generated by the transportation and utility sectors of the economy which, combined, are alone responsible for only one-third of U.S. GHG emissions.[6] Subsectors that produce GHG emissions from sources other than energy generation—such as cement, agriculture, and livestock production—are unaccounted for. In addition to greatly minimizing the impact any carbon regulation will have on overall emissions, this shortcoming also has a distortional impact on overall economic efficiency.

These regulation systems base the utility of a product—and by extension, economic growth—on an arbitrary measure of its weight or volume rather than its overall economic value. Production is discouraged because GHG emissions increase along the value chain. For example, the production process for a metric ton of steel would contain more embedded emissions than the production process for a metric ton of coal, despite the steel's significantly greater value and utility. Production processes that emit more GHG per kilogram of product will be restricted, while other sectors will be ignored entirely, despite having greater overall emissions.

ECVS would calculate the ratio of lifecycle GHG emissions directly attributable to the production, transport and use of a product or service to its economic value as measured in dollars of gross domestic product—$MgCO_2$/$1000GDP. (Intranational calculations would be based on the particular country's currency while international calculations would be based on the dollar exchanges at purchasing power parity.) This measure would apply to any economic activity producing GHG emissions, covering the vast majority of a nation's emissions. Such a universal measurement would be possible because of ECVS's ability to quantify emissions from all products and services, regardless of type.

This approach offers several advantages, the first of which is the ability to compare emissions from different products and services, regardless of type. It also encourages wealth creation; other things being equal, if Product A and Product B have equal emissions and Product A has a higher economic value, it will receive a lower ECVS emissions score. Adding yet more value to Product A will further reduce its score, encouraging its efficient use—for example, corn chip snacks have a significantly lower rating than the corn used to produce them. (See Appendix 1 for an example with the complete calculations).

No measurement system will have much impact on reducing GHG emissions unless it is used in conjunction with a regulatory system. ECVS is no exception. It would be most effective when used with a tax imposed on all GHG-emitting products and services based on their lifecycle emissions. Multiplying the ECVS score by the carbon tax—i.e., $50/metric ton $CO_2$—gives the cost of GHG emissions as a percentage of the product's value. Unlike upstream taxes on GHG emissions—those that tax emissions at the wellhead or mine—ECVS would work best when combined with a tax imposed on the lifecycle emissions associated with a final product, demonstrating which segments of the value chain are the least efficient as a measure of economic value and giving producers an incentive to make them more efficient.

A likely criticism is that the ECVS, like any tax on a product or service, would ultimately be regressive, imposing a greater burden on the poor than the rich. The logic behind the criticism of regressive taxes is that because the tax impacts all purchasers equally, those with less money will ultimately spend a greater percentage of their income or savings to pay the tax than will those with more money, resulting in a disproportionate impact on the poor. It is not necessary here to debate over whether U.S. sales taxes are regressive in practice because studies have shown that the ultimate regressivity of a carbon tax is unlikely to be nearly as steep as critics fear.[7] Any disproportionate impact could also be alleviated through the use of tax refunds or cuts, funded with the proceeds of the carbon tax.[8]

*Conclusion*

The intensity of the scientific debate over how best to reduce global GHG emissions is matched by the complexity of the issues facing the policymakers and politicians who will ultimately put any reductions into practice. The stakes are high: a failure to slow the rate of global warming means the world will incur enormous costs to counter its impact[9]; failure to do so efficiently means the global economy could absorb equally great financial losses.

The ECVS provides the necessary incentive for countries to join together in a global effort to reduce GHG emissions, something the Kyoto Protocol lacks, and does so in a manner that would be both effective and transparent, traits that the European Union's Emissions Trading Scheme and the Waxman-Markey cap-and-trade plan both lack. The ECVS would protect domestic jobs without running afoul of the global free trade framework. Finally, its uniform nature would allow for its widespread global adoption. The ECVS holds significant potential, and further study is needed to examine its impacts.

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## Appendix

(1.1) GHG emissions from agricultural corn production[10] and corn chip production[11] measured by the ECVS and assuming a corn price of $155.50/metric ton.

$$\frac{Mg\,CO2}{\$1000 GDP\,corn\,production} = 2.29$$

$$\frac{Mg\,CO2}{\$1000 GDP\,corn\,chip\,production} = 0.05$$

(1.2) GHG emissions assuming corn chips contain 80% corn.

$$\frac{0.2848\,Mg\,CO2}{Mg\,corn\;chips} + \frac{0.7675 Mg\,CO2}{Mg\,corn\;chips} = \frac{1.0523 Mg\,CO2}{Mg\,corn\;chips}$$

(1.3) Conversion to ECVS using Amazon.com list price for a 14.1 oz. bag of Fritos.

$$\frac{1.0523\,Mg\,CO2 / Mg\,corn\,chips}{\$15686 / Mg\,cornchips}\, x\$1000 GDP = \frac{0.067\,Mg\,CO2}{\$1000 GDP}$$

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