The Embedded Carbon Valuation System:
A policy concept to address Climate Change

Tristan Brown, Dermot Hayes, and Robert Brown
The Embedded Carbon Valuation System:

A policy concept to address Climate Change

Submitted to Farm Foundation 30-Year Challenge Competition

Tristan Brown, Dermot Hayes, and Robert Brown
Executive Summary

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

All economic activities generate greenhouse gas emissions. Until this fact is acknowledged, attempts to regulate greenhouse gas emissions will be inefficient and work to the detriment of U.S. agriculture. For example, under current regulatory and measurement systems (the IPCC Guidelines for GHG Inventories, California’s Low Carbon Fuel Standard, and the Waxman-Markey Bill) when crude oil is imported to the U.S., the carbon emissions become the responsibility of the U.S. because this is where the carbon is released. However, when corn is exported from the U.S., the carbon emissions associated with the production of the corn are also assigned to the U.S. rather than the country where the corn is used as animal feed.

Fundamental to the inefficiency of the current system is assignment of carbon burdens to the manufacturing facility rather than the manufactured product, which will have the perverse effect of increasing manufacturing costs in countries that adopt greenhouse mitigation policies and moving the U.S. manufacturing base to countries with higher carbon intensities. Chinese and other foreign-based manufacturing will not have to pay this burden and will therefore have a competitive advantage. This is inefficient because the U.S. manufacturing sector produces far less carbon per unit of economic value than does China. A potential solution to this dilemma is to develop and implement a system that acknowledges that carbon is “embedded” in goods and services.¹ This system would account for the amount of carbon accumulated along the value chain of a product’s manufacture.
The Embedded Carbon Valuation System (ECVS) solves several of the problems presented by the current systems. ECVS calculates the total greenhouse gas 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, carbon-emitting producers would find it cheaper to outsource jobs to countries that do not regulate carbon. When used in conjunction with the aforementioned carbon tax, 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 this system, U.S. corn exports would be assigned a net benefit because the corn that is exported contains carbon. The U.S. would tax Chinese imports at the border based on the amount of carbon that was released in China when the products were manufactured. If the carbon emissions are measured at each point in the production system with the tax applied to the ultimate measurement, then the incentives to reduce carbon emissions would be aligned with U.S. and world interests, regardless of the exporting country’s policy. This policy concept is being submitted to the 30-Year Challenge as a means to effectively incent decrease in carbon emissions on a world-wide basis.
The proposed system would have the effect of making domestic production competitive with foreign production without running afoul of General Agreement on Tariffs and Trade (GATT), which allows for taxes that are borne by the product to be imposed on the imports of like products. 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. Additionally, many of the traditional outsource destinations (such as China and India) utilize manufacturing processes that are not as energy-efficient as their counterparts in the U.S., increasing the tax they would pay on their exports until they improved their processes. The ultimate competitiveness of any product would depend on the efficiency of the associated production process, encouraging the 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 obtain the benefits of reductions elsewhere without the costs of imposing their own restrictions. This problem would be solved by the utilization of ECVS in conjunction with a downstream carbon tax. The combination of the ECVS and a carbon tax would do much to remove this disincentive: the system would allow emissions to be calculated for all products and services imported to the U.S. and the tax would be imposed on these imports (rather than just energy sources) at the border, 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, however, as the tax would be country-neutral and would apply uniformly to both imports and domestic production.

A major shortcoming of current carbon regulating systems is that 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 that are not party to it have no incentive to become members and in fact have a strong incentive not to become members, as non-members will have a trade advantage over members in such a scenario. The ECVS system is incentive compatible in that it encourages producers in non-carbon regulating countries to truthfully reveal the emissions associated with any product or service it is exporting to a carbon-regulating country. At best, it encourages them to become party to the agreement. The aforementioned 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 their own tax or carbon price on any exports and no tax would be imposed on them at the U.S. border as a result (or, if the carbon tax in the exporting country is the lower of the two, the U.S. could impose a tax equal to the difference).

An additional problem with the current carbon-regulating systems is that they fail 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 characteristics of
the product being measured. The first of these is grams of carbon dioxide equivalent greenhouse gas emissions per megajoule of fuel energy (g CO₂e per MJ) and is used to measure 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 greenhouse gas emissions per kilometer traveled (g CO₂e per km). This captures the differences in the performance of various fuels in different vehicle types (i.e., 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 greenhouse gas emissions per kilogram of product (g CO₂e per kg). This measure allows for the evaluation of emissions from products other than fuels but is extremely limited even in this regard. While, for example, a comparison of the emissions associated with producing 1 kilogram of steel and the emissions associated with producing 1 kilogram of corn chips would reveal a quantifiable emissions amount, no practical purpose would be served by this measurement due to the inherent differences between the two products and the lack of a common denominator.

The final measurement is grams of carbon dioxide equivalent greenhouse gas emissions per gallon of fuel (g CO₂ per gal). This measure is of little use even when comparing
different transportation fuels given the differences in energy amounts in different fuels (1 gallon of ethanol contains less energy than 1 gallon of gasoline, for example).

All of the aforementioned measurements do share one trait, however: none of them can be used to quantify the emissions associated with services in a way that can be compared with other services, let alone products. Given that the service sector is responsible for 78% of the U.S. workforce\(^4\) and 1/3 of U.S. industrial GHG emissions,\(^5\) this is a notable omission. The ECVS would provide a common denominator by which the emissions from service activities could not just be quantified and compared against one another, but against product emissions as well.

Perhaps the biggest flaw in the current carbon regulating systems (California’s LCFS, Waxman-Markey, and the European Union’s Emission Trading Scheme) is that they only regulate emissions generated by the transportation and utility sectors of the economy which, combined, are responsible for only 1/3 of U.S. GHG emissions.\(^6\) Sectors that produce GHG emissions from sources other than fossil fuels - such as cement, agriculture, livestock production, etc. – 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, when implemented in conjunction with current measurement systems, base the utilitarianism of a product (and, by extension, economic growth) on an arbitrary measure of its weight or volume rather than on its overall economic value. Production is discouraged because carbon emissions increase along the value chain, with the
production process for a metric ton of steel containing 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 is calculated as the ratio of lifecycle greenhouse gas emissions directly attributable to the production, transport, and utilization of a product or service to the economic value of the product or service as measured in dollars of gross domestic product - MgCO2/$1000GDP (intranational calculations are based on the particular country’s currency while international calculations are 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 the system’s ability to quantify emissions from all products and services, regardless of type. Under ECVS the denominator for each product would be the same.

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 (for an example with the complete calculations, see Appendix I).

No measurement system will have much of an impact on reducing GHG emissions unless it is used in conjunction with a regulatory system and ECVS is no exception. It is most effective when used with a downstream carbon tax imposed on all GHG-emitting products and services based on their emissions rates. Multiplying the aforementioned ECVS score by the carbon tax (i.e., $50/metric ton CO2) reveals the cost of GHG emissions as a percentage of the product’s value. Unlike upstream carbon taxes (i.e., those that tax emissions at the wellhead or mine mouth), however, ECVS would work best with a downstream tax that was imposed on the 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 (i.e., a sales tax), 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 ultimate tax amount impacts all purchasers equally, those with less money will ultimately spend a greater percentage of their income or savings to pay the tax than those with more money will, resulting in a disproportionate impact on the poor. It is not necessary to discuss the specifics of the debate over whether sales taxes are regressive in practice here because studies have shown that the ultimate regressivity of a carbon tax is unlikely to be nearly
as steep as critics fear. Any disproportionate impact could also be alleviated through the use of tax refunds or cuts, funded with the proceeds of the carbon tax.

**Conclusion**

The intensity of the scientific debate over how to best 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: fail to slow the rate of global warming and the world will incur enormous costs to counter its impact; fail to do so efficiently and the global economy could absorb equally great financial losses. The ECVS provides the necessary incentive for countries to join 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 EU’s ETS and the Waxman-Markey cap-and-trade plan both lack. It would protect domestic jobs without running afoul of the global free trade framework. Finally, its uniform nature would allow for its widespread adoption, whether nationally or internationally. The ECVS holds significant potential and further study is needed to examine its impacts on a larger scale.
Appendix

(1.1) GHG emissions from agricultural corn production\textsuperscript{10} and corn chip production\textsuperscript{11} measured by ECVS and assuming a corn price of $155.50/metric ton.

\[
\frac{\text{Mg CO}_2}{\text{GDP corn production}} = 2.29
\]

\[
\frac{\text{Mg CO}_2}{\text{GDP corn chip production}} = 0.05
\]

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

\[
\frac{0.2848 \text{ Mg CO}_2}{\text{Mg corn chips}} + \frac{0.7675 \text{ Mg CO}_2}{\text{Mg corn chips}} = \frac{1.0523 \text{ Mg CO}_2}{\text{Mg corn chips}}
\]

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

\[
\frac{1.0523 \text{ Mg CO}_2}{\text{Mg corn chips}} \times \frac{\text{S15686}}{\text{Mg corn chips}} \times \frac{\text{S1000GDP}}{\text{S1000GDP}} = \frac{0.067 \text{ Mg CO}_2}{\text{S1000GDP}}
\]
References


Non-discrimination Statement

"Iowa State University does not discriminate on the basis of race, color, age, religion, national origin, sexual orientation, gender identity, sex, marital status, disability, or status as a U.S. veteran. Inquiries can be directed to the Director of Equal Opportunity and Diversity, 3280 Beardshear Hall, (515) 294-7612."