Carbon Emission Trading System Analysis: Schemes Selection, Permits Allocation, and Auction Revenue Distribution

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CARBON EMISSION TRADING SYSTEM ANALYSIS:
SCHEMES SELECTION, PERMITS ALLOCATION, AND AUCTION REVENUE

DISTRIBUTION

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ABSTRACT


The carbon trading system is one mechanism proposed to reduce carbon dioxide emissions and to solve global warming. The key issues in adopting a carbon trading system include trading schemes selection, emitting permits allocation, and auction revenue distribution. This thesis discusses these problems from a Neoinstitutionalist perspective, and conducts an analysis under the socio-ecosystem framework rather than the restricted market system analysis. It is found that the most important issue is to set an appropriate cap for the total allowed emission amount through recognizing the socio-ecosystem value. The absolute cap-and-trade system is supported since it can decrease the emissions to the targeted level where the ecosystem sustains. By including social cost in the analysis, it becomes clear that the auction method should be adopted to allocate emission permits. The thesis uses the property regimes theory and concludes that Barnes's Sky Trust should be established to allocate auction revenues. In addition, Swaney's co-management approach is recommended for managing the atmosphere.
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This thesis is dedicated to my husband, Yi Zhang.
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I. INTRODUCTION

For the last 10,000 years we have been living in a remarkably stable climate that has allowed the whole of human development to take place. In all that time, through the mediaeval warming and the Little Ice Age, there was only a variation of 1°C. Now we see the potential for sudden changes of between 2°C and 6°C. We just don’t know what the world is like at those temperatures. We are climbing rapidly out of mankind’s safe zone into new territory, and we have no idea if we can live in it.

—Robert Corell, Arctic scientist and IPCC member; The Guardian 5 October 2007

Climate models from the Intergovernmental Panel on Climate Change (IPCC), as well as models from other scientific organizations, indicated that global concentrations of greenhouse gases (GHGs) increased steadily over the past 100 years. Although arguments continued as to whether GHGs are causes of global climate change, significant impacts of climate change existed, including increasing sea levels; more severe droughts and floods, unusual weather patterns regarding hurricanes and blizzards, and increasing global temperatures. The United Kingdom Royal Commission on Environmental Pollution concluded that “Climate change is an enormous challenge ... threatening generations to come”. [RCEP, 2000, p. 9]

Nearly all countries recognize the severe impact of climate change—192 of the 195 countries signed the United Nations Framework Convention on Climate Change (UNFCCC) to “prevent dangerous anthropogenic interference with the climate system” [UNFCCC, 1992, Article 2]. UNFCCC was targeted to encourage the industrialized countries to stabilize their GHGs emissions. The Kyoto Protocol that linked to UNFCCC was adopted in 1997 and entered into force in 2005. Under the Kyoto Protocol, industrialized countries committed to reduce GHGs emissions by about
5% from 1990 levels by the period 2008-2012. Until 2008, 183 parties of UNFCCC members have ratified the Kyoto Protocol [UNFCC, 2008]. Those participating countries have the obligation to reduce their emissions by different levels so the overall goal in the Kyoto Protocol can be achieved.

Among various greenhouse gases, carbon dioxide is the most significant component that contributes to global warming because of the wide use of fossil fuels. It contributes about 60% of the human-enhanced greenhouse gas emissions [UNEP, 2008].

Figure 1 The Keeling Curve, showing the accumulation of carbon dioxide in the atmosphere.

Charles Keeling measured the CO2 concentration in the atmosphere on top of Mauna Loa in Hawaii for many years. Figure 1 summarized the carbon dioxide concentration from 1958 to 2008 [Scripps Carbon Dioxide Program, 2008]. The figure showed a clear upward trend with
about 23 percent increase of accumulation of carbon dioxide in the atmosphere during these years\textsuperscript{1}.

Figure 2 showed carbon dioxide concentration and global temperature over the past 400,000 years [Petit et al, 1989]. Clearly, a strong correlation exists between them.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Atmospheric Carbon Dioxide Concentrations and Atmospheric Temperature over the Past 400,000 years.}
\end{figure}

Due to carbon dioxide’s major contribution to climate change, reduction of carbon dioxide is potentially the most effective solution to approach the issue of global warming. The substitution of fossil fuel with renewable energy such as solar and wind could significantly decrease carbon dioxide emissions since fossil fuel is both a significant energy source for current economies and a major carbon dioxide emission source. For companies, the adoption of more costly technologies

\textsuperscript{1} The reason for the variation of carbon dioxide accumulation within a year is that there are more trees to absorb carbon dioxide in summer than in winter.
increases production costs and makes their products more expensive and less competitive in the marketplace. Currently, no incentive exists for companies and individuals to use renewable energy sources because the social cost\(^2\) of emitting carbon dioxide is not considered in private decision-making. To reduce carbon dioxide emissions, the issue becomes how to include the social cost of carbon dioxide emissions into the firm's for-profit\(^3\) production cost and therefore, decision-making.

Carbon trading, also referred to as “cap-and-trade”, and carbon tax are two existing practices to reduce carbon dioxide emissions by including the carbon dioxide emissions into the production cost. The permission to emit carbon dioxide is treated as a commodity in the cap-and-trade market. The price to emit carbon dioxide into the atmosphere is determined by the market through the trading of emitting permits among participating parties. The total carbon dioxide emissions that can be emitted are fixed at a threshold level because the total amount of emitting permits is set by the government or an independent market operator. A company must own a permit to release carbon dioxide emissions into the atmosphere; otherwise, it will be penalized.

Carbon emission trading is a hot topic. The cap-and-trade system was incorporated into Intergovernmental Panel on Climate Change (IPCC) and already was adopted in Europe. It was also proposed by 2008 presidential candidates Barack Obama and John McCain in the United States [CFR, 2008]. Edmonds [1999] suggested that a carbon trading system should be favored because it provided market flexibility in determining where it was the cheapest way to reduce emissions.

\(^2\) Social Cost refers to the harmful consequences and damages which third party or communities suffer as a result of productive processes and for which private entrepreneurs does not account for, see detailed discussion at Section 2.2.2.

\(^3\) For profit means individual company in the market system has the incentive to minimize its individual cost so as to maximize its profit.
carbon dioxide emissions. The key issues in adopting the cap-and-trade system include 1) how the cap should be set for every year; 2) to what extent the government should be involved, and who administrates the carbon trading market; 3) which trading scheme should be chosen; 4) how to initially allocate emission permits—auction or grandfathering (offer free permits to polluting companies); and 5) how the revenues associated with permits auctions should be distributed.

Most of the current economic research focused on analyzing the different trading schemes, permits allocation and permits auctions revenue distribution via the market system. The present thesis discusses the problems from a Neoinstitutionalist perspective and conducts the analysis under the socio-ecosystem framework rather than the restricted market system analysis.

Influenced by K. William Kapp, Thorstein Veblen and Karl Polanyi, Swaney, published his Elements of a Neoinstitutional Environmental Economics [1987]. Swaney considered the social system as “evolutionary, organic and holistic” [p. 1747]. He proposed to analyze environmental problems with ecology ethics under a holistic system where political power and economic power mix with market forces. The concept of “coevolutionary sustainability” was then introduced, under which both the social costs and cost shifting were considered. He further argued that coevolutionary sustainability should be used as a core principle to evaluate development paths or technological changes.

Following the idea of incorporating social cost from the Neoinstitutionalist School, this thesis argues that the auction method should be used to allocate emission permits, and claims that the most important issue involved with a carbon trading system is to set an appropriate cap for the total emission amount. To our best knowledge, these issues were skipped and assumed to be
known when previous researchers conducted studies. This thesis further discusses the
distribution of permits auctions revenue by using property regimes theory\(^4\).

Overall, this thesis analyzes the issues in adopting a carbon trading system under the
socio-ecosystem framework and evaluates the extent to which a trading system can potentially
alleviate the urgency of global warming. One primary question I seek to answer: Will a carbon
trading system be sufficient to solve global warming or should it just postpone the transition to
renewable energy sources?

\(^4\) Property Regimes Theory was developed by Bromley. Bromley [1991] used “property regimes” to define the
social relation that involves property holders, benefit streams and duty buyers. Bromley [1991] classified three
general types of property regimes including private property, state property and common property. See the
detailed discussion at Section 2.2.5.
II. BACKGROUND

This chapter summarizes the history of emission trading systems and types of trading schemes, compares auctioning and grandfathering emitting permits, and introduces the issue of distributing permits auctions revenue. Predominantly, these topics have been discussed within the restricted market framework with little consideration of the interlinkages among economic, social and ecological systems. To analyze the issues associated with an emission trading system under the socio-ecosystem framework, this chapter also explains the concepts broadly used in the Neoinstitutionalist School, including discussion of market system versus socio-ecosystem, social cost versus individual cost, cost shifting, methods of valuation, and property regimes for managing open-access resources.

2.1. Carbon Trading System

2.1.1. Emission Trading System Overview

The first large-scale, long-term emission trading scheme was established in 1995 in the United States. The Trading program basically arose under the Clean Air Act (1990) to reduce sulfur dioxide (SO₂) emissions and, consequently, acid rain. This trading program allowed polluting companies rather than the government to decide how and where to reduce sulfur dioxide emissions in order to comply with the Clean Air Act. Benkovic and Kruger [2001] claimed that
the SO$_2$ program in the United States was very successful and United States reduced more than 4 million tons of SO$_2$ since 1995.

### 2.1.2. Emission Trading Schema

Three different types of trading schemes were discussed by researchers [Kuik and Mulder, 2002]: 1) Absolute cap-and-trade system, where the total allowed emission quantity for a nation is fixed by legislation. Companies have to own emission permits to release carbon dioxide into the atmosphere. Companies are fined if they emit more emissions than the quantity allowed by the permits. 2) Relative cap-and-trade system, where emissions are legislatively fixed per unit of output or per unit of input, e.g., emissions per megawatt electricity produced or per ton of steel produced; however, there is no cap on total emissions. 3) A combination of the absolute and relative cap-and-trade system.

Kuik and Mulder [2002] compared and contrasted the three trading schemes to analyze their pros and cons at the domestic level in the Netherlands. They found several advantages for the relative trading system compared to the absolute trading system. The relative trading system provided continuing incentives for firms to reduce emissions. Also, arguably less negotiating cost was required to implement the policy since agreements pertaining to energy-efficiency standards among firms and governments already existed. The system was favored by the producers because it did not constrict their production scale. The disadvantage of the relative trading system over the absolute trading system was that total emissions reduction was not guaranteed. Since the total emission quantity is not capped, carbon emissions would increase with an increase in total output due to economic development. Disregarding the relative trading
system’s low effectiveness for reducing carbon emissions, Kuik and Mulder [2002] favored the relative cap-and-trade system because it did not interfere with the market system. They objected to the adoption of an absolute cap-and-trade scheme and the mixed scheme and claimed that those schemes have high administrative costs. They argued for the adoption of the relative cap-and-trade system along with other policies such as energy taxes to achieve additional emission reductions in the Netherlands.

Gielen et al. [2002] used a simple partial equilibrium model to analyze the relative cap-and-trade system. Their analysis showed that the relative cap-and-trade system tended to generate greater emissions at the industry level because of the larger output, although it could generate the same emission reduction level as the absolute cap-and-trade system if the relative cap-and-trade system had higher permit prices and levels of abatement. This implied that the relative cap-and-trade system had less overall efficiency than the absolute cap-and-trade system to reduce carbon dioxide emissions.

Overall, the relative cap-and-trade system cannot effectively reduce the total carbon dioxide emissions by a sufficient amount to combat global warming. The relative cap-and-trade system is favored if stronger preference is held for the market system, thereby allowing companies more freedom to emit carbon dioxide. We have to recognize that companies’ freedom to emit carbon dioxide is built on the degradation of the socio-ecosystem.
2.1.3. Allocation of Emission Permits

In addition to choosing a trading scheme, one of the most important decisions in the emission trading system is the choice of an emission permits allocation method. Two alternatives were considered: government auction and grandfathering. In the government auction, the revenue from auctioning emission permits is collected by the government. The grandfathering allocation distributes free permits to the current emission producers.

Historically, grandfathering was a popular practice of emission trading schemes. Two arguments were made by the proponents of the grandfathering allocation: 1) current emitters had the burden to reduce emissions in the future; 2) the gains from the free emission permits helped companies to engage in the programs that could reduce emissions, and therefore minimized the cost increase of their products. One example of the grandfathering allocation method is the sulfur dioxide trading system in the United States. In the sulfur dioxide trading system, the permits were given away free to those polling utility companies based on their historical SO₂ emission quantity in 1985. Although utility companies were regulated by state public utility commissions in the United States, no relevant guidance directed how the profit generated from grandfathering permits should be treated at the beginning of the SO₂ trading program. [Williams, 2008]

Without proper planning, grandfathering allocation can even generate negative impacts. According to Sijm et al. [2005], too many emitting permits were allocated freely to the carbon dioxide producers in the European Union Emissions Trading Scheme (EU ETS) in 2005. The grandfathering allocation brought substantial profit to the carbon dioxide emitters because those
companies collected revenues by selling extra permits in the emission trading market. Sijim et al. [2005] calculated the windfall profits from grandfathering permits for companies who were rewarded free permits in Germany and the Netherlands. Those windfall profits accounted for 9.6% to 46% of those companies’ baseline profits in 2005. The profits could ultimately benefit the shareholders of emitting companies.

Cramton and Kerr [1998] favored government auction over grandfathering allocation on the basis of three reasons. First, government could use the revenues to decrease the distortion taxes and then to increase economy efficiency. Second, auctions could increase equality in the economy by distributing auction revenues to the citizens. Third, small producers and new parties could gain fair access to the potential profitable emission permits. Klassen et al. [2005] held similar opinion and argued that auctions could increase both efficiency and equality by creating price transparency.

Ekins [2001] explained the popularity of grandfathering with the political power of the emitting companies. The energy-intensive sectors usually were considered industrially important. They would become losers in the auction system. To avoid losing, they used lobbying power to influence government’s decision to adopt the grandfathering method.

2.1.4. Auction Revenue Allocation

Barnes [2001] favored the common property ownership of the atmosphere in his book Who Owns the Sky. He treated the sky where the carbon dioxide was emitted as common goods to which everyone on earth was entitled an equal share. Barnes’ analysis specifically discussed the
ownership of sky specifically in the United States. He considered three potential owners of the sky: private companies, the federal government, and citizens. Although the proponents of privatization of common goods argued that corporations would provide a *quid pro quo* service to the public, the history of this type of privatization showed that the government usually just gave away the valuable assets [Snider, 2007]. Also, Barnes [2001] argued that common properties such as land, timber and spectrum managed by the government often were sold at far below market value. By studying the Alaska Permanent Fund, Barnes [2001] proposed the establishment of the Sky Trust to manage the revenues that came from auctioning emission permits. The funds in the Alaska Permanent Fund come from the oil revenues generated from oil wells on the land owned by Alaska. Since those lands are common property of Alaska’s residents, it was determined that 25% of those revenues were deposited into the Alaska Permanent Fund. The fund is owned by Alaska’s residents, and each of them has an equal share and receives dividends every year.

The proposed Sky Trust in the United States was similar to the Alaska Permanent Fund except that it operates at the national level [Barnes, 2001]. First, the Congress or the trustees of the Sky Trust decided how many emitting permits should be sold by considering the balance of ecological sustainability and economic development, besides the actions taken by other countries [Barnes, 2001]. Second, these permits were sold by auctions to companies and individuals who had a need for or are interested in these permits. A market for the permits was generated and the price of the permits was determined in the market because the cap of the permits was fixed at a level lower than current carbon dioxide emissions. Third, the revenue from the auction was deposited in the trust and was paid out equally to every citizen in the nation. When the emitting
permits were auctioned every year, recycling revenues were generated for every citizen and they can use the revenue to offset the higher living cost resulting from limiting carbon dioxide. Barnes [2001] also proposed the establishment of a Transition Fund for a certain period to help those who may lose their jobs (e.g., coal miners or truck drivers) because of the adoption of a carbon trading system.

Barnes and Breslow [2003] summarized the following key advantages of the Sky Trust: First, this allocation method achieved the efficiency of incentive-based regulation. Second, the Sky Trust recognized that the carbon-absorptive capacity of the atmosphere was common property to which everyone was entitled and the natural wealth such as atmosphere and biodiversity should be held collectively and distributed equally, and any entity that degraded the natural wealth had to pay the price. Third, the equal distribution of auction revenue from the Sky Trust increased household income of the lower income class more than the higher income class. Barnes and Breslow [2003] used neoclassical cost-benefit analysis to study the distribution impact. They considered the cost as the increased price of fossil fuel and other goods and resources produced with fossil fuel after the adoption of carbon-trading system. The benefit was the revenue allocated from auction revenue. One drawback left by Barnes and Breslow is the benefit derived from the ecosystem as a result of lower carbon emissions.

The distribution impact of a Sky Trust is analyzed for several nations. In terms of U.S, Barnes and Breslow [2003] found that the income of households in the lowest 10% would rise by $354, or 5.1 percent and the income of households in the top 10% would fall by $1,378, or -0.9 percent.
Boyce and Riddle [2007] conducted a similar study. They used an estimated price of $200 per metric ton of carbon (an emitting permit) that would achieve the goal to reduce U.S. carbon dioxide emission by about 7 percent below the current level. Their calculation showed that the estimated cost per American household of median income would increase by $1,570 per year because of the more expensive fossil fuels and increased price of other products. Total annual revenues from the permit auctions were estimated to be about $200 billion. If the revenues were distributed to every American citizen equally, the dividends received by the majority of the households were more than what they paid as a result of higher fossil fuel prices.

Brenner et al. [2005] analyzed the distributional impact of a Sky Trust in China. They discovered the progressivity of auction revenue collection and distribution, and the huge difference between rural and urban areas. The rural area of China was very different from the rural area of the United States. The households in rural China had extremely low cash incomes and expenditures. They acquired their 60 to 90 percentage of energy from biomass. Consequently, auction revenue collection and distribution in China is progressive, and the net effect of the Sky Trust had a larger impact on the distribution of income in China than in the United States. Brenner et al. [2005] estimated that the rural poverty in China would decline by 4.2%.

Ferjentsik and Ash [2007] analyzed the distribution impact for Hungarians if Hungary adopted the Sky Trust in its carbon trading system. Hungary joined the European Union (EU) in 2005 and its per capita income was about 60 percent of average EU per capita income [OECD, 2006]. Ferjentsik and Ash [2007] classified Hungary as “a small, open-economy,
They found that revenues from auctioning the emitting permits were almost flat compared to the Sky Trust distributing income. Combining the Sky Trust revenue recycling, Ferjentsik and Ash [2007] found that the net effect on income distribution in Hungary was moderately progressive. They found that the income of households in the top 10% in Hungary would fall by $859, or 4.4 percent. The income of households in the lowest 10% in Hungary would rise by $498, or 11.4 percent. The impacts on the income of the median households would be small but positive.

Comparing the distribution analysis conducted in the three countries, one can conclude that the same environmental policy generates different impacts. In China, low income people benefit more from the carbon trading system than those in the United States and Hungary. This lends support to the Neoinstitutionalists’ argument that we must recognize the importance of heterogeneity in institutional arrangements across cultures and geographical regions.

2.2. Key Concepts in Neoinstitutional Economics

The literature review in the previous section focuses primarily on the carbon trading system within market relations. This thesis conducts the analysis under the Neoinstitutional economics framework. Original institutional economics included market relations as part of social relations. Furthermore, Neoinstitutional economics included socio-ecological interconnectedness. The following sections discuss the concepts in Neoinstitutional economics which are fundamental to this thesis.
2.2.1. Market Economy Vs. Socio-ecosystem

Karl Polanyi [2001] discussed how the market economy was separated from the society and became self-regulated in his book The Great Transformation. He used the term self-regulation to describe economic relations where all production was for sale on the market and all incomes were derived from such sales. Therefore, a self-regulating market institutionally separated the society into economic and political spheres. Labor and land became fictitious commodities and components of the market economy since the nineteenth century. The substance of society and ecosystems were considered subordinate to the law of market. Meanwhile, Polanyi [2001] explained that society also reacted with protective countermoves to reduce the damage of the market economy on society—the so-called double movement.

Swaney [1989] argued that viewing the market as a separate sphere apart from the socio-ecosystem was broadly accepted in the status quo of economic and political power. Polanyi [2001] termed this habit of thought “market mentality”. The consequence was the ignorance of the social cost and ecological disturbance. Mounting evidence existed that increased human well-being was realized at the expense of ecological stability [Swaney, 1986].

Neoinstitutionalists viewed the market economy embedded in society and recognized the interaction between social and natural systems and the complexity of natural systems and humankind’s rapidly expanding power to break ecological chains. Currently, we know little about interactions between social systems and ecosystems. Since individuals might maximize their own utility by shifting cost to others or the ecosystem, Neoinstitutionalists favored social and ecological control over the market system to reduce unexpected negative impact on the global
socio-ecosystem. [Swaney, 1987]. As discussed above, we must evaluate the public policy not only via a market system but also via the socioecosystem framework.

2.2.2. Social Cost vs. Individual Cost

K. William Kapp [1950] employed the concept of “social cost” in The Social Costs of Private Enterprise. This term was used to describe all the harmful consequences and damages which third persons or communities suffered as a result of productive processes and for which private entrepreneurs were not easily held accountable. Different from the traditional definition of social cost as total social opportunity cost, Kapp [1950] defined social cost as the remaining part of social opportunity cost after deducting the paid private costs. This definition was also different from Alfred Marshall’s externality concept which implied that the uncompensated social opportunity cost was exceptional and incidental to the market economy. Kapp considered “social cost” pervasive and systemic. Kapp [1970] stated that the externality concept was developed under the economic theory that assumed the allocation, production, exchange and distribution occurred in an essentially closed and autonomous economic sphere with only minor effects on man’s natural and social environment. On the other hand, Kapp [1970] argued that social cost resulted directly and systematically from the market system, with harmful impacts on workers and other people in addition to the environment. Swaney [1989] also described social cost as “n-party” effects, where multiple, often distant individuals or groups or societies or human-supporting ecological systems are injured. Thus, social cost is both an exogenous and endogenous institutional structure because the market has a built-in tendency to generate uncompensated effect to third parties and communities.
2.2.3. Cost Shifting

Social cost is considered closely related to “cost-shifting by Kapp [1950]. His The Social Costs of Private Enterprise [Kapp, 1950] contained a detailed study of the manner in which the social cost produced by private companies was not counted in the companies’ business expenditures and further shifted to third persons and the community. Cost-shifting occurred when business expenditures were reduced not by employing advanced production methods that could benefit the overall society, but rather by avoiding outlays at the expense of workers, the environment, or the community at large. Individual cost was the cost for which entrepreneurs were directly accountable in the market system. An individual firm had the incentive to minimize its cost so as to maximize its profit. The firm that conducted such a cost shifting benefited and maximized its profit, but society as a whole was damaged by the cost-shifting. Swaney [1989] suggested that the damage might be particularly critical if this shift occurred in a competitive environment where other companies had to either follow or exit. As Kapp [1970] argued, the realization of monetary returns and market shares at the individual firm level does not generate a social optimum but may result in a disruption of the natural and social environment even when there is perfect information about all consequences. Social costs are by definition borne by others since they are not paid for by the producing firm but rather are shifted externally. From this perspective, Swaney [1989] stated that cost-shifting was nearly synonymous with social costs: those who created the harmful consequences were not held responsible. Swaney [1989] further suggested that cost-shifting implied that the companies had an incentive to shift costs onto others since the entities in market systems had great pressure to become competitive.
The cost-shifting incentive was attributed to the profit seeking principle and competitive character of the market system. Neoclassical economics emphasized how the competitive market could provide goods or services to consumers at the lowest possible price. This lowest possible price only allowed the firm to realize just enough profit to stay in business. Under the pressure of cutting cost or going-out of business, a systematic incentive induces the firms to avoid individual monetary costs. Companies were under more pressure to cut cost or shift social cost to the society or ecosystem when the market was more competitive. In the real world, costs were cut wherever gains (avoided costs) exceeded the entrepreneurial effort expanded to achieve profit maximization. Avoiding individual firm’s costs did not necessarily mean the reduction of social costs. Society’s total costs may increase “as violators of ethical or legal rules find it worthwhile to produce misinformation” [Swaney, 1987, p. 1760].

The pecuniary valuation under modern market systems told us that the “rational” manager or entrepreneur would pursue the most cost-effective means to improve the bottom line profit. If it was cheaper for an individual entity to shift costs than to employ technology that was superior from a social perspective, the rational profit-maximizing manager would choose the former. Otherwise, he or she would be weeded from the ranks of managers by the forces of competition. As a result, social costs became the direct result of incentives within the market system itself but not the result of unfortunate and accidental side effects of economic activity.

Kapp’s social cost concept provides a methodological umbrella, under which the widest range of unaccounted costs could be explored. Since global warming impacts every nation,
every person, and all species on earth, we have to evaluate a carbon trading system in consideration of “social cost” and “cost-shifting”.

2.2.4. Valuation

Pecuniary evaluation was broadly used in the market economy as prices determined the production and distribution of goods. Historically, the contribution of ecosystems was largely neglected in the pecuniary valuation process. The analytical separation of market from socio-ecosystem did not recognize ecosystems’ contributions to economic provisioning. When soil, wood, and other environmental products were abundant, they contributed the most to economy, but their market value was small. When environmental products were scarce, the market value was high. Odum [2000] argued that market price evaluation could not appropriately assess environmental capital, its contributions, or its impacts.

The failure to recognize the value of ecosystem in the market economy was regarded as one of the underlying reasons of environmental degradation. Ecological economists began developing valuation methods to assign an economic value to the ecological system and its services to describe the interdependency of human economies and natural ecosystems [Farber 2002, Turner 2003].

Neoclassical economists developed the contingent valuation method (CVM) to quantify the value of ecosystem services which were not considered in the market. The CVM method was aimed to measure people’s willingness to pay (WTP) for an environmental benefit or their willingness to accept (WTA) a change that was likely to reduce welfare. Variations include
avoided cost, replacement cost, factor income, travel cost, hedonic pricing, contingent valuation etc [Farber, 2002]. One of the most important syntheses of existing studies was done by Costanza et al. [1997]. They collected economic values of 17 ecosystem services from more than 100 studies, and calculated the total as the value for the entire biosphere on earth in terms of 1994 US dollars. Ackerman and Stanton [2008] estimated U.S. economic impacts from global warming would be as high as 3.6 percent of gross domestic product (GDP). Four global warming impacts alone, including hurricane damage, real estate losses, energy costs, and water costs, would come with a price tag of 1.8 percent of U.S. GDP, or almost $1.9 trillion annually (in 2008 dollars) by 2100. The issues with CVM methods included relying on overly restrictive assumptions such as individual utility maximization and having exogenous preference for ecological goods and services. These methods often produced poor descriptions of the environmental values people actually held as well as of the process of preference formation [Spash, 1997, 2000].

Swaney [1987] proposed “co-evolutionary sustainability” as the principle to evaluate the impact of development paths or technological applications on the ecosystem. To achieve co-evolutionary sustainability, the paths or applications that placed serious threats to long-run compatibility and sustainability of socio-ecosystem evolution should be avoided.

To achieve co-evolutionary sustainability, Gregory Hayden [1991] suggested that valuation of ecosystems had to be accomplished within a socio-ecosystem framework. Hayden developed a general instrumental methodology for determining value indicators to evaluate natural resources and ecosystems. The methodology was designed to conduct valuation of: (1) Norms and control properties, (2) Biodiversity, (3) Ecodevelopment, (4) Restoration cost and (5) System restoration.
Norms and control properties guided the development of the socio-ecosystem. Hayden [1982] discussed two norms—the one developed in the system and the one imposed on the system. He proposed to use a Social Fabric Matrix to evaluate the effectiveness of the normalization controls by measuring the system flows that resulted from those norms. Regarding the carbon dioxide emissions reduction, currently few normalization controls were implemented to reduce carbon emissions because only a few people were aware of the existence and impact of global warming and insufficient actions were undertaken. A carbon trading system can be viewed as the imposed norms to solve global warming.

According to Hayden [1991], biodiversity valuation provided information about the inventory of different kinds of species. This evaluation can be used for quantifying the impact on biodiversity of global warming and the impact can be included in calculating the ecosystem cost of global warming.

Ecodevelopment valuation integrated the social, ecological and economic concerns for evaluating production projects. Hayden [1991] used the Social Fabric Matrix data to determine a normalized flow that maintained ecosystem sustainability. The normalized flow can be used to determine the cap of carbon trading system.

According to Hayden [1991], restoration cost was “an operational action to convert the ecosystem into a budget sufficient for restoration” [p. 932]. Consideration of restoration cost is helpful to identify and include the indirect impact of global warming. All the costs to restore the current ecosystem to the sustainable stage should be recognized.
System Restoration valuation was used to evaluate the alternative restoration projects to choose the optimal one. "The optimal restoration alternative is the one that generates flows to return the ecosystem to its original purpose and structure without creating other adverse deliveries outside the threshold level for the system" [Hayden, 1991, p. 933]. The optimal alternative also needs to minimize the use of resources during the restoration process. Restoration valuation could evaluate different paths to reduce the carbon dioxide emissions.

2.2.5. Property Right Regimes

An example of Hayden's norms and control properties is the property right regimes. Bromley [1992] argued that property was not an object but was a social relation that defined the property holder with respect to benefit against all others. While carbon emission was released to the atmosphere, the current research discussed very little about the property regimes of the atmosphere. Emphases have to be made on the consequence of this social relation when evaluating a carbon emission trading system. Bromley [1991] argued for the use of the term "property regimes" to define the triadic social relation that involved benefit streams, right holders, and duty buyers. He classified three general types of property regimes and open access as the following:

Private property: Individual owner have right to conduct socially acceptable uses, and have duty to avoid social unacceptable uses. Non-owners have the duty to refrain from preventing socially acceptable uses, and have a right to expect that only socially acceptable uses will occur.

State property: Individuals have duty to observe use/access rules determined by controlling/managing agency. Agencies have right to determine use/access rules.
Common property: The management group has right to exclude nonmembers, and nonmembers have duty to abide by exclusion. Individual members of the management group have both rights and duties with respect to use rates and maintenance of the thing owned.

Open access (Nonproperty): No defined group of users or “owners” and benefit stream is available to anyone. Individuals have both privilege and no right with respect to use rates and maintenance of the asset. [Bromley 1991, p. 31]

Swaney [2003] argued that there was conflation of open access and common property for decades. For example, Gordon [1959] treated the open access as common property in “The Economic Theory of a Common Property Resources: The Fishery”. Hardin’s “The tragedy of the Commons” [1968] perpetuated this confusion.

Hardin [1968] proposed two means to restrict access and consumption of the open-access resources including privatization and regulation. Government regulation proposed by Hardin typically converted open-access (non-property) into public/state property or some mixed form of public and private property [Cole, 2002]. After Hardin’s false dichotomy, Coase produced free market environmentalism that suggested privatization as the solution to prevent resource degradation. Free market environmentalists believed that the market alone could solve the global warming issue. We can view the design of carbon trading schemes as one of their experiments. Different from Gordon, Hardin and free market environmentalists, Swaney favored common property regimes to manage the open access resources. He argued that the “open access” regime, not the common property regime, leaded to environment degradation. Swaney further suggested that private property regimes were not suitable to manage open-access resources. Open-resources were mixing and mobile. Since private property regimes only protected owners’
right and refrained from non-owner’s access, the mixing and mobility characteristics made it impractical to prevent the benefits or cost from spilling over to non-owners.

Swaney [2003] argued that capitalism broke down previously common property regimes (e.g. lands owned by Indian tribes) to open access through commodification, then some open access resources were converted to private property regimes. During this process, the resources were overexploited and degraded without holding anyone accountable for the costs. To manage the open-access resources such as air and water effectively, Swaney [2003] proposed new co-managed property relations as the solution.

Swaney’s “co-management” regimes solution incorporated private, state and common property regimes to manage the current open-access resources. In co-management regimes, government still set the broad use rules on a regional or global scale, and the local community was involved in the resources management. Swaney’s solution corresponded to Kapp’s proposal at the United Nations Conference on the Human Environment in 1971. Kapp [1971] proposed that common or collective property rights should be used to manage natural resources such as air, water, esthetic values etc. This co-management approach could be used in the carbon trading system since the atmosphere involved is open-access resource. The community should be involved actively in the process to determine the cap of the emission permits in a carbon trading system.
III. ANALYSIS

3.1. Cap Determination

If the ultimate goal for adopting a trading system is to solve the climate change issue, the cap has to be deliberately determined at the level where the ecosystem can sustain itself. Without the effective cap, no point exists to discuss other issues related to the adoption of the carbon trading system. To our knowledge, no research papers discussed the cap determination. It was assumed that the government could set the appropriate cap for carbon dioxide emissions reduction.

The appropriate cap depends on the analytical framework that we adopt and the sort of valuation applied in the socio-ecosystem. The value indicators developed by Hayden [1991] could be used to value the socioecosystem. The value technique included the means to conduct valuation of: (1) norms and control properties, (2) biodiversity, (3) ecodevelopment, (4) restoration cost and (5) system restoration. Norms and control properties valuation could be used to assess the current norms and controls to reduce carbon dioxide emissions. Understanding the current system can help to establish an appropriate cap. Biodiversity and Restoration valuation were important means to evaluate the ecosystem value. Biodiversity evaluation could be used for quantifying global warming's impact on biodiversity. The quantified impact could be included into the calculation of the ecosystem cost of global warming. Considering restoration cost is helpful to identify and calculate the indirect impact of global warming. System
restoration valuation includes all the costs to restore the current ecosystem to the sustainable stage. It can help define the ultimate goal for carbon dioxide emissions reduction.

3.2. Trading Schemes Selection

Among the three trading schemes (absolute cap-and-trade system, relative cap-and-trade system and the combination of absolute and relative system), this thesis concludes that the absolute cap-and-trade system is the best system to effectively reduce carbon dioxide emissions. In the absolute cap-and-trade system, polluters must own the emitting permits to gain the right to produce carbon dioxide emissions in the atmosphere in a given time frame. Also, there is a guarantee for reducing total carbon emissions to a certain level because of the established cap.

In the absolute cap-and-trade system, since the number of total available permits is usually less than the current amount of carbon dioxide emission, the demand for buying the permits is generated. Generally, the polluter can choose between holding more permits or reducing the emissions. Theoretically, if we adopt marginal analysis, at the equilibrium of the free trading market mechanism, the price of the permit equals the cost of reducing one more unit of pollution. The uniform market price has all the polluters faced with an equal marginal cost of pollution. Firms with higher marginal pollution reduction cost choose not to decrease emission but to buy permits in the trading market. If a firm’s marginal cost to reduce emissions is lower than the permit price, it will choose to decrease emission release and sell the permits in the carbon trading markets to make a profit. Therefore, the minimized national abatement costs can be achieved while limiting the national emissions at the same time.
In the relative cap-and-trade system, the cap is not absolute. It means the maximum emissions are not fixed but the emission per certain level of activity such as carbon dioxide emissions per unit of steel production are fixed per the requirement of legislation or domestic standards. A pre-determined relative standard is established for the used level of activity in the system. The number of the permit units is calculated by multiplying the size of the activity with the difference between the actual emissions per unit of activity and the relative standard. The relative cap-and-trade system does not guarantee to reduce carbon emissions to a certain level.

If we look through the prism of Neoinstitutional analysis and step from the marginalist framework, the major issue is to reduce the carbon dioxide emissions, to control global warming, and to sustain ecosystem stability. Therefore, although the relative cap-and-trade system could increase companies' competitiveness at the international level, this argument is not relevant for the problem of global warming as it focuses only on the firm or the nation's individual cost. The absolute cap-and-trading would address better the Neoinstitutional concerns of social cost of carbon emissions.

### 3.3. Permits Allocation

Although the grandfathering method was widely adopted in the world, this thesis concludes that the auction method is superior over the grandfathering method for allocating emitting permits. Both auction and grandfathering have the same result on reducing emissions because the cap is the same under the two allocation methods. The difference is the revenue flow. The government or the citizens receive the revenues in the auction method. Under grandfathering, the previously socially inefficient companies (those highly polluting) obtained a higher share of the total permits.
and had more windfall profits. The companies who shifted social cost were rewarded after transferring cost to the community and environment.

Under the auction method, the polluting entities account for the impact on the community and nature through purchasing the permits for carbon dioxide emissions. This method makes the entity in the market system pay for the social cost. By incorporating the social cost into their production cost and cause the cost-shifting impracticable, the entity has the incentive to develop advanced technology to decrease carbon dioxide emissions, e.g., the use of the renewable energy sources instead of fossil fuels.

In the auction system, the socially efficient and less polluting entities are rewarded since they only need purchase fewer permits. It provides an equal opportunity for any party who is interested in the permits. In the grandfathering method, only the polluting companies have the privilege to receive those free emitting permits. Auction system can also serve as a tool for the government to manage the trading market. In the sulfur dioxide trading market in the United States, the government used the auction method as a tool to send a price signal to the market [Matsuo, 1998].

Although the proponents of the grandfathering allocation method claim that polluting companies can develop the technology to reduce their emissions and avoid increasing their product price substantially through using the windfall profits, current research does not support such claims [Sijm, 2005]. The free allocation of emitting permits did not bring customers stabilized electricity prices in Germany and the Netherlands when grandfathering was used in the European Union Emissions Trading Scheme (EU ETS) in 2005. Sijm et al. [2005] examined the
electricity price in Germany and Netherlands and found that the electricity prices increased 50% to 
60% and the electricity industry passed about 60% to 120% of the carbon costs to their customers 
in 2005. Their data showed that electricity companies passed through the cost although they 
received windfall profits. The grandfathering allocation system only brought substantial profit to 
the carbon-dioxide emitters and their shareholders who usually belong to the wealthier classes in 
those countries.

The combination of auction and grandfathering is another option. It allows a portion of the 
emission permits to be auctioned by the government and the rest to be allocated among the 
polluters. Ten Northeastern and Mid-Atlantic states established the Regional Greenhouse Gas 
Initiative (RGGI) to reduce greenhouse gas emissions in the United States. RGGI committed to 
auction the majority of its Carbon Dioxide permits through quarterly auctions. It conducted its 
first Carbon Dioxide auction in Oct. 2008. [RGGI, 2008]

Another argument for the auction method is related to the property right issue. This thesis 
agrees with Barnes’ view that the atmosphere is a common property since every person is entitled 
to inhale oxygen and exhale carbon dioxide. Since the atmosphere is a common property to 
everyone and everyone is equal in the world, every person should have an equal share of the 
atmosphere. Those companies which produce carbon dioxide have to pay a price to those who 
own the property, i.e., every person in the world or within the nation. The auction method 
recognizes everyone’s property right. In the grandfathering method, only the users (the polluting 
company), not the owners of the atmosphere are rewarded because only the polluting companies 
can receive the free but valuable emitting permits.
The choice of an allocation method is made through the negotiation and bargaining power among different parties including large companies and citizens. The popularity of the grandfather allocation shows that large companies used their lobbying power to influence politicians to adopt policies that benefited themselves. It is important for citizens to recognize the difference between auctioning and grandfathering permits and take actions to inform their representatives in Congress which one is better for them.

3.4. Revenue Distribution

Given that one can conclude the superiority of the auction allocation method in the carbon trading system, the next issue concerns the entitlement and allocation of the auction revenues. This thesis supports Barnes's Sky Trust proposal and Swaney's co-management approach. Barnes's Sky Trust proposal not only recognizes every person's equal ownership of the atmosphere but awards those owners in the economic system by distributing equal dividends to every person. Another benefit of the establishment of the Sky Trust is to decrease the burden of the lower income households who suffer from adopting a carbon trading system. The literature review section discussed the case studies of the distribution effect of the Sky Trust in China, the United States and Hungary. All the cases showed that lower income households benefited from the carbon trading system if a Sky Trust was adopted. Evidence showed that the distribution income from a Sky Trust benefited low income individuals and increased social equality.

Meanwhile, we have to acknowledge that the ultimate goal for adopting the trading system is not to realize social equality. The objective is to resolve the climate change issue and to use the air resources in a sustainable way. As Hayden and Swaney emphasized, social arrangements and
environmental conditions are connected. In the process to achieve carbon emissions reduction, we can also use the appropriate distribution method to realize social equality. The two goals are inter-related.

Barnes’s Sky Trust distribution reflected the common property regimes character of the air. In Swaney’s view, the co-management approach should be applied to manage those open-access resources such as air and water. This approach emphasized the collaboration between government and local community. The government sets the broad use rules on the regional or global scale, and the local community is responsible for resources management. If local communities have more knowledge about nearby local resources than the national government, they should not be isolated from the resource management. Compared to Barnes’s Sky Trust, Swaney’s co-management approach requires the local community (the citizens) to play an active role in managing the air rather than only receiving the revenue from the government.
IV. CONCLUSION

Reducing carbon dioxide emissions is an urgent issue for any country in the world because of the severe impact of global climate change. An absolute cap-and-trade system will help reduce the carbon dioxide emissions. The cap of the trading system has to be determined at a level estimated through a socio-ecological framework of valuation that goes beyond individual cost, and conceptualizes social cost.

The trading system provides companies the choice to either purchase additional permits to release carbon dioxide or develop advanced technologies to reduce carbon emissions through comparing the price of the emission permits and the cost to implement advanced technologies. Auction allocation avoids the wind fall profits for polluting companies by imposing a fee on polluting companies. It requires the market system to account for the social cost of emitting carbon dioxide. The revenues generated through auctions also provide the opportunity for the owners of the atmosphere to benefit from their ownership. Grandfathering emitting permits benefit only the polluting companies and their shareholders. This does not resolve the environmental social cost problem, and rewards cost-shifting behavior. Grandfathering not only encourages continuing social cost shift in the future but also increases the social inequality by only rewarding the companies who already have privileges to produce carbon dioxide to the atmosphere.
Barnes's Sky Trust is preferable for distributing auction revenue from the sale of the emitting permits. The equal distribution income from a Sky Trust can ease the burden on lower income households who suffer from increasing living costs after adopting the carbon trading system. One must recognize that the cost-benefit analysis of Barnes' Sky Trust only focuses on household's increased living expense because of higher fossil fuels price and increased income through receiving distributions from the Sky Trust. Barnes failed to consider the factors that can't be measured by monetary valuation alone. For example, health problems can be measured by the money spent on treatment, lost income, etc. but emotional and ecological consequences cannot be offset entirely by money income. No meaningful monetary compensation exists for a destroyed ecosystem that can't be repaired. To understand the impact of a Sky Trust, a more comprehensive evaluation should be conducted in the future.

In addition to Barnes's Sky Trust, Swaney's co-management approach should be applied to manage the atmosphere. Local communities should take an active role in reducing carbon emissions to sustain the ecosystem along with the government.

During the United States 2008 presidential campaign, both candidates, Senator John McCain and Barack Obama, supported the establishment of a carbon trading system to solve the global warming issue. The major difference between them was the choice of methods for allocating emitting permits. Senator McCain favored grandfathering the permits and conducting the auctions gradually over time. Senator Obama argued that the public owned the sky and proposed to auction all the permits. Senator Obama also proposed to invest the auction revenue to renewable energy fields to realize the transition to a green economy. The cap under Senator
Obama's plan was to reduce the carbon emissions to 80 percent below the levels in 1990 by 2050.

In support of the analysis conducted above, this thesis advocates Senator Obama's proposal over Senator McCain's.

We must acknowledge that the establishment of an appropriate cap is built on the base of recognizing the value of the socio-ecosystem. Future research needs to quantify reasonably the socio-ecosystem value by using Hayden's [1991] value indicators. During the process to establish the appropriate cap for the trading system and managing auction revenues, the government, local community and citizens should be involved actively and worked cooperatively.
Reference


34. Regional Greenhouse Gas Initiative (RGGI), [http://www.rggi.org/home](http://www.rggi.org/home), retrieved on 10/12/2008


