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Options for Returning the Value of CO_2 Emissions Allowances to Households

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RESOURCES FOR THE FUTURE

Options for Returning the Value of CO_2 Emissions Allowances to Households

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Abstract

This paper examines alternative ways that the value of CO_2 emissions allowances created under cap-and-trade policy could be returned to households. One approach (based on principles of economic efficiency) is effectively a "tax shift" that would use revenues from an auction of CO_2 emissions allowances to reduce preexisting distortionary taxes. A second approach (based on principles of property rights for common-pool resources), known as cap-and-dividend, would refund allowance value as equal lump-sum cash transfers to households. Economic theory suggests (with some caveats) that a tax shift would be considerably less costly to the overall economy. In contrast, cap-and-dividend provides ample compensation for low-income households, though it appears to be more costly than other approaches, including perhaps well-designed regulatory policies. A dividend approach might be combined with other policies to provide incentives for households to invest in energy-efficient technologies and thereby lower the costs of the carbon policy.

Key Words: cap-and-trade, auction tax shift, revenue recycling, tax interaction, dividends

JEL Classification Numbers: H23, Q54, Q58

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1. Introduction

California is on the verge of implementing a cap-and-trade program to introduce a price on carbon dioxide (CO_2) emissions beginning in 2012, as part of its overall strategy to reduce greenhouse gas (GHG) emissions. This program will create a new commodity—tradable emissions allowances—with substantial market value. For California, the projected value of allowances for 2012 is $2.5 billion to $7.5 billion, rising to $7.3 billion to $21.9 billion in 2020 (2007 dollars).[1]

California's program design could also influence decisions at the national level. A federal trading program could generate value of $100 billion to $200 billion a year by 2020.[2] This would represent the largest creation of a federally enforced property right since the 19th century, when the American West was opened to private property ownership. As with land in the western states, the air has always been here and had value. What is different with the introduction of cap-and-trade is the government commitment to enforce an intangible property right guaranteeing use of the limited resource. A fundamental question is, To whom should this value belong?

There are numerous options, and combinations of options, for allocating allowance values, with dramatically different implications for the overall economic costs and distributional impacts of the cap-and-trade program.

One option is to auction the allowances and use the revenues to substitute for other taxes, like income taxes, either directly or indirectly—by reducing the need to raise revenues from other taxes to address structural budget deficits. Taxes in the broader fiscal system have the

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[1] Economic and Allocation Advisory Committee (EAAC 2010).

[2] CBO (2009a) provides the lower estimate. Krupnick et al. (2010) project that recent cap-and-trade proposals would limit domestic, energy-related CO_2 emissions to about 5.38 billion tons in 2020, with an associated allowance price of $33 per ton, implying potential revenues of $178 billion in that year (in 2007 dollars). One difference in these estimates is the anticipated availability of emissions offsets.

harmful effect of causing a difference between the social value of an activity and its reward, which distorts economic activity in various ways. For example, a tax on labor income reduces the real (after-tax) wage that workers receive below the value of the activity to the economy, with a depressing effect on hours worked, labor force participation, accumulation of skills, and so on. Similarly, taxes on the income from saving and investment depress the levels of capital accumulation below levels that would otherwise be economically efficient. A wide array of tax exemptions and deductions (e.g., for homeownership or employer-provided medical insurance) add further distortions by creating a bias toward tax-favored spending.

Adding a new, environmental or other regulatory burden can be expected to worsen some of these preexisting tax distortions, to the extent they contract the overall level of economic activity, employment, and investment. At the same time, tax distortions can be alleviated (slightly) by using allowance auction revenues to cut the rates of income or payroll taxes. In fact, a large body of evidence with simulation modeling suggests that recycling revenues in this way would produce relatively large economic efficiency benefits, which would substantially lower the overall costs of the cap-and-trade program to the economy. However, there is uncertainty about how well these models apply to the California economy, at least in the short run.

A very different approach, cap-and-dividend, would return auction revenues in equal lump-sum transfers (i.e., cash rebates) to households. The value that would accrue to households across the bottom half of the income distribution would likely more than compensate for the effect of higher energy prices. Equal per capita dividends have been rationalized on the ethical premise that all individuals have equal ownership rights to the environment, and therefore proceeds from charging for use of the environment should be shared equally. The dividend approach is transparent and may help with feasibility because it directly addresses a major concern about cap-and-trade programs—that they impose a disproportionately large burden on poor households through higher energy prices. But these advantages come at a considerable cost, since recycling in the form of cash transfers does not produce economic efficiency benefits.

Another possibility is to use allowance auction revenues to fund the development and adoption of clean-energy technologies that facilitate compliance with the cap-and-trade program. However, it is difficult to make general statements about whether such revenue use yields significant gains in economic efficiency, without detailed evaluations of the specific programs.

Yet another option for emissions allowances is simply to give them, and their associated property rights, away for free to existing emissions sources, rather than auction them. This approach may help overcome producers' opposition to the program, but in fact, this approach lost support once it became clear that under Europe's CO_2 Emissions Trading System, power companies were earning large windfall profits because the value of allowance giveaways to these entities greatly exceeded their compliance costs (e.g., Sijm et al. 2006).

Given all those choices, the appropriate allocation of allowance value will depend on what weight policymakers attach to multiple, and often conflicting, objectives, particularly containing overall program costs, addressing ethical or distributional concerns, and promoting political feasibility. The role of the economist in this setting is to provide, insofar as the evidence allows, some sense of the trade-offs involved among these objectives in the allocation of allowance value. A theme of our discussion is that these trade-offs can be quite stark. In particular, economic theory suggests that addressing ethical, distributional, and feasibility goals can imply considerably higher overall program costs. In fact, using at least some of the revenue to execute a tax shift by lowering distortionary taxes may be needed to ensure that costs to the economy with cap-and-trade are lower than with other alternatives, including direct regulation (Parry and Williams 2010a).

In 2010, a state advisory committee recommended to the California Air Resources Board, the agency responsible for implementation of the state's GHG law, that tradable emissions allowances be distributed through a revenue-raising auction, and that a majority portion of allowance value be returned to citizens or consumers.[3] The focus of this paper is therefore limited to the two main alternatives identified in the second recommendation—cutting income taxes and providing per capita lump-sum dividends. Furthermore, the analysis done here and decisions made in California can have an important role informing future national policy.

Our discussion is organized as follows. The next section discusses some further details on the policy background. Section 3 provides some approximate sense of the costs of prospective cap-and-trade proposals for California under alternative possibilities for allocation of allowance value. We also compare outcomes with those under an alternative, regulatory approach, to indicate the conditions under which the cap-and-trade approach has a clear advantage. Section 4 focuses on the burden of cap-and-trade and regulatory approaches across different household

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[3] EAAC (2010). The committee also recommended that approximately one-quarter of allowance value go to various program-related goals, such as investment in infrastructure and energy efficiency, as well as adaptation to climate change.

income groups in California, and looks at the trade-offs between distributional objectives and policy costs. Section 5 addresses political economy aspects in the choice of revenue use. Section 6 offers concluding remarks.

2. Background

In 2006 California adopted the Global Warming Solutions Act (AB32), requiring the state to achieve substantial reductions of GHGs by 2020. The California Air Resources Board (CARB) is charged with responsibility for overseeing the development and implementation of a plan that will reduce California's aggregate GHGs to 1990 levels by 2020. As part of the plan, CARB intends to launch a statewide cap-and-trade program slated to take effect in 2012.

Leaving aside, for the moment, interactions with the broader fiscal system, establishing a price on economy-wide CO_2 emissions is thought to be more cost-effective than regulatory (i.e., nonpricing) approaches. A price on emissions helps exploit all potential opportunities for emissions reductions throughout the economy. And because all emissions sources face the same price, this approach helps equalize marginal compliance costs across different sources, thereby minimizing the overall burden of compliance costs for a given target emissions reduction. In contrast, a regulatory approach would require multiple sets of standards to try to promote behavioral responses (e.g., fuel switching in the power sector, adoption of energy-saving technologies by various facilities in each sector). Even under a comprehensive regulatory framework, cost-effectiveness would still be sacrificed to the extent that marginal compliance costs differ across different emissions sources.[4]

There are several ways that a price on CO_2 could be introduced to the economy. Each possible approach suggests different options for distributing the value that is created.

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[4] One reason is that regulators lack information that is available to private entities, so they are less able to identify the cost-minimizing action for each entity throughout the economy. Regulatory approaches are unlikely to provide adequate credit-trading provisions across sectors, so marginal complaince costs are not equated. The introduction of a price on CO_2 enables private entities to adjust their own investment and operational decisions to independently minimize their own costs, given the observed price, and this private behavior is expected to lead to minimum overall social cost. A second reason is that the price of goods and services throughout the economy is expected to adjust to reflect the price of CO_2 under emissions pricing, ensuring adequate incentives for households and firms to reduce demand for energy-intenstive agoods.

A cap-and-trade program is just one way that regulators could introduce a price on emissions. Cap-and-trade works by limiting the volume of emissions that can occur and enabling the trade of emissions allowances among entities that are regulated. A price on CO_2 will emerge that reflects the marginal cost of achieving emissions reductions. This is the approach taken in the implementation of the sulfur dioxide (SO_2) trading program that was launched under the 1990 Clean Air Act amendments, where the value of emissions allowances was assigned to incumbent emitters that had been in existence in the 1985–1987 base period. Cap-and-trade also has been used to reduce emissions of nitrogen oxides in the Northeast states, which took several approaches to distributing allowance value: free allocation to incumbent emitters, free allocation to current emitters, direct sale, and a revenue-raising auction. Cap-and-trade programs for CO_2 exist in the European Union (EU) under the Emissions Trading Scheme, which took effect in 2005. In the first two phases of that program, through 2012, nearly all allowances were given for free to incumbent emitters, but a small portion was auctioned, with revenue accruing to EU member states. Beginning in 2013, a majority of allowances will be auctioned in the EU, with the portion continuing to grow over time. In the United States, 10 Northeast states organized the Regional Greenhouse Gas Initiative, which took effect in 2009. In that program, nearly 90 percent of allowances are auctioned, with a substantial portion of the revenues explicitly directed to strategic energy investments and other program-related goals.

A similar outcome can be accomplished without an emissions cap, but it will be somewhat less efficient than cap-and-trade. An example is the tradable performance standard program that was used to phase out lead from gasoline in the 1980s under the federal Clean Air Act. Under that program a concentration standard limiting the amount of lead per gallon of refined product was implemented. Firms could average and trade to achieve the standard, and an informal market emerged. More recently, there has been debate about a tradable CO_2 per kWh standard for the power sector or, similarly, a clean energy portfolio standard requiring firms to meet a certain fraction of generation through zero- or low-carbon fuels (e.g., Palmer et al. 2010). One interesting distinction in these programs is that an explicit assignment of the value does not occur under a tradable performance standard because there is no fixed emissions cap. Rather, value accrues implicitly to the firm only with each unit of production as it forms the basis for calculating performance.

Another way that a price can be introduced on CO_2 is through an emissions tax, such as has been implemented by Denmark, Sweden, and British Columbia, Canada. An emissions tax has a specific connotation regarding the assignment of value because revenue is collected and is available to the government. The decision of how the government uses the revenue collected under a tax parallels the general expenditure questions that constitute the government's budget process.

In contrast, under cap-and-trade, the government could auction allowances or it could directly give free allowances to a variety of entities.[5] There are many claimants for the ownership rights of emissions allowances. This paper focuses on the return of allowance value to citizens and two possible ways this could be achieved, which we label succinctly as tax reform and dividends.

3. Cost-Effectivness

Assessing the costs of cap-and-trade, and alternative climate mitigation policies, is complex not least because their costs depend inevitably on how policies interact with distortions in the economy created by the broader fiscal system. In the first part of this section we focus on the issues associated with the tax system, and in the second we address the relevance of other government spending priorities. We then discuss the potential interaction with other government expenditures.

A. Initial Assessment of Mitigation Costs (Ignoring Prior Tax Distortions)

We attempt to boil this issue down to the basics using a highly stylized discussion to give some rough empirical sense of alternative policy costs. We begin by discussing policy costs in the (unrealistic) case when there are no preexisting taxes in the economy. Subsequently, the analysis is extended to account for linkages between climate policies and the broader fiscal system, under alternative assumptions about revenue use. Our focus is limited to the cost side of policies—we do not discuss the climate-related benefits of emissions mitigation policies.[6]

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[5] In principle, the same distributional result could occur under a carbon tax through exemptions from the new tax or use of carbon tax revenues to pay for various tax reliefs. In practice, however, granting emissions allowances implies conveyance of a property right to private parties that is not a component of an emissions tax.

[6] Recent studies review evidence on the benefits per ton from reducing CO_2. Most of these reviews point to values in the range of about \$15 to \$35 per ton (in 2010 dollars). However, the valuation of future global warming damages (or the benefits from slowing projected climate change) remains highly contentious. Much higher estimates are obtained if global warming damages to future generations are discounted (based on ethical grounds) at rates that are well below market interest rates or under alternative models of extreme catastrophic risks to the planet. For a review, see, for example, IAWG (2010).

The economic cost, known as welfare cost or deadweight loss, from a broad-based cap-and-trade program to reduce CO_2 emissions represents the costs of all the behavioral responses to reduce emissions that are induced by the policy. Suppose, for now, that there are no distortions in the economy due to taxes or other market imperfections. Following basic and long-established principles in public finance (e.g., Harberger 1964), we can represent the welfare costs, in a given year, of a CO_2 cap-and-trade system as the area under the marginal cost curve for reducing CO_2 emissions.

Marginal costs of a cap-and-trade system are represented by the lower upward-sloping curve in Figure 1, where emissions reductions due to the cap below (the emissions level in the absence of policy) are shown moving from left to right along the horizontal axis, and the cost of the last ton reduced (i.e., the marginal cost) is the height of the curve. The marginal cost is initially zero, reflecting the lack of a price on CO_2 emissions in the absence of policy. That is, without a price on emissions, fossil fuels are used up to the point where the benefit from extra use (e.g., the value of extra electricity produced or extra automobile travel) equals the incremental cost of supplying fossil fuels. Therefore, reducing emissions by a very small amount would entail essentially no welfare cost because the benefits forgone (from reduced fossil fuel consumption) would be approximately offset by the savings in supply costs. However, as the emissions reduction becomes progressively larger, the price on emissions (given by the price of emissions allowances) rises, and this results in giving up progressively more valuable uses of fossil fuels, implying a rising marginal cost schedule for emissions reductions.

Suppose emissions are reduced by an amount in Figure 1 and the corresponding price on emissions is given by p. Then, making the assumption that the marginal cost curve is linear (which is probably a reasonable approximation for the range of emissions reductions considered here), the total annual cost of the emissions reduction is simply the area of the shaded triangle in Figure 1, equal to .

How large are these costs? The prospective cap-and-trade program in California will limit CO_2 emissions to 365 million tons in 2020. However, the level of 2020 emissions in the absence of the cap and the projected allowance price under the cap are uncertain because they depend, in particular, on future growth in energy demand, fuel prices, and the availability and cost of cleaner technologies. Based on the report of California's Economic and Allocation Advisory Committee (EAAC 2010), we illustrate possibilities where the cap cuts emissions by 10, 15, or 20 percent below levels that would otherwise prevail in 2020. This implies that emissions without the cap would be approximately 406 million, 429 million, or 456 million tons, respectively. Also based on EAAC (2010), the allowance prices associated with these scenarios are assumed to be \$20, \$40, or \$60 per ton, respectively (all prices and costs here are expressed in year 2007 dollars). Then, using our simple formula, the estimated total cost of the policy in 2020 would be \$0.4 billion, \$1.3 billion, or \$2.7 billion, depending on the allowance price scenario (see row 1, Table 1).

In our analysis so far, the costs of a carbon tax would be the same as under a corresponding cap-and-trade program if the tax rate per ton of emissions were set equal to the allowance price in the equivalently scaled cap-and-trade system. The cost of a nonmarket regulatory alternative is likely to be higher, however. To see this, consider an emissions performance standard for the electric power generation sector, where the regulation is "smart" in terms of allowing credit trading among suppliers. Under this policy, power generators would be required to limit the CO_2 emissions rate per unit of generation to a given level through shifting their fuel mix (e.g., increasing the share of renewables) and/or purchasing credits from suppliers whose emissions rates are below the standard. The emissions standard would affect electricity prices less than a cap-and-trade system (achieving the same emissions reductions) and would therefore be less effective at exploiting CO_2 reductions through reduced electricity demand (e.g., Palmer et al. 2010). Nor does the policy by itself exploit CO_2 emissions reductions outside the power sector (e.g., through reduced use of automobiles or reduced industrial fuel consumption).[7]

The marginal cost schedule for the emissions performance standard in isolation will have a steeper slope than that for cap-and-trade, as indicated in Figure 1. How much more costly is this approach? According to Palmer et al. (2009), approximately 50 percent of the CO_2 reductions under California's prospective cap-and-trade program will come from fuel switching in the power sector. In terms of Figure 1, this means that the emissions allowance price of *p* would generate reductions of from fuel switching. In turn, this means that the marginal cost for a

[7] The emissions performance standard for the power sector is essentially equivalent to a cap-and-trade policy confined to the power sector, where all the emissions allowances are auctioned and given free to local distribution companies with the expectation that the allowance value will not be passed forward into higher electricity prices. In practice, under an emissions performance standard, the absolute level of emissions is not fixed but moves with changes in the level of production. If the standard is adjusted to achieve the same emissions target, the price of emissions allowances will rise. Palmer et al. (2009) estimate the effect of free allocation to local distribution companies on behalf of electricity consumers within a cap-and-trade program in the Western Climate Initiative region. This allocation approach has approximately the same effect on electricity prices as would an emissions performance standard while holding emissions fixed. They find this approach leads to a 22.6 percent increase in the allowance price.

policy that exploits fuel switching would be only (approximately) twice as steep as the marginal cost for cap-and-trade. That is, if an emissions rate standard for the electricity sector were used as the exclusive mechanism to achieve an emissions reduction of in 2020, according to our highly simplified analysis, the total costs would be about twice as large as under comprehensive cap-and-trade.

In Table 1 we illustrate cases where regulatory approaches cover 30, 50, and 70 percent of the opportunities for reducing CO_2 that would be exploited under cap-and-trade. Greater coverage might be obtained by combining emissions rate standards with, for example, energy efficiency standards.[8] Costs are about 40 percent greater (when the coverage rate is 70 percent) to 230 percent greater (when the coverage rate is 30 percent) than under cap-and-trade (compare rows 2–4 in Table 1 with row 1). Moreover, this assumes marginal compliance costs are equated across different generation sources—in the absence of a comprehensive credit-trading program, compliance costs under regulatory approaches would be larger still (e.g., Newell and Stavins 2003).

The discussion so far has underscored the traditional case for market-based approaches in general over regulatory alternatives for emissions control. Given their narrow focus, regulatory approaches—even if designed with flexible credit-trading programs—are potentially a lot more costly because they exploit fewer emissions reduction opportunities.

Nonetheless, as discussed later, the distributional effects of regulatory approaches may be more benign, given their much weaker effect on energy prices. Most important for this section, however, is that by omitting an important component of overall welfare costs, the above discussion obscures important distinctions among cap-and-trade systems with different allowance allocations, and the costs of these policies relative to regulatory approaches.

B. Full Welfare Assessment of Mitigation Costs (Accounting for Prior Tax Distortions)

It has long been recognized among public finance economists that the welfare effects of any new policy intervention in the economy depend on how the policy affects preexisting distortions away from economic efficiency created by the broader tax system, as well as market

[8] In fact, CARB has identified specific measures that are expected to achieve more than 80 percent of the emissions reductions that would be required by 2020 and that, potentially, could be regulated.

failures like unpriced pollution emissions (e.g., Lipsey and Lancaster 1956). Harberger (1964) developed a general formula for this welfare cost, which depends on the size of distortions in other markets (e.g., tax rates or the magnitude of pollution damages) times the behavioral response (or quantity changes), as a result of the new policy, in markets affected by these distortions. In what sense is this relevant for the costs of California climate policies?

In this subsection we discuss the theory of how taxes distort economic activity and ways in which the welfare costs of carbon policies depend on how they affect these distortions.

How Do Preexisting Taxes Distort Economic Activity?

Figure 2 illustrates how the tax system distorts the labor market. The height of the demand for labor curve reflects the value of the output that would be produced from additional use of labor inputs. In Figure 2, this curve is drawn to be flat, which reflects the common assumption that, in the long run, output expands in proportion to increases in labor input along with increases in other inputs like capital (e.g., Hamermesh 1986). The height of the labor supply curve reflects the opportunity cost to the last worker of being in the labor force—that is, the value of the time given up that could have been spent in child rearing, leisure, other home activities, and so on. As the household wage rate increases, this may encourage, for example, a previously nonworking spouse to join the labor force, an older worker to delay retirement, and an existing worker to put in more hours on the job. As a consequence of all these behavioral responses, the labor supply curve is upward sloping (evidence on this is discussed below).

In the absence of any tax distortions, the quantity of labor supply would be L^* in Figure 2. This follows given that, in a competitive market, the wage paid by firms approximates the value of the marginal product of labor (i.e., the value of the last unit of labor supply to production), while people join the labor force up to the point where the wage just compensates the last worker for the value of her forgone time. L^* therefore represents the economically efficient amount of work effort.

However, a variety of taxes combine to drive a wedge between the costs to employers of hiring labor and the net wages received by households. These include federal income taxes, state income taxes, and Social Security taxes paid by employers and employees. They also include sales taxes, which reduce the real return to work effort (i.e., the amount of goods that can be purchased with wage income) in the same way that direct taxes do. The combination of all these taxes is represented by t in Figure 2, which drives a wedge of tw between the gross wage paid by firms (w) and the net of tax wage received by households ($(1-t)w$). The equilibrium employment level, L^0, is below the efficient level, causing a welfare cost indicated by the light-shaded triangle. This loss represents the value of forgone production compared with the efficient level (the area under the demand curve between L^0 and L^*) less the value of the additional time in the nonmarket sector (the area under the supply curve between L^0 and L^*).

Now suppose that a new climate policy raises energy costs, leading to a general increase in the consumer price level that, in turn, reduces the real household wage. Theory suggests this would lead to a reduction in labor supply at any given nominal wage $(1-t)w$, causing the supply curve to shift to the left, albeit very slightly. The resulting welfare loss is shown by the dark-shaded rectangle in Figure 2, with base equal to the labor supply reduction and height equal to the tax wedge (the difference between the social benefit and cost per unit of labor supply). Conversely, there would be a corresponding welfare gain to the extent that a new policy increased labor supply.

A caveat here is that changes in labor supply may not be fully reflected in changes in labor market equilibrium during periods of high unemployment when job opportunities are harder to come by. At the national level, the average unemployment rate from 1976 to 2009 was 6.2 percent, but in 2009 it spiked to 9.3 percent. In California the average rate over this period was 7.0 percent, but it was 11.4 percent in 2009 (Table 4). It is worth noting that individual willingness to make investments in human capital that increase productivity may remain responsive to changes in the expected long-run real wage even in periods of high unemployment. The theory and analysis we present apply on average over the business cycle with greater relevance in the longer run, when labor markets have overcome transitory bouts of involuntary unemployment.[9]

Like the labor market, the capital market is also distorted by preexisting taxes (e.g., corporate income taxes, personal taxes on unearned income, capital gains taxes) that drive a wedge between the gross rate of return on investments to business and the net rate of return on saving. According to theory, there would be analogous welfare effects in the capital market (to those in the labor market) if allowance value were used to reduce taxes on capital.

[9] Other important assumptions that underpin economic theory, and that are sometimes called into question, include equating the wage with the value of the marginal product. There are reasons that the wage may differ from this value for extended periods of time, though probably not by enough to make an appreciable difference to our calculations, below. Also, it is possible that individual labor supply decisions may not respond symmetrically to changes in sales or income taxes, as we assume they do to a change in the pretax wage.

Furthermore, not only does the tax system create distortions in labor and capital markets, but it also distorts the pattern of spending—that is, the composition of goods produced in the economy. In particular, the tax system creates a bias in favor of goods that are exempt from, or deductible from, income and payroll taxes. These tax preferences cause an excessive amount of spending on tax-favored goods like employer-provided medical insurance and owner-occupied housing, at the expense of ordinary (non-tax-favored) spending.[10]

Welfare Gains from Cutting Distortionary Taxes

There is general acceptance of the proposition that using new revenue sources to reduce distortionary preexisting taxes produces a gain in economic efficiency. Revenue from an allowance auction could be used for this purpose. The efficiency gain, which is termed the revenue-recycling effect (e.g., Goulder 1995), has two components.

First, obviously, is the amount of revenue used in this fashion. The maximum amount of revenue that could be raised from a cap-and-trade policy is indicated by the rectangle with height *p* in Figure 1 and base equal to the actual level of emissions , where would be the emissions level in the absence of policy. Revenue would be lower to the extent that emissions allowances were given away for free. Moreover, not all of the revenue raised may be used to reduce other taxes. We denote the amount of revenue raised and used to cut other taxes by , where is the fraction of emissions allowances that are auctioned and is the fraction of revenue used to cut distortionary taxes. The second component of the revenue-recycling effect is the efficiency gain per dollar of revenue that is used to cut distortionary taxes, which is essentially the same as the *marginal excess burden (MEB) of taxation.*[11] In Figure 1, the revenue-recycling effect is therefore indicated by the shaded rectangle, which has area .

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[10] It might be argued that these tax preferences are addressing some source of market failure, in which case they are not distortionary. However, our sense is that there may be little validity to this claim. Health economists tend to view the tax preference for medical insurance as more of a historical accident than a policy to correct market failures in health care provision. And although homeownership may confer some broader community benefits (e.g., if people take better care of their homes and gardens when they own rather than rent), there are counteracting effects (e.g., loss of open space and added congestion if the tax preference encourages urban sprawl). The failure to fully charge developers for the costs of new infrastructure (schools, roads, etc.) required for additional housing further raises the likelihood that too much, rather than too little, is spent on residential housing development. The alternative minimum tax, which caps mortgage and other tax deductions for high-income earners, does limit tax preferences, though this is taken into account in the studies we use to infer a value for the MEB.

[11] The MEB is the efficiency loss from an increase in distortionary taxes, expressed per dollar of extra revenue raised.

How Large Is the Gain from Revenue Recycling?

We use what we believe is a reasonable value, 0.35, for the MEB (i.e., 35 cents of welfare gain per dollar recycled in tax cuts).

Based on older literature that focuses on labor market distortions only, a typical estimate for the MEB is around 0.25 based on compensated labor supply responses, and around 0.15 based on uncompensated responses.[12] The compensated response is applicable to our case. This is because we are comparing labor supply responses from an uncompensated tax cut with labor supply responses when instead revenue is returned to the private sector in lump-sum compensation. In both cases there is an income effect; therefore, comparing one case with another leaves only the substitution effect.

However, following Feldstein (1999), public finance economists have been concerned with measuring the combined costs of distortions created by changes to the tax system, including the distortions in factor markets and also the shifting between tax-favored and ordinary (non-tax-favored) spending. The combined effect can be inferred by estimating how taxable income (i.e., earnings from labor and capital less tax-favored spending) responds to changes in tax rates. The empirical evidence on this is carefully reviewed by Saez et al. (2009), for uncompensated price changes, and based on this, Parry and Williams (2010b) estimate an MEB of 0.25, with a plausible range of about 0.10 to 0.40. We use 0.35 to make some allowance for the larger labor supply response to a compensated price change.

The maximum welfare gains from revenue recycling, based on empirical measures and economic theory, are indicated in Table 1. We term these the maximum potential gains when all allowances are auctioned and all revenues finance a general reduction in marginal income tax rates or sales taxes (i.e.,). A large amount of revenue is raised when allowances are fully auctioned in 2020—$7.3 billion to $21.9 billion under different scenarios for the allowance price. And the welfare gains from using all this revenue to cut distortionary taxes is substantial, $2.6 billion to $7.7 billion under our MEB value (see row 5, Table 1), or 2.8 to 6.4 times the costs as previously estimated under the assumption of no preexisting taxes.

[12] See, for example, Browning (1987), Ballard et al. (1985), and Stuart (1984). These estimates are based on empirical studies of labor supply responses to changes in household wages, averaging over male and female workers, and accounting for changes both in hours worked on the job and in labor force participation rates. The most important component of the labor supply response is the participation decision by married females.

Effect of Higher Energy Prices on Tax Distortions

The potential revenue that is raised under an allowance auction results from introducing a price on CO_2 emissions via a cap-and-trade system. This new price on CO_2 causes higher fuel and electricity prices and consequently a general increase in the costs of producing goods and services throughout the economy. As a result, the real wage will decline, as will the real rate of return on capital. In other words, the price increase acts like an "implicit" tax and could be expected to affect labor supply and capital accumulation in the same way as do other distortionary taxes (e.g., Goulder 1995). Consequently, we would expect the quantity of work effort and capital accumulation to fall, resulting in a welfare loss, which has been termed the tax-interaction effect (Goulder 1995). Although the effect of carbon policy on economy-wide labor supply (the base of the rectangle in Figure 2) is small, the welfare loss per unit reduction in labor supply (the height of the rectangle) is large, given that federal and state income taxes, employer and employee payroll taxes, and sales taxes combine to drive a large wedge of around 35–40 percent between the gross wage paid by firms and the net of tax wage received by households. Consequently, the tax-interaction effect significantly increases overall policy costs.

Economists have paid considerable attention to the issue of whether the welfare loss from the tax-interaction effect is smaller or larger than the gain from the revenue-recycling effect (under an environmental tax, like a carbon tax, or a cap-and-trade system with full allowance auctions). In models that capture only the distortions in factor markets created by the tax system, the typical finding is that the tax-interaction effect exceeds the revenue-recycling effect (e.g., Bovenberg and Goulder 2002; Schoeb 2006).[13]

Moreover, as explained above, the tax system also creates a bias toward tax-preferred spending, and allowing for this increases the revenue-recycling effect. In contrast, the tax-interaction effect is largely unaffected by tax preferences: higher energy prices induce little substitution between tax-favored and non-tax-favored spending, given that the energy intensity of these product categories is broadly similar. As a result, the welfare gains from the revenue

[13] This finding is consistent with a large literature in public finance that explores what an optimal (economically efficient) tax system would look like (e.g., Sandmo 1976). A basic insight from this literature is that (leaving aside pollution and other market failures) taxes on narrowly defined products, or intermediate goods like fuels and electricity, are generally more costly (i.e., cause more economic distortion) than broader-based taxes like labor income taxes, for a given amount of revenue raised. Consequently, imposing a narrow-based tax and using the revenues to lower a broad-based tax will tend to increase the overall distortionary costs of the tax system.

recycling effect can actually dominate welfare losses from the tax-interaction effect (e.g., Parry and Bento 2000).

One further point is that preexisting tax distortions have less dramatic implications for the overall welfare costs of regulatory policies. Although these policies do not raise revenue, they also have a much weaker effect on energy prices and production costs in general than (comparatively scaled) CO_2 pricing policies, as there is no analog to the pass-through of allowance value in higher prices. Consequently, regulatory policies will have a weaker adverse effect on economy-wide employment, investment, and so on from higher energy costs (e.g., Goulder et al. 1999).

In Table 1 we provide an approximate estimate of the tax-interaction effect under alternative climate policies, based on applying formulas for cost markups due to fiscal interactions that are derived and discussed in Goulder et al. (1999) and Parry and Williams (2010b).

For the cap-and-trade policy, the tax-interaction effect falls somewhat short of the full revenue-recycling effect, as indicated by a comparison of rows 5 and 6 in Table 1. For example, for the $20 allowance price scenario, the revenue-recycling benefit is $2.6 billion (per year in 2020), while the tax-interaction effect costs $1.9 billion. When revenues are used to reduce preexisting taxes, the net effect of fiscal interactions is therefore to lower the overall costs of the policy. For example, in this case the overall costs of the policy fall from $0.4 billion when prior tax distortions are ignored to negative $0.2 billion (compare rows 1 and 7 in Table 1). That is, in this case the shift from the labor income tax to auction revenues for CO_2 would lead to economic improvements before accounting for any of the benefits of climate policy.

In contrast, for the cap-and-trade system where there is no revenue-recycling effect, policy costs increase significantly when taking just the tax-interaction effect into consideration, as can be seen by comparing rows 1 and 9 in Table 1. Costs increase by 222, 309, and 475 percent for the $60, $40, and $20 allowance price scenarios, respectively.

The costs of regulatory approaches are also higher because of fiscal interactions, but the cost increase is much more measured because the change in product prices is smaller. Comparing rows 11 and 2, rows 13 and 3, and rows 15 and 4 from Table 1, we see that in each case costs increase by an estimated 25 percent. Consequently, the overall costs of the regulatory policy can be smaller than for the cap-and-trade policy with no revenue recycling. In fact (comparing rows 11, 13, and 15 with row 9 in Table 1), in seven of the nine cases the regulatory policy is less costly to the overall economy than cap-and-trade with no revenue recycling, even though the regulatory policy places “too much” burden on some abatement opportunities and “too little” on others. (Again, bear in mind the caveat that our assumed regulatory policy is smart in terms of equating marginal compliance costs across covered emissions sources within a sector.)

Summary, with Qualifications

Economic theory suggests there are significant distortions in labor and capital markets, and in the pattern of spending, due to the tax system and tax-sheltering provisions. Climate policy, whether implemented as a new regulation or as cap-and-trade, tends to compound distortions in labor and capital markets because higher energy costs have a (slight) contractive effect on economic activity, employment, and investment. The magnitude of this effect is likely to be greater under cap-and-trade because of the introduction of a price on CO_2. Using the revenue from an auction of emissions allowances to reduce preexisting taxes can offset, or perhaps more than offset, a large portion of the cost of cap-and-trade. However, theory suggests that if revenues from an auction are not used to reduce preexisting taxes, the welfare cost of cap-and-trade policy could be much greater, possibly even greater than direct regulation of CO_2 emissions.

Some reasons for caution. We should be careful not take the above theoretical results as fact, however, because there are always uncertainties in measuring projected policy effects and there is always a risk that a given economic model has missed something of importance. For example, the MEB is estimated with a fair degree of uncertainty, though it is still appropriate to use a value reflecting middle of the range estimates; today’s best judgment may change in light of future evidence. Here we comment on some further qualifications.

First, as noted, the labor supply effect of carbon policies may be more muted in the short term because of the currently slack labor market. The persistence of high unemployment may mean that change in labor supply might not lead to change in labor market equilibrium.

Second, on the other hand, if the tax cut is targeted on capital rather than on labor (e.g., if business taxes rather than personal taxes are reduced), the welfare gains from the revenue-recycling effect can be larger, given that the MEB for taxes on capital is thought to exceed that for taxes on labor (e.g., Bovenberg and Goulder 1997; Judd 1987). However, cutting business taxes would likely be viewed as less equitable than cutting household taxes.

A third consideration is whether the above estimates of the MEB, which are based on national-level data, are reasonable for California. State-level personal income taxes and sales taxes together represent 8.9 percent of personal household income in California (Table 2). These taxes are higher, but only moderately, than the corresponding tax rates averaged across all states (7.8 percent). Moreover, what matters for the MEB is the combined distortion from both state and federal taxes. Accounting for the latter, as indicated in Table 2, the overall (average) tax rate on California income is 36.1 percent which is not that much larger in relative terms than for the nation as a whole (34.6 percent). Furthermore, we see no obvious reason why behavioral responses to tax changes in California should be significantly higher, or significantly lower, than the national average. In the absence of evidence on the latter point, it seems reasonable to use the same MEB value for California as for the national economy.

Finally, the efficiency gains from revenue recycling will depend on the specifics of the tax cut. Implicitly, behind the MEB estimates is a proportional change in marginal income tax rates—at the federal or state level—across all household income groups. If instead the tax cut took the form of an increase in personal income tax thresholds (the income below which the marginal tax rate is zero), the gains in economic efficiency would be considerably smaller. This policy would encourage more labor force participation among lower-income persons or second-income earners in the household, because it increases the net take-home pay from working. However, it would not exploit other behavioral responses that depend on marginal (rather than average) tax rates, like working harder on the job or shifting from tax-favored to non-tax-favored spending. On the other hand, we would expect a cut in the sales tax to produce welfare gains comparable to those from a general reduction in marginal income tax rates, because it would exploit the same margins of behavior. In particular, lower sales taxes would increase the real rate of return on all work effort (whether through increased hours on the job or through increased participation rates) and would also alleviate the bias toward tax-preferred expenditures, which are largely exempt from sales taxation.

C. Interactions with Other Program Goals

Addressing climate change will require dramatic technological change. A price on CO_2 is a useful tool to bring into the market innovations that are commercially available, but many observers believe it is unlikely that the political process will support a price that is sufficient to accelerate research and development upstream in the lifecycle of innovation.[14] Furthermore, the magnitude of investment that is necessary is substantial. The International Energy Agency (2008) estimates that to cut today's emissions levels by half will require additional investments (beyond the baseline) of roughly $45 trillion. The vast majority of this investment will have to come from private sources.

The timing of investment is also important—to capture near-term opportunities to reduce emissions, to alter the nature of infrastructure that will be in place over the next century, and to accelerate the process of innovation. Although some element of technological change will result from major breakthroughs relating to important new technologies, such as carbon capture and storage, most of it is likely to proceed from incremental discovery and innovation that result from commercialization of incremental technological improvements (e.g., Alic et al. 2003). Near-term investments contribute to accumulated capital of technological knowledge as well as physical infrastructure.

In the case of California, agencies and advisory committees have identified public investment priorities related to the emissions reductions goals of the state (EAAC 2010, ETAAC 2008, 2009, EJAC 2008). These include the need for new transportation infrastructure, investment in the electricity grid to facilitate transmission of renewable energy from remote regions, smart electricity meters that provide improved pricing information to consumers, research and development into clean energy technologies, efficiency upgrades in schools and other public buildings, community-based support for mitigation and adaptation, and support for weatherization and other energy-saving capital purchases by businesses and households, especially low-income households. Furthermore, there is interest in recycling revenues back to the economy in ways that are most effective in helping the economy recover from the present recession.

[14] Survey research on attitudes toward environmental and climate policy suggest that the U.S. public is in favor of efforts to reduce emissions of GHGs but doesn't want to pay an explicit price, such as a carbon tax, to achieve those reductions. The U.S. public has a clear preference for action in the electricity sector, and a preference for standards over cap-and-trade or taxes (Bannon et al. 2007). Further, survey research indicates that Americans continue to be extremely anxious about the cost of energy, and investment in clean technology is the most popular policy option (American Environics/EMC 2007). The public appears to like its taxes hidden, and imposing a technology standard on CO_2 emitters may be one way to impose reductions without introducing an explicit tax or allowance price to the economy.

It is difficult to make general statements about the merits or drawbacks of these broader alternatives in the absence of specific evidence on the benefit and costs of spending measures, accounting for possible "market failures" that they might address. In a companion paper, Farbes and Kammen (2010) present an assessment of the aggregate social benefits of these spending priorities. Whatever the benefits, it is clear that public policy reflects the belief that for equity, efficiency, or other reasons, public investments to address these priorities are important.

In sum, the need for investment in new technology is substantial. It is unlikely to be realized fully from incentives put in place by cap-and-trade or from public funding. Moreover, the need is timely. Consequently, in Section 5 we consider how value that is created by the introduction of a price on CO_2 and potentially returned to households might reinforce goals to increase investment in energy-efficient technology.

4. Distributional Implications

Besides its overall economic cost, the consequences of carbon policy for individual households also depend on its distributional burden. Distributional incidence is a limited measure of well-being because it compares only relative effects, not absolute effects. If all households were made better off but high-income households were made much better off (as a proportion of income) relative to low-income households, a distributional analysis would describe the policy as regressive. Conversely, even if the policy made everyone worse off but had a larger effect on high-income households (relative to their income), a distributional analysis would describe the policy as progressive.

In this section we focus on the *relative* effect on households across the income distribution. Again, we compare the options of tax reform (representing a proportional reduction in the income tax burden across all households) and dividends, but using a study projecting effects for the year 2016. We evaluate the tax reform option as a proportional reduction in the income tax burden. We assume that this reflects the preferences of policymakers regarding the distribution of the tax burden in general, and that changes in marginal rates are aligned to achieve this result.

We analyze results in a partial equilibrium framework, which means we account for the net resource costs (policy costs with no prior tax distortions) across households. Since there is no behavioral response through the tax system, the effect under these two policies on the average household is equal. Data for this analysis are based on the Consumer Expenditure Survey for the years 2004–2008.[15] Information about marginal and average tax rates, including federal and state income and payroll taxes, comes from the Congressional Budget Office (2005). The model accounts for automatic indexing of tax brackets and benefit programs, such as Social Security programs, in response to inflation. Additional details for how the policies are modeled can be found in Blonz et al. (2010).

One important consideration in this analysis is the effect of a cap-and-trade program on government's own expenditures. One way the government is affected is through the change in the cost of direct energy expenditures. Federal, state, and local governments account for 14 percent of total energy expenditures. Consequently, to keep government budgets whole, we withhold 14 percent of the allowance value.[16] Although the setting in this study is California, we assume that changes in costs at federal facilities in the state lead to an increase in costs at all levels of government. This increase in costs ultimately affects household budgets, so for a distributional assessment we account for this cost by deducting value from the pool of emissions allowances.

This model for California is built on a national climate policy, where abatement, goods price changes, and allowance price are calibrated at the national level. Nonelectricity abatement behavior is taken from the Energy Information Administration's analysis of H.R. 2454 (EIA 2009). The electricity sector is modeled within RFF's electricity market model, called Haiku. Residential electricity is regionally disaggregated, with California-specific price and demand changes, along with the CO_2 content of electricity generation in California and neighboring states, to reflect the emissions intensity of electricity actually consumed in the state.

Income deciles in the analysis are constructed nationally. California's average income is $11,269 higher than the national income, meaning more households reside in higher national income deciles. As a result, California has an asymmetric number of observations in each decile

[15] There are drawbacks to using annual income to assess a household's ability to bear the burden of a tax or other policy. It has been argued that a measure of "permanent" or "lifetime" income is a better metric than annual income by which to categorize households for the effects over time, but this measure is difficult to implement. Studies that use lifetime income—often proxied by annual consumption expenditures—generally find that carbon taxes and cap-and-trade systems look much less regressive over lifetime income (Fullerton and Rogers 1993; Walls and Hanson 1999; Burtraw et al. 2009; Hassett et al. 2009).

[16] CBO (2009a) predicts that this cost for federal, state, and local government combined will be 14 percent of allowance value; CBO (2009b) predicts it will be 13 percent.

(Table 3). Average incomes within deciles, however, do not differ significantly from the national averages, since they represent the average income of those Californians who fall within the nationally defined deciles. Also note that family size (persons per household) varies across the income distribution in California (and also for the nation).

The results from Table 3 are displayed graphically in Figure 3. The picture that emerges from the data in Table 3 indicates that a reduction in income tax rates is regressive across the entire income distribution. Households in the bottom nine income deciles (defined at the national level) are made worse off, but households in the top income decile (which constitutes 15 percent of the households in our sample for California) benefit. The dividends approach has nearly the opposite result. Households in the bottom five income deciles are strictly better off under the policy, and households in the sixth decile about break even under the dividend policy.

In the absence of effects from interaction with the tax system, a dividend approach would appear to be better for households through the eighth income decile nationally. In our sample this constitutes 72 percent of all households in California. That evidence would seem to suggest that a dividend approach could be politically popular.

We also conduct analysis using consumption quintiles rather than income quintiles. Current consumption often is based to some degree on lifetime or permanent income, rather than on current income alone. For example, some households with low current earnings might actually be consuming at a higher level because of their position in their career path (beginning or retirement) or other factors.

The results regarding the distribution across the lifetime income quintiles (proxied by annual consumption) are similar to those with annual income quintiles, but the regressivity is diminished. The distributional effect of using revenue from an allowance auction to reduce income taxes appears less regressive, and the dividend approach appears somewhat more progressive, when evaluating annual consumption rather than annual income.

In all cases, the absolute levels of effect on households vary from that which would emerge if the analysis were to include interactions with the tax system. That approach, built on the assumption (described previously) that in the long run, equilibrium in labor markets will respond to changes in labor supply, would show the dividend approach to be more costly *overall*, and under most scenarios it would be more costly for all income groups. None of these analyses are able to account for interactions with expenditure priorities. If distribution of a dividend could be designed to improve the effectiveness of other government priorities, as we discuss in other sections, such an approach could reduce its cost.

5. Political Economy Considerations

We discuss three aspects of political economy in the subsections below. First we discuss the philosophical framework for emissions trading versus taxes. Second, we discuss the practical political issues of the choice of a tax shift versus dividends as alternative mechanisms to return CO_2 allowance value to households. Third, we discuss the role of behavioral issues in the potential design of a dividend program, which might enhance its effectiveness in helping to achieve related program goals.

A. Philosophical Framework

There are two defining aspects of climate change as an economic problem. First, the atmosphere is *nonexclusive:* absent some kind of regulation, it is impossible to restrict access to the atmosphere. Second, it is *depletable:* emissions from one source degrade the status of the environment for everyone. These characteristics define climate change as a *common pool resource problem* in economic theory.

A fundamental question follows from that definition. Who owns a common pool resource? Or equivalently, perhaps, when the government decides to regulate access to a common pool resource by restricting supply and enforcing an intangible property right, as occurs with enforcement of a cap-and-trade program, to whom should the newly created property rights be assigned?

A conventional interpretation of a common pool resource is that it is owned collectively by the parties who are affected by the resource or depend on its use. One example is when many parties have legal access to an oil reserve, a nonexclusive and depletable resource. A race to harvest the oil can reduce total productivity of the resource. This dilemma is often solved with a regulatory solution called unitization, which establishes shares and rates of extraction among the private parties to maximize the net present value of the resource. Another example is when the management and disposition of the resource are subject to political control, wherein each citizen in a political democracy has an equal voice in the determination of its outcome.

Equal ownership of a common pool resource has practical meaning within a cap-and-trade program. The value of emissions allowances represents the payment for environmental services (Boyce and Riddle 2007). The common pool aspect might imply that the payment for services, or in other words the value of emissions allowances, should be divided in equal amounts among the citizenry (Barnes 2001).

The state of Alaska has experience with an annual transfer of dividends to households. The “permanent fund” in Alaska was created in 1976, and everyone who has lived in the state for at least 12 months is eligible to receive dividends from royalties on oil and gas extraction. Goldsmith (2004) suggests that people feel entitled to their share of the Alaska Permanent Fund because their dividends may be viewed as the disbursement of profits from an asset held in common by all residents. Framing the dividends in this way appears to popularize progressive income redistribution even though Alaskans recently revealed a preference for a demonstrably regressive sales tax over a progressive income tax.

Another view would be that government functions as a trustee on behalf of its citizens, and its purpose should be utilitarian in trying to maximize the well-being of society. The government would be expected to search for an assignment of value resulting from the introduction of a price on CO_2 that achieved this objective. This view would seem especially applicable in the context of an emissions tax. Under a tax, government might be expected to treat CO_2 value as a new source of revenue that contributes to meeting the requirements of its budget. Using CO_2 revenue to reduce preexisting taxes would be an investment in economic efficiency that would be likely to have positive effects throughout the income distribution by promoting economic growth, even if the immediate beneficiaries of the tax reduction are not distributed evenly.

In summary, in the case of cap-and-trade, the creation of an intangible property right embodied in an emissions allowance conveys ownership of a common pool resource. The philosophical point of departure for a cap-and-trade program suggests the use of dividends. In contrast, in the case of an emissions tax, the government is presumed owner of the CO_2 value, which would be treated like other sources of revenue.

B. Practical Aspects of Climate Policy

Mistrust of government appears to be high in the present era, and distaste for new taxes even higher. This is one reason that cap-and-trade has emerged as the current political option, rather than an emissions tax, and why dividends have attracted political support as an approach. The populist, egalitarian, antigovernment flavor of per capita dividends appeals to the politics of both the left and the right. Dividends also appear simple. Given that climate change is a problem characterized by fundamental uncertainty, a policy design that appears complicated is likely to heighten the uncertainty perceived by households (Blonz et al. 2010). In contrast, a simple design may counteract some of the perceived risk.

Distribution of costs is another issue. The way that households use payments from the government appears sensitive to household income and the form of the payment. Dividends are expected to be progressive, and tax reform to be regressive. There are three distinct pieces of evidence that a dividend could contribute to the government's progressive income distribution goals.

First, looking at the Alaska Permanent Fund, Hsieh (2003) finds that households may anticipate dividends and smooth consumption over time. Hsieh argues this is possible because the formula for calculating dividends under the Alaska program is widely known, and newspapers accurately estimate the current year's dividend months before delivery. In contrast, the same households that smooth consumption of their dividends fail to do so with their annual tax refund. This may be due to a combination of qualitative and quantitative difference between the two changes in income—namely, the dividend is larger (recently in the $1,500 range), and it is close to costless for consumers to learn the size of their future dividend with a large degree of accuracy. Second, Shapiro and Slemrod (2003) find that just under half of survey respondents said they would mostly pay debt with their 2001 tax rebate, versus about one-third who said they would mostly save it and the rest who said they would mostly spend it. They also find that households with high wealth in stocks spend their rebates at a significantly higher rate. Finally, on the lower end of the spectrum, Bertrand and Morse (2009) use a field survey of payday borrowers to conclude that the infusion of cash from rebates helped some borrowers significantly reduce their payday debt.

Those three findings suggest that a dividend might simultaneously stimulate aggregate demand by high-wealth households while establishing a baseline level of income and relieving debt of some low-wealth households. But none of these outcomes suggest that the purchase of durable goods is a primary consequence of dividends, so they do not coincide with the goal of many existing government programs—to promote investment in energy-efficient household capital.

C. Implications of Behavioral Issues for Dividend Program or Tax Cut

The expenditure of money received through tax reductions or dividends is the sovereign decision of households. However, government might want to influence that decision with information or with incentives to promote household investments that increase the cost-effectiveness of its own efforts. Is it possible to use information or incentives to leverage and expedite private sector investments in energy-related investments using revenues from tax reductions or dividends?

Previous Experience with Tax Reductions and Dividends

In 2001 taxpayers received a rebate in the form of a check delivered in a single payment. The literature on spending from the 2001 tax rebates indicates a low marginal propensity to consume on durable goods and services, which constitute capital purchases for households (Johnson et al. 2006). Evidence suggests that consumers initially used the 2001 rebates to pay down their credit card debts but resumed spending in the months that followed (Agarwal et al. 2007).

In Alaska, where dividends are returned on a per capita basis, Hsieh (2003) concludes that households effectively smooth consumption of their Alaska Permanent Fund dividends, and that dividends are not directed primarily to a boost in consumption of durable goods. This indicates that these dividends may be a good substitute for regular income. The evidence is consistent with the possibility that large expenditures on durables are more planned and therefore appear less responsive to one-time changes in income. Taking this one step further, tax reductions or dividends to households may not lead to greater purchases of household capital. However, to achieve program-related goals, the government may want to influence households to invest dividends toward the purchase of durable goods, such as energy-efficient appliances and vehicles. How might this occur?

There is limited evidence about how households might be encouraged to allocate dividend funds within their household budget. Alaskans can open a college savings plan and directly allocate funds from their annual dividend to the fund, and 19,198 Alaska residents have contributed half of their dividends, totaling more than $64 million dollars (Clancy et al. 2009), to this option since 1991. A new effort to promote charitable giving has produced more moderate results. In 2009 the fund added a charity option called “Pick. Click. Give,” which in its first year achieved only a 1 percent participation rate.[17] Across the nation, households have the opportunity to make charitable donations with tax refunds in 220 check-off programs available to taxpayers in 41 states and the District of Columbia. In 2000, total taxpayer donations to check-off programs reached $32.8 million (Federation of Tax Administrators 2003).

New Policies to Affect Household Spending and Investment

Thaler (1990, 1999) describes simple ways in which people might make savings-consumption decisions. Thaler suggests people maintain assets, current income, and future income accounts in their heads. Changes in income affect the balances of these mental accounts in different ways according to idiosyncratic rules of thumb depending on the character of the change. For instance, a rule of thumb might be to use current income for current consumption, except in emergencies. If carbon auction revenues are returned as a dividend, and the dividend is large relative to regular income, it might be directed to the asset account. If it is relatively small, it might be directed to current income. This would result in an increase in savings or expenditures, respectively. Thus, smaller monthly installments might induce greater spending than the equivalent annual dividend.

Thaler also argues that self-control is costly, which is why Social Security is a popular program, and people make decisions in the present that will limit their ability to spend savings in the future. In this light, smaller installments would make it more difficult for households to save enough to make energy-saving capital investments. Suppose the government wants to deliver the revenues in a way that would induce more capital investment, especially on energy-related capital. An annual dividend would impose a level of self-control promoting savings over the course of the year. But out of concern for cash-strapped households, the government also might be interested in monthly dividends so that household budgets are bolstered in the near term against increases in the prices of energy and other products.

One way to link the two concerns would be to use default options. Several authors suggest the default setting is likely to affect the consumption and savings behavior of

[17] Alaskans can donate a portion of their dividends (from $25 to the full amount) to eligible nonprofit organizations of their choice while they file online for their Permanent Fund dividends (Pick. Click. Give., http://www.pickclickgive.org/). In the first year of the program, more than 5,000 Alaskans donated about $545,000. If each donor gave the minimum amount, this represents about a 1 percent participation rate.

households,[18] especially when households lack experience or familiarity with the decision point.[19] In the present context, a dividend program might automatically deposit monthly increments into an interest-bearing account. Recipients could still have immediate access to these funds by choosing to transfer funds to other accounts. However, interest earnings might be tax favored if funds are used for qualified purchases, thereby providing a nudge and an incentive to influence expenditure decisions. These and other elements of the design of a dividend program have not been widely explored, but might help to improve the efficiency of dividends or allow them to leverage greater cost-effectiveness from other program-related initiatives.

More specifically, an approach embodied in proposed federal legislation (Cantwell and Collins, S. 2879) would enable recipients to borrow from future-year dividends to make qualified energy-related purchases in the present. This program could be characterized as a zero-interest loan. If the reason that households do not make cost-effective energy-related investments is liquidity constraints, a zero-interest loan would provide immediate net benefits for the household. Typically, a loan subsidy implies costs, including both the cost of capital and risk of default. With dividends as collateral, the risk of default is removed. Moreover, by coupling such incentives with information, the government may be able to affect the savings-consumption decisions of households in a way that would leverage greater private sector spending on energy-related purchases than would occur otherwise.

6. Conclusion

This paper examines alternative ways that the value created by introducing a price on CO_2 could be returned to households. We compare two bookend approaches. One approach would be to use revenues from an auction of CO_2 emissions allowances to reduce preexisting taxes. Economic theory suggests this approach could substantially lower the overall cost of climate policy. The other is the direct refund of allowance value as per capita dividends, which would be more transparent and predictable. In an era of populist rancor about government policy, the dividend approach may have political appeal.

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[18] Thaler and Sunstein (2009).

[19] List (2003); Löfgren et al. (2010).

The choice of approach has some relation to program design and the fundamental characteristics of the climate problem. The atmosphere is a nonexclusive and depletable resource, which defines its management as a common pool resource problem. If the government were to choose to implement a trading system by enforcing a property right that limits the supply of emissions allowances, then the common pool nature of the resource problem might imply that the property right should be distributed on an equal, per capita basis. If, instead, the government were to choose to introduce a tax on emissions, then the revenue would not be associated with an assignment of property rights to private parties. Although the use of allowance value to reduce preexisting taxes is expected to offer a substantial efficiency advantage, there may be ways that a dividend policy could be designed to help achieve program-related goals—by providing information or incentives to encourage households to use dividends to accelerate the investment in energy-efficient household capital.

Finally, as we note that the enforcement of property rights under a cap-and-trade approach implies ownership, the notion of ownership is not necessarily a static one rooted just in either philosophical underpinnings or philology. Rather, the popular basis for the assignment of property rights may depend on social norms, which tend to evolve over time to rationalize behavior (Axelrod 1986). Raymond (2010) argues that social thought is influenced both by distributional justice and by efficiency, and over time a combination of these arguments can be successful in building a more successful political coalition. Norms may emerge that affect how people consider the ownership of atmospheric resources as well.[20] Consequently, one might expect a hybrid policy to emerge that addresses both distributional and efficiency concerns.

[20] Olmstead (1998) points out that informal institutions may emerge that effectively manage common pool resources.

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Figures and Tables

Figure 1. Marginal Costs from Cap-and-Trade and Emissions Standard

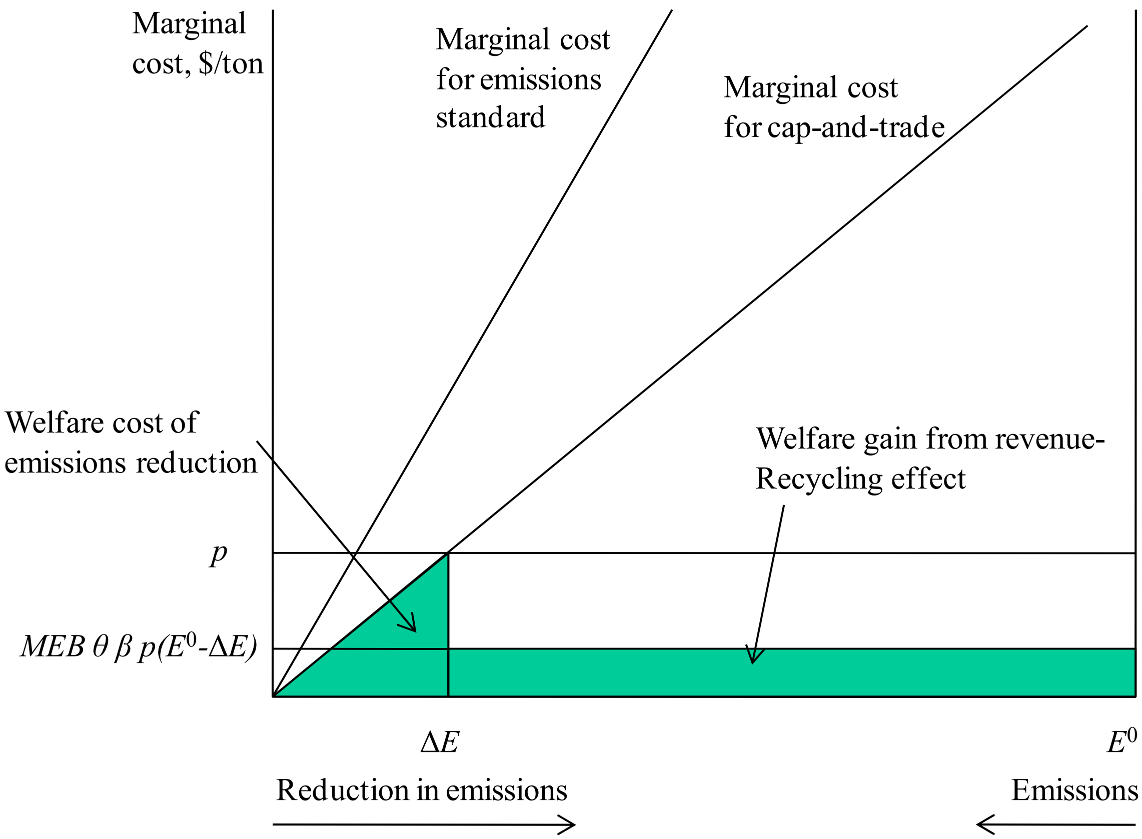

Figure 2. Welfare Losses in Labor Market from Preexisting Taxes

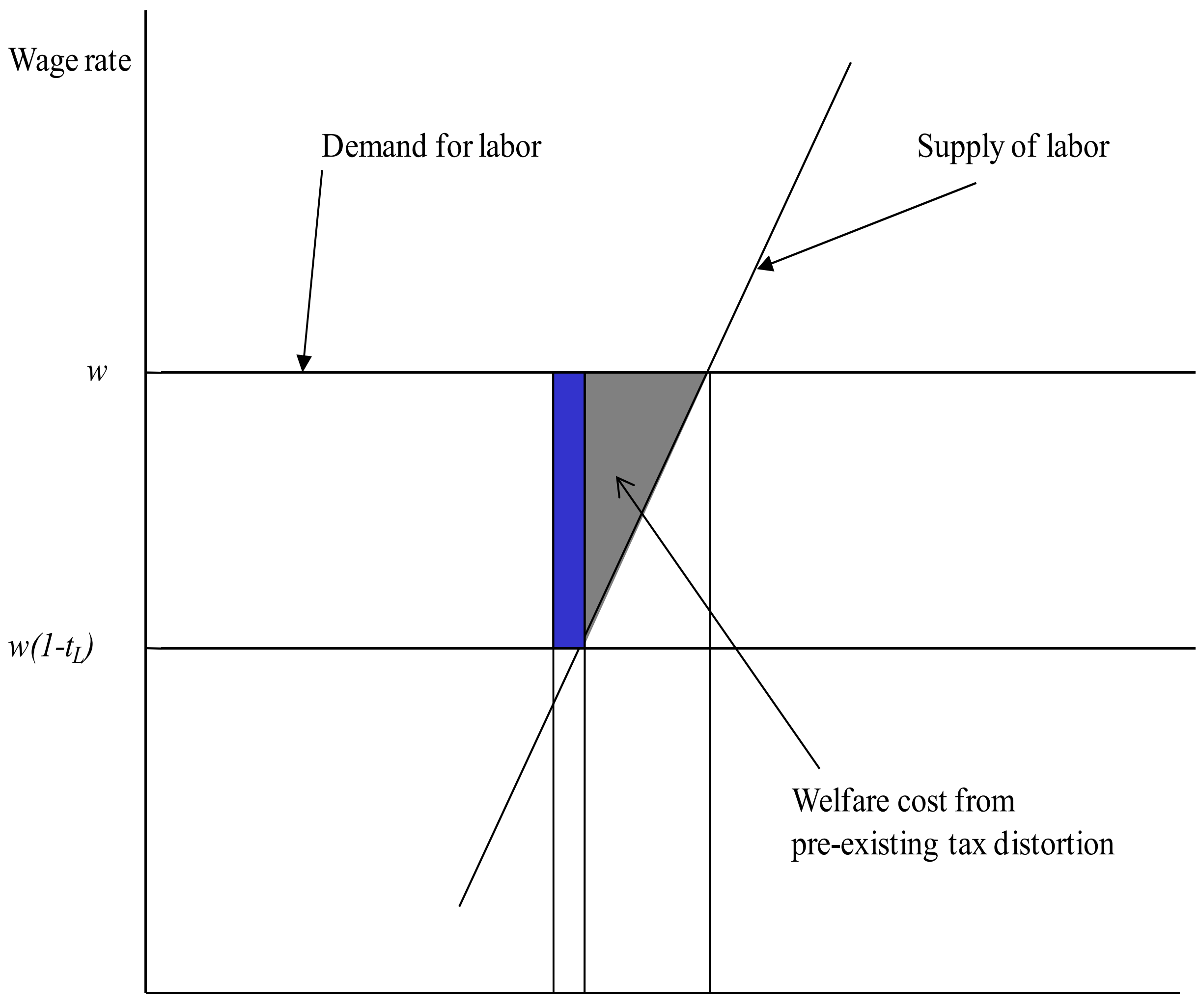

Figure 3. Household Burden by Income Decile

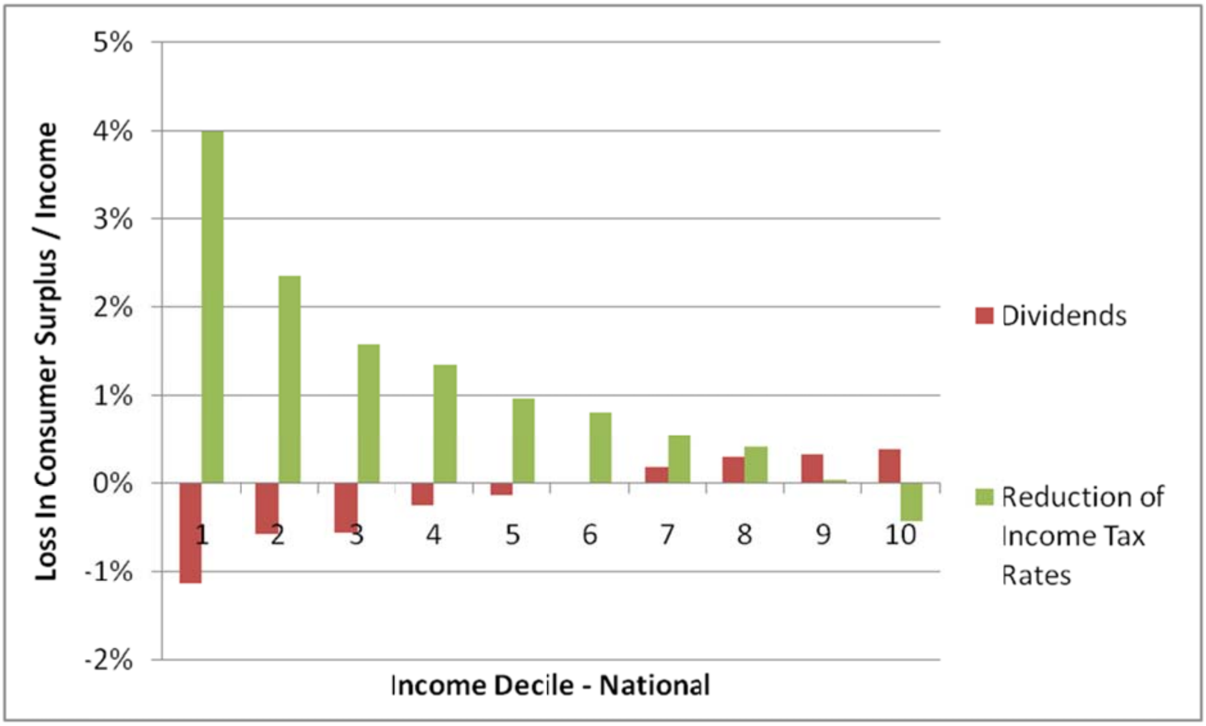

Table 1. Partial Illustrative Calculations of Costs of Cap-and-Trade and Regulatory Policies, 2020

	Allowance price, \$/ton of CO_2		
	20	40	60
Target level of CO_2 emissions, million tons	365	365	365
Assumed CO_2 emissions in the absence of control policy	406	429	456
Proportionate emissions reduction below baseline level	0.10	0.15	0.20
Maximum revenue (100 percent allowance auctions), \$billion	7.3	14.6	21.9
Policy costs with no prior tax distortions, \$billion			
1. **Cap-and-trade**	0.4	1.3	2.7
Regulatory alternative with coverage rate[a]			
2. 30 percent	1.4	4.3	9.1
3. 50 percent	0.8	2.6	5.5
4. 70 percent	0.6	1.8	3.9
Additional policy costs due to prior tax distortions, \$billion			
Cap-and-trade with full revenue-recycling effect			
5. Welfare gains from revenue recycling	2.6	5.1	7.7
6. Welfare loss from tax-interaction effect	1.9	4.0	6.0
7. Total welfare cost[b]	**-0.2**	**0.2**	**1.0**
Cap-and-trade with no revenue recycling effect			
8. Welfare loss from tax-interaction effect	2.6	5.1	7.7
9. Total welfare cost[b]	**2.3**	**5.3**	**8.7**
Regulatory alternative with coverage rate[a]			
30 percent			
10. Welfare loss from tax-interaction effect	0.3	1.1	2.3
11. Total welfare cost[b]	**1.7**	**5.4**	**11.4**
50 percent			
12. Welfare loss from tax-interaction effect	0.2	0.6	1.4
13. Total welfare cost[b]	**1.0**	**3.2**	**6.8**
70 percent			
14. Welfare loss from tax-interaction effect	0.1	0.5	1.0
15. Total welfare cost[b]	**0.7**	**2.3**	**4.9**

Source. See text.

Notes. Costs are expressed in year 2007 dollars.

[a] Regulatory alternative assumes marginal compliance costs are equated across covered sources.

[b] Total cost is cost with no prior tax distortions plus the tax-interaction effect less any revenue-recycling effect.

Table 2. Comparison of Tax Rates for California and United States, 2006

Tax revenue as a percent of labor income	California	United States
Employment taxes	10.5%	10.2%
Federal personal income taxes	16.4%	15.9%
State (and local) personal income taxes	4.4%	3.1%
Federal excise taxes	0.3%	0.6%
State and local sales taxes	4.5%	4.7%
Total	36.1%	34.6%

Sources.
Personal income per capita (US DOC 2010, Table 665).
State Population (US DOC 2010, Table 12).
Individual income tax revenue (IRS 2009, Table 5).
Federal individual income taxes by state (Tax Foundation 2006).
State and local individual income tax collections per capita (Tax Foundation 2010).
State and local general and selective sales tax collections per capita (Tax Foundation 2009).

Table 3. Partial Equilibrium Distribution of Burden under Tax Reform and Dividends

Income Decile - National	Average California Household Income	Dividends	Reduction of Income Tax Rates	Family Size	California Observations
		Loss In Consumer Surplus / Income			
1	7,619	-1.14%	3.99%	1.72	811
2	15,522	-0.56%	2.37%	2.06	1,094
3	22,923	-0.55%	1.57%	2.53	1,074
4	30,479	-0.25%	1.34%	2.67	1,271
5	39,185	-0.13%	0.96%	2.90	1,152
6	49,040	0.02%	0.81%	3.01	1,415
7	60,604	0.18%	0.55%	3.04	1,280
8	76,718	0.30%	0.42%	3.00	1,387
9	100,525	0.33%	0.04%	3.41	1,627
10	182,186	0.40%	-0.42%	3.44	1,981
All	69,470	0.22%	0.22%	2.89	13,092

Table 4. Unemployment Percentage of Labor Force

Year	*National*	*CA*
1976	7.7	9.2
1977	7.1	8.3
1978	6.1	7.2
1979	5.8	6.3
1980	7.1	6.9
1981	7.6	7.4
1982	9.7	10.0
1983	9.6	9.8
1984	7.5	7.8
1985	7.2	7.2
1986	7.0	6.8
1987	6.2	5.8
1988	5.5	5.3
1989	5.3	5.1
1990	5.6	5.8
1991	6.8	7.8
1992	7.5	9.4
1993	6.9	9.5
1994	6.1	8.6
1995	5.6	7.9
1996	5.4	7.3
1997	4.9	6.4
1998	4.5	6.0
1999	4.2	5.3
2000	4.0	4.9
2001	4.7	5.4
2002	5.8	6.7
2003	6.0	6.8
2004	5.5	6.2
2005	5.1	5.4
2006	4.6	4.9
2007	4.6	5.3
2008	5.8	7.2
2009	9.3	11.4
Average	6.2	7.0

Source: U.S. Bureau of Labor Statistics