Appendix:

Comments on the ARB's Updated Economic Impacts Analysis

by the Economic Impacts Subcommittee of the Economic and Allocation Advisory Committee

(revised 18 April 2010)

1 Introduction

As indicated in the introduction to main text of this report, in June 2009 the California Environmental Protection Agency Secretary Linda Adams and ARB Chair Mary Nichols appointed the 16-member Economic and Allocation Advisory Committee (EAAC). The EAAC was assigned two roles. One was to provide advice to the ARB relating to the method of allocation of emissions allowances under the cap-and-trade component of AB 32. The other was to assist the ARB in its analysis of the economic impacts of the AB 32 Scoping Plan. For the latter role the EAAC formed an Economic Impacts Subcommittee, whose members are listed below:

James Bushnell, Subcommittee Chair
Associate Professor, Cargill Chair in Energy Economics, Iowa State University
Lawrence Goulder, EAAC Chair
Shuzo Nishihara Professor in Environmental and Resource Economics and Director, Stanford Environmental and Energy Policy Analysis Center, Stanford University
Christopher R. Knittel
Associate Professor of Economics, Chancellor's Fellow, University of California, Davis
Stephen Levy
Director and Senior Economist, Center for Continuing Study of the California Economy
Nancy E. Ryan
Deputy Executive Director for Policy and External Relations, California Public Utilities Commission
Nancy D. Sidhu
Chief Economist, Kyser Center for Economic Research, Los Angeles County Economic Development Corporation
James L. Sweeney
Professor, Management Science and Engineering, and Director, Precourt Energy Efficiency Center, Stanford University

Since its inception, the Subcommittee has worked closely with the ARB, offering suggestions about data and modeling, as well as about interpretation and presentation of model results. In the Subcommittee's opinion, it developed a good

working relationship with ARB staff. We appreciated the staff's accessibility and its sustained good-faith efforts to incorporate our suggestions in its analyses. Many of the Subcommittee's suggestions are reflected in the main text of this report.

The Subcommittee also wished to offer brief comments on the ARB's completed report. This appendix provides such comments.

As indicated below, the Subcommittee finds that the ARB's updated analysis has some important strengths as well as some significant limitations. The strengths include:

- careful formulation of a reference (or "business as usual") case
- detailed treatment of specific technological options for providing energy
- statistically derived specification of responses of energy demand to changing fuel prices
- analysis of the contributions of individual components of AB 32 (in particular, the "complementary policies") to the law's overall impact
- detailed and careful presentation of the model results

The limitations include:

- incomplete integration of the Energy 2020 and E-DRAM models used in the assessment
- use of an economic forecast for the "reference case" that now appears optimistic
- lack of sensitivity analysis for critical assumptions and parameters influencing costs
- lack of attention to potentially offsetting changes in emissions outside of California
- lack of attention to alternative ways to recycle auction revenues

The limitations yield opposing biases to the results. As discussed below, the lack of attention to environmental "co-benefits" and revenue-recycling alternatives implies an upward bias to the cost assessments, as does the use of a reference case (business-as-usual) economic forecast that now appears too optimistic. On the other hand, some assumptions about complementary policies, along with the inattention to out-of-state "leakage," produce the opposite bias.[1] There is no obvious overall bias to the results.

Based on our review of the ARB's updated assessment, we believe that, despite some shortcomings, the ARB's analysis has considerable merit and provides important information that should help refine expectations about the potential impacts of AB 32, both for particular sectors or consumer groups and for the economy overall. A main conclusion from the ARB's updated analysis is that the net

[1] Inattention to leakage leads to overestimation of the emissions reductions achieved. As a result, it biases toward underestimation of costs per ton of emissions reduced.

impact of AB 32 on the California economy will be small. We find that the ARB has provided significant evidence to support this conclusion. Other studies have employed less optimistic assumptions in estimating the impact of AB 32 on the California economy. Among the methodologically sound studies, the estimated costs tend to be somewhat higher – but they are still small relative to the California economy. Even the most pessimistic studies find that, under AB 32, California's economy will experience considerable per capita real income growth over the next few decades at rates very close to the rates that would occur in the absence of AB 32.

2 Strengths and Weaknesses of the Analysis

2.1 Data and Parameters

2.1.1 General

The ARB has assembled a very impressive data set to investigate the impacts of AB 32. To our knowledge, it employs the most detailed data on technology options by California producers of any analysis of the California economy.

However, the ARB has performed only limited sensitivity analysis for key parameters that determine the costs of various elements of AB 32. Such analysis is crucial for revealing the range of uncertainties regarding the impacts of AB 32. The updated analysis offered virtually no sensitivity analysis regarding assumptions determining the supply costs of alternative fuels and the costs of energy-efficiency improvements.

The report could do more to expose uncertainties on the demand side as well. In Energy 2020, one of the two models employed in the ARB's analysis, the demand-side responses depend on a number of factors and change through time. Apparently, prior statistical work underlies the specification of the timing and magnitude of responses to given price changes in given sectors. This aspect of the modeling might be a particularly strong element. Unfortunately, however, the nature of this specification is left obscure. Future work should expose the empirical basis of this specification and the relevant formulas. In addition, alternative specifications should be performed to reveal the sensitivity of overall results to the assumptions involved.

2.1.2 Technology Cost Curve Assumptions

One area where additional sensitivity analysis is especially important is in connection with "technology cost curves." A large share of the greenhouse gas reductions under AB 32 will come from changes in the products or services offered to consumers. Automobiles will have greater fuel economy, and low-carbon fuels will make up a larger share of automobile fuels. Large reductions will also come from retrofitting existing buildings with more energy efficient appliances and insulation and from improvements in how new buildings are constructed. Calculating the cost of these behavioral changes requires assumptions about technology cost curves – the curves indicating how rapidly product costs increase as efficiency increases.

Greenhouse gas reductions can be achieved two ways. One is by improving the efficiency of a particular product (e.g., increasing the fuel-economy of a car with a given engine horsepower). The other is by changing the product attribute (e.g., reducing the power of the engine). Holding product attributes constant, the cost of greenhouse gas reductions depends on the cost of improving efficiency as specified by the assumed technology cost curves. The steeper are the technology cost curves, the larger the social costs.

Assumptions about technology costs can critically influence the outcome of economic models. Additional analysis involving alternative cost curve assumptions is warranted. Such sensitivity analysis would give a much better picture of the potential range of impacts of AB 32.

2.1.3 Contributions of Complementary Policies

In its updated analysis, the ARB not only considered the impacts of the entire AB 32 "package" but also explored the contribution of several of its key components. This is a particularly attractive element of the analysis. The ARB summary of impacts of the various measures appears in the ARB report Table 13, entitled "2020 Complementary Policy Direct and Indirect Expenditure Changes," which we copy below:

Table 13 from ARB's "Updated Economic Analysis of California's Climate Change Scoping Plan"

2007 Dollars	33% RPS	Energy Efficiency	Combined Heat and Power	Pavley II	Low Carbon Fuel Standard	VMT
Total GHG Emissions Reduction (MMT)	20	12	5	4	14	5
Fuel Expenditures (2007 M$/Y)	$994	($4,720)	($864)	($1,722)	$1,316	($1,945)
Annualized Investment and Operating Costs (2007 M$/Yr)	$4,545	$1,073	$2,233	$279	$512	($6,736)

Although this decomposition is very useful, the ARB's analysis does not provide clear justification for its assumptions about the costs of individual complementary policies. In the ARB's analysis the complementary policies involve very low costs compared to those projected by other studies. We observe below that differences in assumptions about the costs of complementary policies may be the most important determinants of differences in outcomes between the ARB models and other studies. Although the low-cost outcomes derive from empirical work performed by ARB or by commissioned studies, the ARB's report does not fully document the assumptions or their sources. Further clarification would be useful.

VMT Reductions

In terms of estimated net cost impacts, the most important is the large savings associated with the AB 32 commitment to reduce automobile vehicle miles traveled (VMT) by 4% by 2020, from reference case growth rate of 2.2% per year. According to ARB: "This measure is representative of changes that could occur through the implementation of SB 375 — a 2008 state law to reduce GHG emissions from vehicles by redesigning communities. No assumptions are made with regard to exactly how this reduction would be achieved or the cost of achieving it." As shown in the table above, the ARB analysis assumes that these VMT reductions would <u>reduce</u> overall costs (primarily costs of automobile purchases and fuel use) by $8.7 billion. The other five measure together lead to a net cost <u>increase</u> of $3.7

billion. Thus, this one measure alone is assumed to lead to savings that are over twice as high as the net costs of the other five measures together.

The ARB's treatment of cost savings associated with this policy seems very optimistic. Although ARB stated that it made no assumptions about the cost of achieving the reductions, in the modeling, ARB implicitly assumed that these reductions would save $8.7 billion in vehicle and fuel costs and would entail no offsetting increases in other costs to consumers, businesses or governmental entities. However, bringing about reductions in VMT below what would happen otherwise is likely to involve costs, for example through new transit systems, restrictions on land use, or other costly measures[2].

The ARB's assumption of a 4% reduction in VMT from what would otherwise occur merits continued monitoring. The relationship between SB 375 and vehicle use should be updated as regional planning agencies produce their SB 375 GHG emission reduction plans and the next round of their regional transportation and land use plans. The ARB forecasts of reduced expenditures on vehicles as a result of the 4% VMT reduction associated with SB 375 should be tested by further work on the relationship between VMT reduction and auto ownership. It may be that the types of VMT reduction associated with aging and changes in land use may result in less travel but not less auto ownership by 2020. In addition, VMT reductions may not result in substantial reductions in car ownership, depending on how VMT is reduced and regional GHG emission reduction plans may require additional transportation system investments.

Pavley II Standards

A second complementary measure also is likely to be optimistic. The Pavley II standards are automotive fuel efficiency standards that go beyond the fuel efficiency standards now adopted by the Obama administration. Under this policy, California would further regulate vehicle efficiency for passenger cars and light trucks so that beginning in 2017, California would reach a new vehicle fleet of 42.5 mpg by 2020. This appears to be treated in the model as 42.5 mpg <u>on-the-road</u>. However, according to EPA, test values must be reduced by about 20% to show what on average all new models will obtain on the road. Thus, for California to achieve 42.5 mpg on the road, the test efficiency would need to be about 53 mpg. This compares with the new federal standards for test efficiency of 35.5 mpg in 2017. The analysis assumes that the capital cost for the incremental fuel efficiency increase would be small, relative to the value of fuel saved. We believe that this assumption is also optimistic. Such average fuel efficiency of new cars is likely to either restrict consumer choice away from light duty trucks or to require much

[2] However, as discussed in section 2.1.5, it is likely that the reference case assumption of growth in VMT is too high, so that the actual growth in VMT could turn out to be 4% or more below the reference case assumption. However, even if that were true, it would not be appropriate to count an $8.7 billion savings as a consequence of AB 32 implementation.

greater use of hybrids. ARB provides no analysis to show that such incremental increases in fuel efficiency would be available at relatively low cost.

2.1.4 Reference Case Assumptions

The ARB's reference case is the scenario without cap and trade or the complementary policies. This case, described on page 7 of the ARB report, is based on a set of economic, demographic and energy price and usage assumptions that came from the 2009 California Energy Commission Integrated Energy Policy Report (IEPR) and related background reports.

Reference case assumptions are very important because they directly affect the estimated economic impacts of climate policy. In particular, higher economic growth and emissions in the reference case would imply that the emissions reductions under climate policy must be larger in order to reach the specified emissions target for the year 2020. Higher economic growth in the reference case therefore implies higher policy costs.

In its updated assessment, the ARB put much effort into developing a solid reference case. The assessment takes account of various recent California efforts that form part of the reference case. These include the 20% renewable portfolio standard, Pavley I vehicle standards, federal device standards, and federal renewable fuel standards. In its original (2007) economic impacts work, several aspects of the ARB's treatment of the baseline were criticized. The Subcommittee commends the ARB for its current treatment, which is detailed and careful and avoids problems from the earlier analysis.

However, we recommend that some aspects of these forecasts be reconsidered in future work. Some of the most important aspects include:

- *Updating the forecast to reflect recent economic trends and forecasts.* Economic and related forecasts do change over time and their use needs to be monitored to insure that the most up-to-date forecasts are used in future analyses. The economy has performed more poorly than anticipated in early 2009 when the CEC inputs were developed. Job losses have been worse than anticipated and the timing of economic recovery to pre-recession levels is now further in the future. In addition, the California Department of Finance released 2009 population estimates and revised short-term state population projections in December 2009 and January 2010. The new population projection for 2015 and 2020 is lower than the one used in the ARB analysis. Even if the 2020 growth forecast targets in the reference case are reached, it is highly likely that job and output levels (and related emission levels) will be lower than anticipated in the ARB reference case alternative for most of the earlier years before 2020.

- *Re-examining the transportation demand forecasts.* The CEC transportation demand forecasts used a different and higher personal income growth forecast from the one (2.4% annual growth) used in the main IEPR report. The transportation demand forecast was based on a real increase in personal income of 2.9% per year to 2030, which is higher than other current long-term projections examined by EAAC. Since transportation demand (VMT, air travel and trucking) is highly dependent on income growth, there is the likelihood that reference case transportation demands and associated emissions will be lower than in the IEPR transportation forecast.

- *Integrating expected age structure changes into the forecast methodologies.* California's population growth rates differ widely by age group. The California Department of Finance projections used in the reference case show that most of the population growth between 2008 and 2020 will occur in the 55+ age groups. After a decade in which the state's population aged 35-54 grew by 2 million, there will be almost no growth. Energy use for homes and transportation varies by age as well as income. The rapid growth in older age groups will reduce VMT per capita for both work (many older workers will retire by 2020) and non-work travel. In addition the rapid growth in older households combined with no growth in prime family age households should affect both the size and energy usage in homes over the decade to 2020. Given the dramatic changes in the age structure of future population growth, it is important going forward to take account of the relationship between age and energy use.

2.2 Model Structure

2.2.1 Developing an Integrated Model

Each of the two models employed by the ARB was only partly suited to addressing the economic impacts of AB 32. The ARB had neither the time nor the staff necessary to accomplish a full integration of the Energy 2020 and E-DRAM models. Energy 2020 included assumptions about energy demands, which depend on income. E-DRAM projects levels of income, but in only a subset of scenarios were these income projections accounted for in Energy 2020. In addition, the E-DRAM model only focused on the year 2020, so that aggregate income and other macroeconomic variables relevant to Energy 2020 could not be applied to Energy 2020 in years other than the year 2020. A model that integrates the detailed energy technologies of Energy 2020 with the macroeconomic variables of E-DRAM would provide superior economic projections.

2.2.2 Years Analyzed

The ARB study of economic impacts focuses on the year 2020. This is therefore not necessarily reflective of the impacts for 2015, let alone 2012. Since much of the public discussion is focused on the immediate impacts of AB 32 it is important to understand these distinctions. Future analysis that can focus on interim years, such as 2015 will help inform the ongoing public discussion.

The ARB analysis assumes that allowance prices will increase over time to 2020 as required emission reductions increase. If true, this means that economic impacts in the earlier years will, in general, be less than in 2020. Further analysis of the expected path of allowance prices in the years before 2020 under various assumptions will be especially helpful to the ongoing public discussion of economic impacts. We also note that the ARB's study does not clearly report the allowance prices generated by the E-DRAM model.

2.3 Scope of the Analysis

We find three key limitations relating to the scope of the ARB's analysis.

2.3.1 Co-Benefits

The report acknowledges that it does not measure the potential health, environmental and competitiveness benefits of reducing air pollution through the impact of AB 32 on reducing co-pollutants associated with GHG emission reduction. This would also tend to bias upward the cost assessment.

2.3.2 Impacts Outside of California

The ARB report (as well as some similar analyses) focuses on the economic impacts of AB 32 within California. It does not address the important question of the environmental and economic impacts *outside* of California. In particular, the question of how California policies may increase emissions outside of the state is largely not addressed.

This possibility, which can be described as *leakage* or *reshuffling* depending upon the form it takes, is of particular concern when the regulations are applied at the state level rather than on a broader (regional or national) level.

Analysts often focus on the *indirect* leakage that can occur if economic activity migrates away from regions applying environmental regulations. Most often these are the industries that are both energy-intensive and trade-exposed.

However, in the AB 32 context there is great potential for *direct* leakage: a switching or reshuffling of the sources of energy production. For example, the Low

Carbon Fuel Standard (LCFS) in California would require the consumption, in California, of fuels that the national Renewable Fuels Standard will itself require be consumed *somewhere* in the U.S. If both regulations remain in place, it is very plausible that the effect of the California regulation will be to divert some low-carbon fuel to California that otherwise would be consumed in other parts of the U.S. The implication of this diversionary effect (often referred to as *reshuffling*) is that a regulation that reduces local emissions achieves much smaller reductions at a broader level.

As the example above illustrates, these effects are not limited to those created by cap and trade. Complementary measures such as the LCFS and the Pavley II vehicle standards can create a circumstance in which to California standards make the compliance with Federal standards less stringent in other regions of the U.S.

Another important source of potential leakage and reshuffling falls in the electricity sector, where the *first deliverer* policy is intended to be the main deterrent to leakage. Under this policy, importers of electricity into California would be required to surrender allowances equivalent to the carbon content of their imported power. This gives firms an incentive to import power from low-carbon sources, but does not necessarily lead to the high-carbon sources reducing their emissions. If purchasers of power outside of CA are willing to take the output of these high carbon sources, the impact of California's policy on aggregate emissions is reduced.

The ARB study did not attempt to measure leakage. The models utilized are not equipped to capture how California policies might cause firms to alter behavior in ways that lead to leakage or reshuffling. For example, the Energy 2020 model treats certain coal plants currently under contract to California utilities as effectively located within California for purposes of modeling AB 32 regulations. In scenarios where allowance prices are high, many of these plants essentially shut down by 2020 in the face of higher CO_2 prices. However, there is no *California* regulatory mechanism currently under consideration that could compel that result. In the absence of a regional climate policy, a plausible alternative outcome would be that these coal plants continue to operate but sell power to customers outside of California.

Because it is not a focus of the present analysis, it is difficult to estimate exactly how significant these impacts might be. These impacts might be substantial for certain industries – those that are especially energy-intensive and trade-exposed. At the same time, they might be very small for most industries. This is an important area of focus for future analysis.

2.3.3 Impacts of Alternative Allowance Allocation Methods

The ARB's modeling does not consider alternative ways of allocating emissions allowances or the potential implications of alternative ways to return allowance value. As indicated in the EAAC's March 2010 Allocation Report, the choices about these aspects of allowance allocation can have very significant impacts on the overall cost of AB 32 as well as the distribution of this cost across various households and businesses. As discussed in the EAAC's Allocation Report (2010), proceeds from auctioned allowances can be used to finance the government's budget and thereby reduce the government's reliance on ordinary taxes. Studies show that using auction revenues in this way can substantially lower the net cost of a cap-and-trade program compared to an approach that distributes allowances for free (Parry and Oates, 2000; Parry, Williams, and Goulder, 1999).

2.4 Overall Assessment

The limitations discussed above yield opposing biases to the results. As discussed below, the lack of attention to environmental "co-benefits" and to the use of auction revenues to offset ordinary taxes implies an upward bias to the cost assessments. On the other hand, assumptions pertaining to some of the complementary policies, along with the inattention to out-of-state "leakage," produce the opposite bias. There is no obvious overall bias to the results.

3 Comparison with Results from Other Analyses

It is useful to compare the results from the ARB's analysis with results from other studies, and to examine the sources of differences in results.

The table below displays results from recent analyses by the ARB, Charles River Associates (Bernstein *et al.*, 2010), Thomas Tanton (2010), and the U.S. EPA.[3]

[3] In June 2009 Sanjay B. Varshney and Dennis H. Tootelian, operating as Varshney & Associates, submitted a report to the California Small Business Roundtable "Cost of AB 32 on California Small Businesses – Summary Report of Findings." This study estimates costs roughly ten times as high as does the CRA report. This report has been fully discredited by numerous highly respected researchers, including Frank Ackerman (Stockholm Environment Institute and Tufts University), Chris Busch (Center for Resource Solutions), Matthew Kahn (UCLA), James Sweeney (Stanford University), and Mac Taylor (California Legislative Analyst). According to these reviewers, the report contains fundamental problems in its data, methods, and interpretation. For example, the Sweeney review concludes: "Examination of the methods used by the authors leads to the conclusion that these results are highly biased and have no credibility." The Legislative Analyst's office concludes that the Varshney/Tootelian study has "major problems involving both data, methodology, and

The Tanton study was commissioned by AB 32 Implementation Group. The U.S. EPA results are based on two models: the IGEM and ADAGE general equilibrium models. The EPA models were used to assess the impacts of HR 2454, the American Clean Energy and Security Act (Waxman-Markey), and pertain to the U.S. economy as a whole.

Among the three studies focused on California's AB 32, the ARB study projects the lowest costs. The CRA study projects somewhat higher costs, and the Tanton report claims the largest costs. We first consider the sources of differences between the CRA and ARB projections, after which we discuss the sources of differences between the Tanton and ARB results.

Model Results for Year 2020

	ARB	CRA International	Tanton	U.S. EPA (analysis of federal policy – Waxman-Markey bill)
	Energy 2020 and E-DRAM models	Integrated MRN-NEEM Model (runs ARB1, ARB2, and CRA10)		(IGEM and ADAGE models)
Specified Emissions Reduction	25%	25%	25%	17%
Allowance Price Range	-	$52-$78	$20, $60, $200 (assumed)	$18
Gross State Product (% change)	-0.2 to -1.4	-1.4 to -2.2	-2.0	-0.3 to -0.7
Income Gain (+) or Loss (-) per household	+$86 to -$270	-$1175 to -$1380	-$930, -$2800, and -$9330 for allow prices of $20, $60, and $200	-$80 to -$146
Jobs Gained (+) or Lost (-) (thousands)	+10 to -320		-162, -485, -1617 for allow prices of $20, $60, and $200	

3.1 CRA Results vs. ARB Results

As can be seen from the table, the ARB analysis predicts smaller adverse impacts on gross state product than does the CRA analysis. ARB indicates that the impact on state product would be between -.2 percent and -1.4 percent, while the CRA analysis offers a range of -1.4 percent to 2.2 percent.

analysis. As a result of these shortcomings, we believe that their principal findings are unreliable." Given the lack of credibility of the Varshney/Tootelian analysis, we do not list its estimates here.

The difference in results reflects differing assumptions about the costs of the complementary policies. In the ARB study, including the complementary measures as part of AB 32 lowers the overall costs of the package. In contrast, the CRA study finds that including the complementary policies raises the costs of meeting the AB 32 goals relative to a case where these policies are excluded and only cap-and-trade is employed. In the CRA study, the average cost to households in 2020 is $1370 with complementary policies, as opposed to $790 in their absence.

The different impacts of complementary policies stem, in turn, from contrasting assumptions about pre-existing market failures. The CRA study assumes that the only market failure in the economy is that associated with the external costs of greenhouse gas emissions. Otherwise, markets operate efficiently. Under these assumptions, a price-based policy like cap and trade is the most cost-effective approach to achieving emissions reductions. Other policies such as tighter fuel economy requirements or building efficiency codes either are redundant or raise the cost of achieving the overall emission-reduction goal.

In contrast, the Energy 2020 and E-DRAM models used by the ARB implicitly assume other market failures exist beyond the one associated with the climate-change externality. One assumed failure is associated with the fuel-economy offered to consumers and/or consumers' automobile choices. In these models, in the absence of government policies that compel them to do otherwise, consumers fail to purchase more fuel-efficient cars even when the added up-front or capital cost would be more than offset by future fuel costs. In this case, policies that compel consumers to make different choices can make consumers better off. The Energy 2020 and E-DRAM models thus allow for policies that restrict producer or consumer options to raise profits or household income.

Empirical work has not yet advanced far enough to determine whether the assumptions of the ARB models, or those of the CRA model, are closer to the truth. Most analysts agree that other market failures exist beyond the climate-change externality, but the quantitative significance of these market failures remains uncertain. It therefore is important that models introduce a range of assumptions in order to convey the range of potential outcomes of AB 32, depending on the extent and importance of the other market failures.

For most of the complementary policies considered by ARB, it is difficult to tell whether the ARB's modeling assumptions are reasonable, since there is relatively little empirical evidence to draw from. However, as discussed above, the assumptions regarding two elements – the effort to reduce vehicle miles traveled and the Pavley II initiative -- seem optimistic. The ARB assumes that VMT can be reduced by 4% through SB 375 policy implementation, and implicitly assumes that there will be $8l7 billion of net savings associated with that reduction. In addition, the ARB assumes that the incremental cost of vehicles to meet the Pavley II increases in automotive fuel efficiency standards above the federal level will be small relative to the value of fuel saved. ARB provides no analysis to support its

quantification of these two complementary measures. In our view, the analysis of these measures appears to be overly optimistic.

We commend the ARB for its assessment of the relative contributions of various complementary measures. However, we would also call for a clearer presentation of the assumptions driving the costs of individual measures, as well as sensitivity analysis relating to these measures. We would also recommend allowing for a wider set of interactions between cap and trade and the complementary measures. Many of the complementary measures involve intensity requirements (e.g., restrictions on the ratio of high- to low-carbon fuels under the low-carbon fuel standard). They put limits on ratios rather than on the absolute use of fuels. A higher carbon price will tend to induce firms to achieve given ratios with lower absolute uses of fuels. In the Energy 2020 model, a higher price of emissions allowances influences only a subset of the capital-equipment or fuel-input decisions for facilities subject to the complementary measures. Future work should allow cap-and-trade to influence a wider range of decisions.

It is important to note that, even with the strong assumption that no market failures exist other than the emissions externality, the CRA model does not yield very high costs of AB 32 relative to the rest of the California economy.

It is also useful to note that the ARB and CRA analyses yield broadly similar estimates of the differential impacts of AB 32 across various industries. Table 27 of the ARB report shows impacts on value added for California industries divided into twelve categories. In eight of the twelve industries, in the year 2020 value added is projected to fall by less than 1.5 percent relative to business as usual. These eight categories represent approximately 80 percent of the non-governmental economic output and 86 percent of non-governmental employment.[4] The impact on all but two industries is at or below 3.0 percent, representing 97 percent of economic output and over 99 percent of employment. Agriculture, forestry, and fishing-related industries are predicted to benefit from AB 32, likely because of the availability of agricultural-related offsets. Value added falls most (relative to 2020 under business as usual) in the mining and utilities industries. The CRA's estimated industry impacts offer a similar picture.

The changes in value added can correlate with changes in profit, but the degree of correlation will depend importantly on whether allowances are auctioned or freely allocated. Importantly, ARB's predictions for value added are based on the assumption that there is no free allocation of allowances. Thus they assume that the allowances are auctioned and firms within these industries must purchase all of their allowances in the initial auction or through trading. Studies indicate that freely allocating a small share of the emissions allowances can prevent losses of profit[5].

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[4] The Scoping Plan reports economic activity and employment for all manufacturing. These figures assume that half of manufacturing is energy-intensive.
[5] See, for example, Bovenberg and Goulder (2001).

3.2 The Tanton Report

In March 2010 T^2 & Associates, with Thomas Tanton as principal, submitted a report to the AB 32 Implementation Group, entitled "An Estimate of the Economic Impact of A Cap-and-Trade Auction Tax On California" (Tanton, 2010). The Tanton report described its results as "a preliminary analysis." It caveats its conclusions with the statement "To the extent that precise formulation and market clearing prices for auctioned permits varies, and decisions that are made regarding distribution of auction revenues and their impacts may change going forward, the results presented here should be viewed as indicative and not predictive; they are order of magnitude correct in scalar and correct in direction."

The Tanton report estimates that AB 32 will have "An annual effective cost increase to the typical family of four to be $818 the first year growing to $2800 in 2020, if market clearing prices for permits are $60 dollars per ton. Those figures are $270 and $930 if permit prices are at $20 and as much as $2720 to over $9330 per family if prices clear at $200 per ton. … These cost increases are average for the population, although some residents may be compensated through a partial return of auction revenues."

Importantly, these estimates are <u>not</u> the net cost to families. These are estimates of the additional payments by businesses purchasing emissions allowances. They are gross costs to families under the expectation that businesses will pass on their costs to consumers. However, these payments by businesses (and gross cost to families) are revenues to the State of California. Those revenues can be redistributed to consumers through the tax system by various means, e.g. reductions in the personal income tax, direct lump-sum payments to consumers, or by avoiding future tax increases.

If the State returns 75% of these auction revenues to families, as recommended by the EAAC, then the net payment by an average family of four, under the Tanton report estimates, would be 25% of the figures above. The net cost would be $700 per family in 2020 if the permit price were $60 per ton or $233 per family if the permit price were $20. Because these costs to families would be net revenue received by the State of California, equivalent to tax revenue, the revenue could be used by the State either for purposes directly related to AB 32 or other general State purposes.

Although the Tanton report focuses its discussion on a permit price of $60 per ton, the report does not take a position on what will be the market clearing prices for permits. The author seems to agree that that market clearing price is both uncertain and time varying. Thus, if the 2020 permit price were $25 per ton, as estimated by ARB, and the State were to return 75% of these auction revenues to families, then the net cost for the family of four would be $292 per year, using the Tanton report estimates. If the 2020 permit price were $53 per ton, as estimated by

CRA, the net cost for the family of four would be estimated at $618 per year. These figures are within the range estimated by ARB and CRA for the equivalent permit prices.

The Tanton report predicts "Lost economic activity of nearly 2% of gross state product…." Again, this is an estimate based on a market clearing permit price of $60 per ton. Under the ARB estimate of a 2020 permit price of $25 per ton, the Tanton calculations would suggest lost economic activity of about 0.8 % (8/10 of 1%) of gross state product by 2020. Thus at this market clearing price the Tanton report suggests that the California economic growth rate would be reduced by about one tenth of one percent per year to 2020.

This loss of economic activity is greater than that predicted by ARB or by CRA (for equivalent permit prices). However, the Tanton report does not provide sufficient information to evaluate why it estimates greater impacts on economic activity. The report states "To evaluate these impacts, input-output or multiplier analysis is used." "The changes in expenditures brought about by investments or expenditures by firms and individuals in complying with regulations are matched with their appropriate multipliers for each industry sector affected by the change in expenditure. The model accounts for both jobs lost directly from the auction tax as well as jobs created by spending the revenues collected, but the result is a net jobs lost due to losses in productivity and increased imports and outsourcing due to higher relative (to competitors) costs." Little additional information is provided.

This apparently fixed-coefficient input-output model is used to estimate the overall loss of economic activity. Thus, the report seems to embed the assumption that price adjustments in the economy will not change factor proportions in the various industries. Thus it appears that the methodology does not include the idea that prices will adjust throughout the economy to equate supply and demand in the various market. But models that assume away such general equilibrium adjustments tend to estimate higher economic costs than do models that incorporate market-clearing adjustments. This methodological difference could explain why the Tanton report estimates greater economic impacts than does the CRA or the ARB study, both of which do incorporate market-clearing mechanisms throughout their representation of the economy.

It appears – but we cannot be sure – that the fixed-coefficient nature of the input-output model is what leads to the Tanton report assertion of large job losses. The report predicts "Annual job losses to the California Economy of 76,000 to 107,000 the first year growing to perhaps 485,000 jobs in 2020, assuming a market clearing price of $60 per ton. These are net jobs losses …" Such predictions can easily come from a fixed-coefficient input-output analysis that assumes away supply and demand adjustment in labor markets. However, labor markets do adjust over time, technologies evolve, and factor proportions do change in response to price changes. We speculate that the Tanton report, that apparently does not include such factors, gives relatively large estimates of economic activity reductions and job losses because it ignores these factors.

3.3 Overall Assessment

The table below summarizes much of the preceding discussion of the ARB, CRA International, and Tanton studies. It lists some of the limitations of the models employed, and indicates the cost-implications of each. A plus sign indicates that the limitation would tend to imply an upward bias in the cost assessment, while a minus sign indicates a downward bias.

Potential Limitations of the Models
And Their Implications for Cost Estimates

	ARB	CRA International	Tanton
Model Characteristic			
Optimistic Assumptions regarding Costs of VMT and Pavley II Efforts	-		
Inattention to Emissions Leakage	-		-
Restricted Scope for Pre-Existing Market Failures		+	+
Absence of Potential for Input Substitution			+
Absence of Technological Change			+
Optimistic Assumptions for Growth of Economy under Business as Usual	+		
Inattention to Alternative Methods for Auction Revenue Recycling	+	+	+
Disregard of Co-Benefits	+	+	+

Note: " + " and " - " indicate that the limitation implies a bias toward toward high and low costs, respectively.

As indicated in the table, limitations in the ARB report imply biases in both directions. There is not enough information to judge the direction of the overall

bias. The listed limitations in the CRA study would tend to work toward overstatement of the costs of AB 32. The Tanton report contains five listed limitations that work toward overestimation of the costs. As discussed, the absence of potential for input substitution could be largely responsible for the much larger cost estimates offered in that report. It is also worth noting that the report tends to equate allowance value with economic cost, when in fact the latter is a small fraction of the former. This can give readers the impression that the costs of AB 32 are many times higher than actual costs.

4 Conclusions

The ARB's analysis provides valuable information on the impacts of AB 32 on fuel prices, allowance prices, employment, and overall economic cost. The results reflect a serious attempt to make use of available data and to consider in detail the available technological options for reducing greenhouse gas emissions. The numerical modeling work is competent, and the report is careful to interpret the results fairly and openly.

As with all studies, this one has its limitations. The analysis would benefit from greater attention to uncertainties, out-of-state impacts, allowance allocation design, and assumptions underlying the reference case and the modeling of cap and trade. The two main models could be more fully integrated.

The report primarily focuses on one set of economic impacts: on output and income, employment, and prices. It is important to recognize that some potential benefits of AB 32 are not considered. Of particular importance are the benefits to health and well-being associated with the environmental improvements stemming from AB 32. These have positive economic implications. In addition, to the extent that AB 32 offers insights into how climate policy might take shape, it could have value in helping stimulate climate policies in other states or at the national level.

The ARB's assessment contributes constructively and importantly to the discussion of AB 32. Although particular omissions or assumptions in the work introduce bias (as discussed above), there is no obvious overall bias to the ARB's assessment. Given the sophistication of the work, we believe that the assessment succeeds in refining our expectations about the likely impacts of AB 32 on households and businesses.

A main conclusion from the ARB's updated analysis is that the net impact of AB 32 on the California economy will be small. We find that the ARB has provided significant evidence to support this conclusion. We expect that future work will lead to further improvements in what is already a solid assessment.

One gains a helpful perspective on the ARB's results by comparing its results with those of other leading studies. When the ARB's results are viewed together with the results from another strong study – that of CRA International -- one gains support for the conclusion that AB 32 is not likely to have large net impact on California economy. In both the ARB and CRA analyses, the impact of AB 32 on the growth rate of the California economy is trivial over the decade from 2010 to 2020. Both models predict annual growth rates of gross state product of about 2.4 percent over this decade in the absence of AB 32. In the presence of AB32, the predicted annual growth rate is about 2.3 percent under the main CRA scenarios and between 2.3 and 2.4 percent in the ARB's analysis. Despite significant differences in model assumptions, both analyses reach the finding that the net impact of AB 32 on the California economy is very small. Both studies indicate that the net impact in the year 2020 is likely to be fairly small relative to the rest of the California economy. The net impacts in earlier years are likely to be especially small since the overall emissions cap employed under AB 32 will tighten through time.

The ARB has produced a competent and highly informative economic impacts assessment despite the fact that very few staff members were devoted to the project. The Subcommittee was disappointed when it observed how few staff members and how little resources were available for the important economic impacts assessment work. These restrictions imposed significant limits on what the ARB could do. ARB staff currently includes only two economists. Although we recognize the severe budget problems California now faces, devoting funds to bring in additional economists at ARB strikes us as a most worthwhile investment that will help assure even stronger economic assessments in the future.

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