Overview

The Boston Consulting Group (BCG) undertook a difficult task: to simulate how AB32 will impact the California economy, and the refining industry in particular. To do this BCG developed a model of the refining industry and allowed changes in refining-sector employment to adversely impact employment in other industries via a reduction in spending from refining industry employees.

BCG summarizes their main findings as follows:

- Given the small number of Advanced Technology Vehicles, no commercially available cellulosic ethanol, and limited available quantities of low carbon intensity (Cl) sugarcane ethanol, LCFS is unlikely to be fully implementable by sometime in the second compliance period. As a result, California refiners that risk being out of compliance, may opt to export fuels, versus supplying the local market, potentially creating product shortages. A likely scenario is for cost recovery to exceed 250 cpg coupled with gasoline supply shortages as early as 2015.

- If LCFS regulation is changed abruptly after 2015, it will likely result in additional costs for refiners, consumers, and suppliers of alternative fuels.

- LCFS driven demand reduction in the second compliance period (2015-17) shifts gasoline trade balances from Singapore imports to Mexico exports. This shift impacts refinery economics substantially and will likely result in closure of 4-6 refineries representing 20-30% of California's refining capacity.

- If LCFS is completely implemented beyond the second compliance period, this will result in the closure of an additional 1-2 refineries, representing 5-10% of California's refining capacity.

- While energy efficiency projects are one way to decrease carbon emissions, they will have a minimal impact on stationary refinery emissions, given that most California refineries are already highly energy efficient and the economics of such projects are not very attractive.
• As a result of forecasted refinery closures, largely resulting from full implementation of LCFS, California could lose 28,000-51,000 jobs, including many high-paying skilled manufacturing jobs, as well as indirect job losses due to multiplier effects. This is net of 2,500 to 5,000 direct and indirect jobs created due to investments in energy efficiency.

• California could lose up to $4.4 Billion of tax revenue per year by 2020, the majority of which will come from lost excise taxes on fuels. This could result in further reduction in employment in certain areas (e.g., road maintenance, local businesses). Other revenue losses will come from decreases in personal income taxes, corporate taxes, property taxes, and sales taxes. These revenue sources will be lost permanently unless replaced by new taxes or other revenues.

• There will be a wealth transfer of at least $3.7 Billion per year by 2020 from refineries and fuel suppliers to the California Air Resources Board as a result of purchasing allowances. Minimum auction prices have been considered for this analysis and the cost could be much more with higher auction prices.

• As a result of AB 32 fuels related measures, California will likely begin to import diesel, increase imports of jet fuel, and begin exporting very large quantities of gasoline. The GHG emissions associated with making gasoline for export will however remain in California.

• California will suffer other negative impacts, including loss of manufacturing expertise and increased cost of living resulting from higher fuels cost.

• Increase in cost of compliance and the resulting cost recovery will disproportionately impact low-income households that spend a greater share of their income on transportation fuels than high-income households.

• California's climate change regulations (e.g. AB 32) will discourage energy intensive industries from locating in the state and existing industry will have an incentive to relocate to other states or even internationally.

My Bottom Line

I have been critical of the LCFS in both my academic work and more general writings. There are good reasons why California policy makers may want to rethink the LCFS. The results in the BCG study are likely to be pretty far down on this list of reasons. The reason for this is that the study does not give the full picture of the dynamics of the refining industry. Take the third bullet point above---what I see as the main result of the study: because of AB32 4-6 refineries go out of business during the second compliance period.

What the study fails to report is whether or not, in the counterfactual world of no AB32, these 4-6 refineries would have stayed in business much beyond 2017. As discussed below the key driver of these exits is that California shifts from being a net importer of
gasoline to being a net exporter during the second compliance period; once this happens it is optimal for some refineries to shut down, or to switch to being purely a blending facility. With AB32, this occurs during the second compliance period (2015-2017). It is entirely possible, and seems fairly plausible, that the counterfactual no-AB32 world, has this happening shortly after 2017. The BCG report does not discuss when this is. Therefore without reporting this, the main findings of the study are potentially grossly misleading. For example, suppose in this counterfactual world, these 4-6 refineries are estimated to exit a mere 2 months later. Policy should not be based on such short time period especially when one considers that the BCG results do not offer any guidance in terms of “confidence intervals”.

Main Driver Behind These Results

Given the complexity of the BCG model employed, it is difficult to understand what assumptions are driving the results from simply reading the report. This is not the fault of BCG, but the nature of these types of models. Most of my comments arise from my attempt to “reverse engineer” the model and its associated results from our discussions with BCG staff.

From our discussions, it seems that there are two features/assumptions of the model appear to drive these results. I first discuss these two features and how they lead to the main findings.

Key Feature #1: AB32 and the LCFS, in particular, speeds up the time in which California goes from being a net importer of refined products (gasoline in particular) to a net exporter. AB32 and the LCFS is not the only reason for this transition. Another big driver of this is that federal fuel economy standards will, even in the absence of AB32, reduce the demand for transportation fuel in California’s light-duty industry. Within the model, however, AB32 speeds this transition up.

The shift from a net importer to a net exporter is very important for the profitability of the refining industry because it changes the location of the marginal gasoline sold in California. When California is a net importer of gasoline, then the most expensive imported gasoline sets the equilibrium price. BCG assumes that this marginal gasoline sells at roughly a $6 per barrel premium above the cost of the marginal gasoline refined in California. In short, when California is a net importer, California refineries earn $6 more per barrel of gasoline that they sell, compared to when California is a net exporter (or neither an importer or exporter). This is roughly a 5% premium.

Figure 1 illustrates this the effect of this. Currently, in most months California is a net importer of gasoline. Because of transportation costs for these imports, even if out of state/country refineries had the same marginal cost of California refineries, their supply curve would be shifted up by the cost of transportation. The current situation is something like point A. If the demand for gasoline were to shift down sufficiently, because of AB32 or federal fuel economy standards, such that California no longer imported gasoline, then the equilibrium would be something like point B. This would reduce the profits that California refineries earned not only because they are no longer
selling at capacity, but more important, because the transportation costs of out-of-state gasoline are no longer reflected in the price.

In my example, the loss in rent (loosely speaking profits) of this shift is the shaded area. One can see how this can be substantial.

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**Key Feature #2:** There is a limited amount of Brazilian sugar-cane ethanol that can be imported into California. Figure 1 illustrates how this changes the equilibrium in the California transportation fuel market. If the supply of Brazilian ethanol is capped, and there are no other compliance strategies, this effectively caps the amount of transportation fuel that can be sold in California. In the graph, we see two supply curves, one where the amount of sugar-cane ethanol is capped (at least the low-carbon variety) and a second hypothetical supply curve under the assumption that Brazil could ramp up production at the same cost of the last gallon sold in the capped scenario. (If they could ramp up production but their costs would increase, then the actual supply curve would have a steeper slope compared to the dotted one. But that turns out not to be very relevant.)
If Brazilian ethanol is capped, then the equilibrium is at point A. If Brazilian ethanol is uncapped, the equilibrium is point B. At first glance, moving from A to B would seem to have an ambiguous effect on the profitability of the refining industry. On the one hand, the industry can’t sell as much gasoline as they would if Brazilian ethanol was unconstrained. But, on the other hand, the equilibrium price is higher. This second effect does not help the industry, however. Within the model if a Californian refiner doesn’t sell into the California market, they export to Mexico. The Mexican price is set by cheap Gulf-Coast gasoline and therefore this is a much less attractive outlet for their gasoline. Therefore, there is a glut of gasoline that wants to be sold in California, even at the price associated with point B. This leads to the rents (loosely speaking, profits) from the higher price as a result of the capped Brazilian ethanol accrue to Brazilian ethanol producers, not California refiners. As a result, Brazilian ethanol being capped both lowers the amount of gasoline sold by California refiners from the quantity associated with point B AND lowers the price that California refineries get for their gasoline from the price associated with point B to the price associated with point C.

On the second conference call, BCG modelers stated that the first feature/assumption is much more important than the second one.
I am not in the position to question BCG’s claims with respect to whether California becomes a net exporter of gasoline as a result of AB32 or whether hard capacity constraints exist for Brazilian ethanol. They may very well be true, and for the purpose of my review, I take them as representative of the markets. My biggest concern, which is more a plea for the entire picture, is with a comparison of BCG’s simulated outcome in the presence of AB32 with their simulated counterfactual world, which models how the refining business evolves in the absence of AB32. There simply is not enough information present to ascribe all of the reported costs of AB32 to AB32.

In particular, the BCG report makes statements such as: “LCFS driven demand reduction in the second compliance period (2015-17) shifts gasoline trade balances from Singapore imports to Mexico exports. This shift impacts refinery economics substantially and will likely result in closure of 4-6 refineries representing 20-30% of California’s refining capacity.” But, the report does discuss whether these closures are simply “shifted up” a few months, or whether these refineries would not go out of business in the absence of AB32. These are two very different outcomes. It is highly possible that AB32 simply moves up when Feature 1 occurs because. That is, because of federal fuel economy standards the shift in equilibrium represented in Figure 1 will even in the absence of AB32, but just a short time later. If this shift occurs in the absence of AB32 but simply outside the years the reports focuses on, then a more accurate description of the results would discuss the impact of AB32 in terms of “job years” or “refinery years”. These may very well be small.

Indeed, our conversations with BCG staff seemed to suggest that they believed that the shift of California from being a net importer of gasoline to a net exporter of gasoline was inevitable. If this is the case, then it is highly likely these refineries would be exiting even in the absence of AB32, but simply outside the period discussed (2015-2017).

For example, I would like to see bullet 3 read as follows (i.e., adding language like that in italics):

- LCFS driven demand reduction in the second compliance period (2015-17) shifts gasoline trade balances from Singapore imports to Mexico exports. This shift impacts refinery economics substantially and will likely result in closure of 4-6 refineries representing 20-30% of California's refining capacity *XX years earlier than they otherwise would close.*

While BCG may have been asked to make conjectures as to what will happen in specific time periods (e.g., from 2015-2017), an understanding of the true cost of AB32 requires reporting their results in a larger context.

A final comment has to do with the use of “job multipliers”. Job multipliers are used as follows: When a refinery goes out of business these jobs vanish, BCG then assumes that the cumulative job loss is 6-8 times the number of refinery jobs just lost. It is very difficult to empirically estimate the true job multiplier. Frequently some sort of regression is used that correlates aggregate employment with employment in the refining
industry. For example, someone might find that, on average, when one job is added in the refining sector 6-8 total jobs are added in the economy.

The problem with this is that correlation is not always causation. In particular, “omitted variable” bias is likely to be a big problem in this case. That omitted variable is the strength of the economy as a whole. When the economy is growing rapidly people are driving a lot. This increases the demand for refined products and employment in the refining sector. Thus there is a strong correlation between refining-sector employment and aggregate employment. Similarly, when the economy is in recession the refining industry cuts jobs and this is correlated with large job losses in other sectors. Therefore, there might be a very strong correlation between aggregate employment and employment in the refining sector, but the employment in the refining sector is not causing aggregate employment to change; instead both refining-sector and aggregate employment are correlated with general macroeconomic activity.

These two situations are very different from a drop in refining sector jobs coming as a result of an increase use of ethanol. Therefore, when the study states that California may lose 28,000 to 51,000 additional jobs as an indirect consequence, (a) this is almost surely overstated, and (b) because of the reasons discussed above the BCG model may have predicted these jobs to be lost just a few months later in the absence of AB32.