Transitions in Light-Duty Vehicle Transportation: Alternative Fuel and Hybrid Vehicles and Learning

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ABSTRACT

New vehicle technologies and alternative fuels are believed to be key factors in improving energy security, air quality and in reducing greenhouse gas emissions. Proposed legislation (Securing America's Future Energy Act of 2001, Energy Policy Act of 2002) would extend very significant tax credits to hybrid and fuel cell vehicles. Analyses using single-period equilibrium models and multi-period scenario analyses are often used to demonstrate the feasibility of technologies to attain policy goals. These analyses typically assume mature markets, large-scale vehicle production and the widespread availability of alternative fuels at retail stations. These conditions are not currently attained and may or may not be realized in a market economy.

We use the Transitional Alternative Fuels and Vehicles (TAFV) model to simulate market outcomes for the use and cost of alternative fuel and hybrid vehicles over a 20 year time period, considering possible transitional barriers related to infrastructure needs, production scale, and technological learning. We incorporate endogenous learning-by-doing in vehicle production to examine the impact of tax incentives that encourage accelerated production. Our results for hybrid vehicles are compared with those for alternative fuel vehicles to identify and quantify common transitional barriers. The focus is on identifying which policies can help attain technology transitions in a competitive transportation market. The method is well suited to a future analysis of the proposed transition to fuel-cell vehicles.

INTRODUCTION

Since there is much hope that new vehicle technologies can advance U.S. environmental and energy security objectives, it is useful to ask which policies can help achieve transitions to new light-duty vehicle technologies. We are also interested in the efficiency, or cost-effectiveness, of those policies. We use the Transitional Alternative Fuels and Vehicles (TAFV) model to simulate market outcomes for the use and cost of alternative fuel and hybrid vehicles over a 20 year time period, considering possible transitional barriers related to infrastructure needs, production scale, and technological learning. One distinct feature of this model is that prices and choices for fuels and vehicles are endogenous, and depend very much on how the market evolves.

From a broad perspective, this paper presents a methodology for simulating the market introduction of new technologies where economies of scale and endogenous feedback effects are important. It is our belief that explicitly modeling these dynamic effects is very important and cannot be ignored for a wide variety of economic and environmental questions that involve substantial investments in capital. Why study dynamic transitions? Long-run static equilibrium analyses typically estimate the market share of an alternative technology many years in the future assuming mature technology costs and scale, and well-developed ancillary markets. Such an approach omits consideration of how that technology matures and how markets develop. The limitations of such an approach are increasingly apparent. Often market conditions do not permit a promising new technology to ever enter the market and ultimately gain the share projected by long-run comparative statics. As a clear demonstration, Figure 1 shows how long-run static-equilibrium modeling results contrast sharply with those of an equivalent dynamic analysis that includes the transitional barriers we discuss in this paper. The long-run "no-barriers" conclusion was that alternative fuels, based on their mature relative-costs, could displace a significant fraction of gasoline use, with four or five alternative fuels each gaining a noteworthy share (Leiby, Greene and Vidas 1996). Accounting for transitional barriers and the time path of market evolution, however, suggests that those long-run market shares may never be attained.

Concern about "whether we can get there from here" and possible "chicken or egg" problems for some new vehicle technologies has lead to an effort to examine prospects and policies for technology transitions. One policy question is whether the U.S. can meet its Energy Policy Act of 1992 (EPACT) fuel substitution goals, which called for displacement of 30% of motor gasoline use by the year 2010. The transitional modeling work summarized here has examined the prospects for fuel substitution by alternative motor fuels, both without new policies and with additional fleet alternative fuel vehicle (AFV) purchase mandates, vehicle technology subsidies, fuel economy credits, or fuel subsidies (Leiby and Rubin 2001, 1999, Rubin and Leiby 2000).

[Figure 1: Static V. Transitional Analysis: Differing Conclusions]

This new work compares the lessons learned from TAFV 1 (alternative fuels only) with those of TAFV 2 (hybrids). In addition, TAFV 2 incorporates endogenous technical change through learning in hybrid vehicle production. As discussed below, learning has important implications on the efficacy of policies designed to promote hybrid vehicles. TAFV 1 found that

transitional barriers are large enough to prevent alternative fuels from making significant market penetration into the light-duty vehicle fleet (Leiby and Rubin, 2001). In particular, TAFV 1 showed that the magnitude of transitional or short-run barriers, such as the lack of alternative fuel (AF) retail infrastructure, is approximately $1 per gallon gasoline-equivalent in 2000, declining to $0.50 per gallon by 2010. In addition to the transitional barriers, the expectation of comparatively low oil prices constitutes a "long-run" barrier to alternative fuels. Without eliminating the long-run price-competitiveness barrier, policies focusing on the short-run transitional problems can be ineffective and costly. Our experiments show, however, that under higher oil prices, transitional policies (temporary non-price or targeted price incentives) can effectively overcome short-run barriers. Absent new policy initiatives (e. g. a sustained large subsidy), or a significant rise in oil prices, EPACT's 2010 alternative fuel goals will not be achieved.

Hybrid-electric vehicles (HEVs) may have some advantages in side-stepping transitional economic barriers. Off-grid HEVs, such as those currently marketed by Honda and Toyota, derive all of their energy from conventional gasoline, and generate the needed electricity on-board. This avoids the often-noted fuel compatibility problem of alternative fuel vehicles (AFVs). In addition, HEVs may achieve cost reductions from economies of production scale more easily than AFVs. The substantial incremental costs of hybrid vehicles are partially model-specific and partially shared across vehicle models. The "shared costs" include the costs of generic components (such as batteries, electric motors, and controllers) which can be produced by third-parties and adapted at low cost for use in a wide range of vehicle platforms by multiple vehicle manufacturers. Thus, the sharing of generic components across vehicle platforms leads to rapidly declining incremental costs, and creates a self-reinforcing dynamic feedback. This cost-reduction feedback may allow targeted policies to be more effective in spurring the hybrid market despite the continued low world oil prices that effectively prevent AFVs from significant market penetration.

2.0 THE GENERAL MODEL STRUCTURE

The overall objective of the TAFV model is to estimate market outcomes, where the competitive market equilibrium is determined as the maximum of consumer and producer surplus (well-being) from transportation services provided by the light-duty vehicles (cars and trucks). The TAFV model characterizes interactions among fuel providers, vehicle producers, fuel retailers, private vehicle purchases and fleet vehicle programs. A schematic of these interactions is shown in Figure 2.[1]

[Figure 2: Schematic of TAFV Model]

As is shown, new vehicles and vintaged on-road vehicle stocks are tracked. Also tracked are vehicle production capacities and utilization, fuel production, and fuel retail production and capacity.

[1]Further details on the general model structure can be found in Leiby and Rubin,1997.

2.1 Cost Function Representation of Supply Modules

Each of the supply modules shown in Figure 2 is represented by a cost function defined for each time period, region, fuel, and vehicle type. Examples include: vehicle production costs; fuel production or conversion costs; fuel retailing costs; raw material supply costs; and sharing or mix costs associated with vehicle and fuel choices. The sharing costs reflect the welfare loss due to the distortion of choice from the ideally preferred mix of fuel and vehicle non-price attributes, given unequal market prices of fuels and vehicles (Small and Rosen 1981, Anderson, de Palma and Thisse 1988). The cost functions summarize the way in which changing levels of activities, inputs, and outputs affect the costs for each supply module, and implicitly define the cost-minimizing behavioral relationships among the model's variables. In some cases the supply module involves investments in fixed capital stocks with long-lived (multiperiod) costs and benefits.

2.2 Market Balancing Conditions and Vehicle Choice

In each year markets must be balanced by equating consumers' demand with producers' supply of fuels, vehicles and transportation services. The equilibrium solution is calculated with GAMS (Brooke, Kendrick and Meeraus 1992) and yields market clearing supplies, demands, trade, and conversion process levels.

Each year, to the extent that existing vehicle stocks are insufficient to satisfy the demand for transportation services, a mix of new vehicles is purchased. New vehicles are chosen according to a nested multinomial logit (NMNL) choice formulation, whose parameters come from Greene (1994, 1998, 2001). Vehicle choice is based on up-front vehicle capital costs, non-price vehicle attributes and expected lifetime nested fuel choice costs. In this way, long-lived investment consequences are reflected in vehicle choice. Fuel choices must be made for the vehicles that are dual or flexibly-fueled. Since vehicle and fuel choice is endogenous, it is important to specify which fuel and vehicle characteristics are considered in the fuel and vehicle choice sub-modules, and which characteristics are endogenously determined. These characteristics are shown in the Table 1.

There are six principal ways that new vehicle types are distinguished from conventional vehicles in the TAFV model. The first is via valuation of the differences in their non-price characteristics in the vehicle choice function. The second is by incorporation of possible tax incentives for HEVs, AFVs, or their fuels. The third is by accounting for economies of scale in the production of new vehicle types. The fourth is by recognizing that initially each new vehicle technology may be offered on only a limited number of makes and models, and that this imposes a disincentive on consumers. The fifth is by accounting for the availability of their fuels, if they are AFVs, and the implied cost to consumers. The sixth and last is by recognizing the greater fuel efficiency of hybrids.

For further discussion of the treatment of each of these factors, and other assumptions and data sources, see Leiby and Rubin 2000, 2001.

3.0 KEY TRANSITIONAL PHENOMENA MODELED

Our analysis identified key areas that could strongly affect the transition to alternative fuels and vehicles. These include the costs to consumers of limited retail availability of alternative fuels; scale economies for vehicle production and fuel retailing; limited AFV model diversity; and any costs to consumers from being unfamiliar with a new technology. Because of their potential importance, all these transitional barriers, except for those related to consumer unfamiliarity, have been explicitly modeled. We did not model the costs of consumer acceptance for new technologies since we had little information to make realistic parameter estimates. As our results below suggest, not including this cost would not likely change any of our quantitative results, since the AFV market has a difficult time getting started given the transitional barriers that we do include.

- Vehicle and fuel production and distribution infrastructure requirements are large
- Alternative fuels are rarely available at filling stations.
- Initial vehicle costs are high at low production scales (See Figure 3).
- Initially, new vehicle types are offered with only limited vehicle model diversity.
- Capital stock turnover is slow.

[Figure 3: Hybrid Vehicle Scale Economies imply much higher early production costs at lower volumes]

3.1 Learning-by-Doing

Learning-by-doing (LBD) is the process by which the costs of new technologies decline as a function of cumulative experience. This phenomenon is observed in various industrial situations where it is described as a learning curve, progress function, or experience curve. It is important to distinguish learning-by-doing, scale economies, and learning by technological progress (the latter is closely related to R&D spending.)

The theory of LBD was first exposited by Arrow (1962). Empirical studies using historical data suggest learning rates in the range of 5%-20% per doubling of experience (e.g. Lieberman 1984, IEA 2000, McDonald and Schrattenholzer 2001). At the same time, however, these rates must be used with great caution. This is because, as McDonald and Schrattenholzer note, the empirical literature varies in its methodologies and data sources by which learning rates are calculated. For example, the literature does not always disaggregate learning from the effects of scale or research and development (R&D) expenditures. Sometimes the dependent variable is price, rather than cost, and price is influenced by supply and demand factors not related to learning. Finally, the time period chosen for the empirical analysis can also affect the calculated learning rate. Notwithstanding these limitations, LBD, as documented the empirical literature, appears to be an important component of cost reduction. The existence of substantial learning may also be important for determining good public policies designed to spur new technologies.

Another concept related to LBD is learning from research and development (R&D). The Partnership for a New Generation of Vehicles and FreedomCAR programs are classic examples of this approach to advanced automotive design. Public policies to encourage new technologies can encourage both R&D and LBD. However, the prospect of learning from R&D can have significantly different policy implications than LBD. As Goulder and Mathai (2000) show in the

context of climate change, if knowledge is gained primarily through R&D, then it may be justified to shift abatement to the future – act later. If cost reductions are also gained via LBD, then the impact of learning and technological change on the timing of abatement efforts is ambiguous. The same reasoning may be applied to policies for promoting new vehicle technologies. Depending on the particular technologies and assumptions, it may be optimal to act sooner, implement technologies, to learn and thereby lower future costs. If the endogenous learning rate is sufficiently celeritous, LBD proponents argue that a rapid divergence from existing technologies by performance mandates could allow otherwise uneconomic technologies to become economically viable.

The choice of an index of experience to use for LBD has long been of topic of research. In TAFV, there are several ways to model cumulative experience: as cumulative new production capacity or new vehicles sold, or as total installed production capacity or number of vehicles on the road (total stock). Given that production capacity and vehicles are scrapped over time, these later two methods allow for "forgetting" as well as learning. Globerson and Levin (1987) have argued that we should incorporate both learning and forgetting into institutional environments. Benkard (2000), drawing on data from the aircraft industry, showed that in certain industries there is evidence of organizational forgetting: "production experience actually depreciates over time, and knowledge gained from building one product doesn't necessarily spill over to the next generation." Benkard found that a model that includes depreciation of experience accounts for the data much better than the traditional learning model.

We currently model LBD in terms of total installed vehicle production capacity. This assumption allows both accumulation and depreciation of experience, and does affect our results. Short-lived vehicle subsidies, if they are insufficiently large or long in duration, may be unable to induce a sustainable HEV production sector. Such temporary subsidies may only temporarily lower vehicle production costs from learning.

Interaction/Spillover Effects from Learning.

Industry-wide LBD is an endogenous feedback effect that is distinct from the plant-level scale economies characteristic of vehicle manufacturing, but it can reinforce scale economies. This LBD/scale-economy interaction is represented in the TAFV model. In some simulations we disallow learning in order to evaluate the impacts of scale economies alone. Given that hybrid vehicles share some components and generic capital, learning investments in one hybrid vehicle type may lower costs and technology choices in other vehicles and regions. With scale economies and learning (which is a dynamic externality), local optima are expected, both in the modeled solution and in the actual economy.

4.0 SIMULATION RESULTS

Our first set of results (using TAFV 1) focuses on the prospects for alternative fueled vehicles. Accounting for the transitional factors discussed earlier leads to results with very little alternative fuel vehicle or alternative fuel use under base conditions. We are led to the clear conclusion that the combination of comparatively low oil prices and fuel/vehicle transitional barriers poses a severe impediment to the introduction of alternative fuel vehicles. Figure 4 plots the effectiveness of policy tools at different oil price levels, as measured by the alternative fuel

market share in 2010. The “oil price shift” cases consider an increase of oil prices above the U.S. Energy Information Administration’s (EIA) base path projection. The assumed oil price increase is achieved gradually over the next 5 years, and sustained thereafter. Even if oil prices do rise, some additional policy is needed to overcome the transitional barriers of low production scale and limited fuel availability, and to induce substantial alternative fuel use by 2010. This is confirmed by the Base Case, or no-new-policy, outcome in Figure 4, in which essentially no alternative fuel is used even under dramatically higher prices.

Most policies under current oil prices lead at best to the sale of some (dual or flex-fueled) AFVs, but little-to-no alternative fuel use. Interestingly, some policies which have almost no effect in inducing alternative fuel use under current oil prices (e.g. a mandate that requires fleets purchase more AFVs *and* to use alternative fuel at least 50% of the time) could be very powerful under sustained higher oil prices (see Figure 4).

[Figure 4: Effectiveness of Policy Tools at Different Oil Price Levels, as Measured by Alternative Fuel Share in 2010 (%).]

Given the large impediments to alternative fuel use, it is not surprising that some policies achieve gasoline displacement only at high cost. Figure 5 shows that a subsidy to alternative fuels on the basis of their reduced greenhouse-gas (GHG) content could displace gasoline with a social-surplus cost of about $0.70 per gallon. This cost reflects consumer and producer surplus losses, including the higher production cost of alternative fuels and vehicles. It does *not* reflect the possible welfare gains from reduced GHG emissions.[2] Note also, from Figure 5, that a mandate requiring commercial fleets to purchase additional AFVs, and to use alternative fuel half of the time, is a very costly way to displace gasoline at current oil prices. However, if the oil price level were to rise and thereby diminish the long-run barrier to alternative fuels, this policy becomes a very efficient and low-cost way to overcome the remaining transitional barriers.

[Figure 5: Costs of Policy Tools to Promote AFVs at Various Oil Price Levels]

Our second set of results (using TAFV 2) focuses on the prospects for HEVs. We first examine the effect of permanent and temporary (5-year) subsidies to induce hybrid electric vehicle sales *without* introducing LBD into the model; scale effects are still available. The HEV types considered include a range of grid-independent configurations such as those currently marketed by Honda and Toyota. The grid-independent configurations include a mild (42 volt) gasoline hybrid with two- and four-wheel drive options, and both a gasoline and diesel fueled full (300 volt) hybrid vehicle. The mild 42-volt, hybrids achieve 15% improvement in fuel economy with a minimum (mature scale) incremental production cost of about $2000, while the full 300-volt hybrid achieves a 33% improvement in fuel economy with a minimum incremental cost of $6000.

Without a subsidy, our simulations indicate little or no hybrid penetration over the next

[2] Again, the "oil price shift" cases consider an increase of oil prices above the EIA base path, achieved gradually over the next 5 years, and sustained thereafter.

15 years (see Figure 6). This indicates that fuel savings and non-price attributes of hybrids, as we have characterized them, are less than their incremental costs compared to conventional vehicles. We see that an HEV subsidy of $2,400/vehicle is effective at inducing a very large penetration of new vehicle sales.[3] This is not surprising given that the subsidy exceeds the incremental costs of hybridization at large-scale production levels. Interestingly we see that the subsidy is effective only so long as it persists. Since the HEV technology involves more modest transitional barriers than AFVs (i.e., no fuel-availability issue with grid-independent HEVs, and the ability to attain scale economies of production more quickly given shared "generic" components), it behaves more like a conventional commodity than AFVs. Accordingly, there are few residual effects of the HEV subsidy once it is removed (other than the persistence of the HEVs already sold in the vehicle fleet). The market for new HEVs returns to its original state before the subsidy. However, if any learning and persistent cost reductions can be gained from the experience of producing many HEVs during the subsidization period, a different outcome is possible.[4]

[Figure 6: Effectiveness of Permanent and Temporary Hybrid Subsidies ($2,400) *without* LBD..

Hybrid Penetration with Learning

As noted above, there does not appear to be a clearly defined learning rate for hybrid technology. We therefore parameterize our model by assuming that at full industry-wide production capacity, the incremental costs of hybrids will be one-half of those at initial, low-volume production. Given our underlying technology, this works out to be a 10.4% reduction in unit production costs per doubling of cumulative production capacity. Making this change to the model produces the results shown in dotted line given in Figure 7. With learning, and a temporary subsidy of $2,400, we see that hybrid penetration exceeds its previous peak level and persists even after the subsidy is removed. Subject to the numerous, necessary assumptions for this type of analysis, we can conclude that the existence of a 10% learning rate in hybrid vehicle production, coupled with a $2,400 temporary subsidy, appears to be able to overcome transitional barriers and allow the hybrid vehicle market to become self-sustaining.

[Figure 7: Hybrid Vehicle Production Shares With and Without LBD, Permanent and Temporary Subsidies, $2,400 Tax Credits]

Figure 8 shows the shows the effect of a $2,000 subsidy with and without learning. In this

[3] We discuss subsidies of $2400 and $2000 here because they yield interesting results with and without learning. Our full set of simulations revealed that a temporary subsidy of at least $2000 was needed to induce substantial HEV sales, while a permanent subsidy of $1600 or greater was required.

[4] Of the HEV alternatives, *when* the market chose HEVs it strongly favors the mild, 42-volt hybrid configuration. The mild hybrid appears to be a more cost-effective strategy for achieving fuel savings than the full 300-volt hybrid. Note that this latter conclusion may not hold true if oil prices rise substantially, or if consumers face a fuel-based incentive rather than a vehicle-based incentive.

case, the penetration level is lower for both the permanent and temporary, subsidies reflecting the lower subsidy. More interesting, is that with learning, hybrid penetration persists for a number of years beyond the end of the subsidy period, but then ends. That is, this simulation shows the effect of forgetting on future hybrid costs. Apparently, the scale of hybrid production and the degree of learning with a $2,000 temporary subsidy are not sufficient to push the hybrid market to be self-sustaining in a competitive market. Clearly, these results depend on the actual level of learning and the costs and performance of the underlying technologies. Nonetheless, it is important that this study identifies and formalizes the phenomenon whereby learning interacts with scale economies and with the magnitude *and* duration of subsidies to determine the prospects for transition to a new vehicle technology.

[Figure 8: Hybrid Vehicle Production Shares With and Without LBD, Permanent and Temporary Subsidies, $2,000 Tax Credits]

5.0 CONCLUSIONS

It is important and revealing to raise questions about technology transitions. Policies motivated by social objectives such as urban air quality, energy security, or greenhouse gas mitigation may be more effectively understood if we ask, "How do we integrate customer's needs, firms' objectives and policy goals in the context of evolving markets?" Focusing on transitional concerns also raises useful questions like "Can mandating new vehicle sales or subsidizing new fuels for a limited time lead to wide scale adoption?" or "Are there vehicles and fuels which serve as bridges to new technologies?"

One lesson learned from the experiments with the TAFV model is the importance of oil prices. Low oil price is a major long-run barrier. Without a change in this long-run barrier, transitional policies can be ineffective and costly, when measured by dollars per gallon of gasoline displaced. Under higher oil prices, transitional policies (non-price policies or targeted price incentives) can effectively overcome short-run barriers. Absent a major shift in oil prices, we find that transitional policies are similarly effective *if* they are coupled with an adequate and sustained tax credit for alternative fuels.

Market barriers to significant new vehicle/fuel systems are substantial, particularly for AFVs. The principal market barriers are limited retail fuel infrastructure availability and vehicle production scale economies. The magnitude of transitional barrier seems to be equivalent to about $1 per gallon, declining to about $0.50 per gallon by 2010. Absent new policy initiatives (e.g. a sustained and large tax credit), or significant change in oil prices, EPACT 2010 gasoline displacement goals will not be achieved

Without subsidies we project no substantial penetration by HEVs, based on their prospective fuel efficiency gains and costs.[5] Hybrid subsidies (on the order of $2000 per vehicle) *can* induce substantial hybrid penetration and gasoline demand displacement under EIA's 2001 oil price projections. This is quantitatively different from the result achieved for AFVs. The

[5] Further work is merited to investigate the prospects for cost-effective HEV penetration in certain market niches, where vehicle size and utilization conditions make hybridization more attractive. Since HEVs can offer 4-wheel drive at modest cost, refining our estimates of consumer demand for this attribute may also alter this conclusion.

efficacy of HEV subsidies is much greater than for AFVs because of the latter's huge infrastructural needs. The HEVs sold are primarily of the "mild" hybrid type, 42-volt system that achieves modest fuel-efficiency gains (15%) with greater cost effectiveness than more extensive hybrid designs. Temporary HEV subsidies are effective at inducing hybrid vehicle penetration, but do not have long-term effects once they are removed unless there are cost reductions due to learning-by-doing. With learning-by-doing we found that a high enough temporary subsidy can be effective in assisting hybrid vehicles to overcome transitional barriers and to become self-sustaining in a competitive market.

Clearly learning-by-doing is an important factor. Its importance for costs has been validated in the literature and confirmed in empirical studies of many industries. Its importance for new vehicle policy was validated again here. But, while important, learning is very tricky to represent. For this reason, in order to better understand the prospects for transitions to new vehicle technologies, including AFVs, hybrids, and fuel-cell vehicles, further work is needed to refine our estimates of technology costs and learning rates, as well as consumer valuations of fuel economy and other new vehicle attributes.

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Figure 1: Static V. Transitional Analyses Yield Differing Conclusions: 2010 Alternative Fuel Demand Shares, Base Case, No New Policies

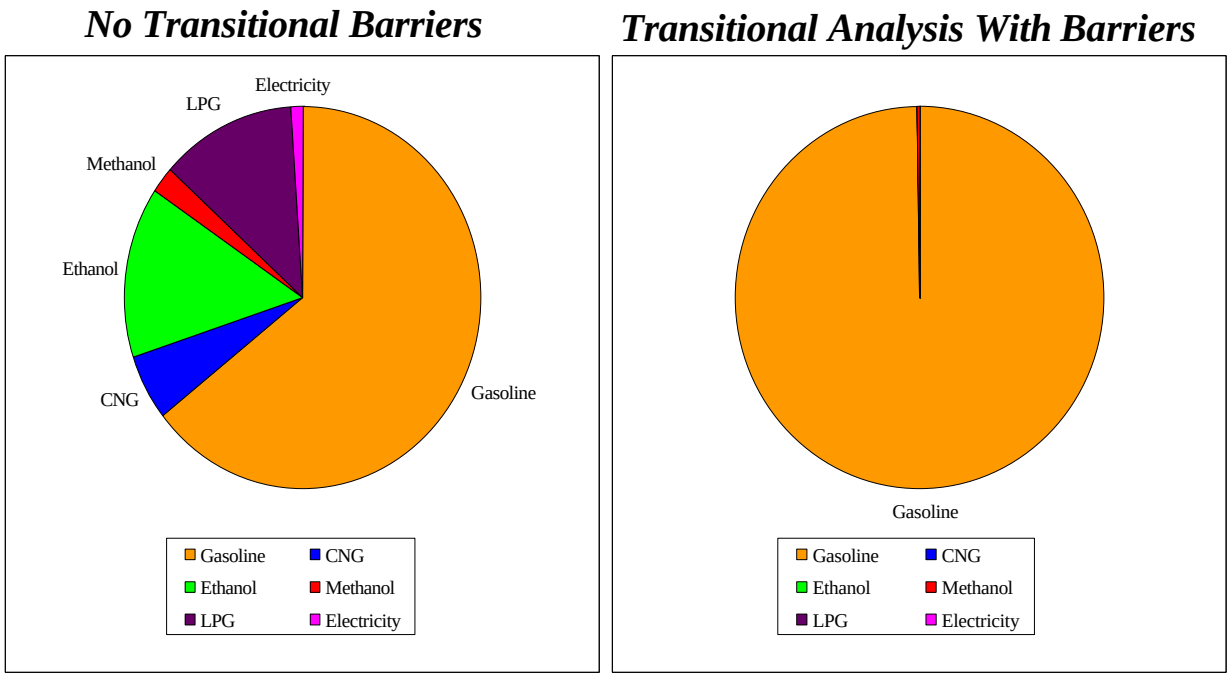

Figure 2: Schematic of TAFV Model

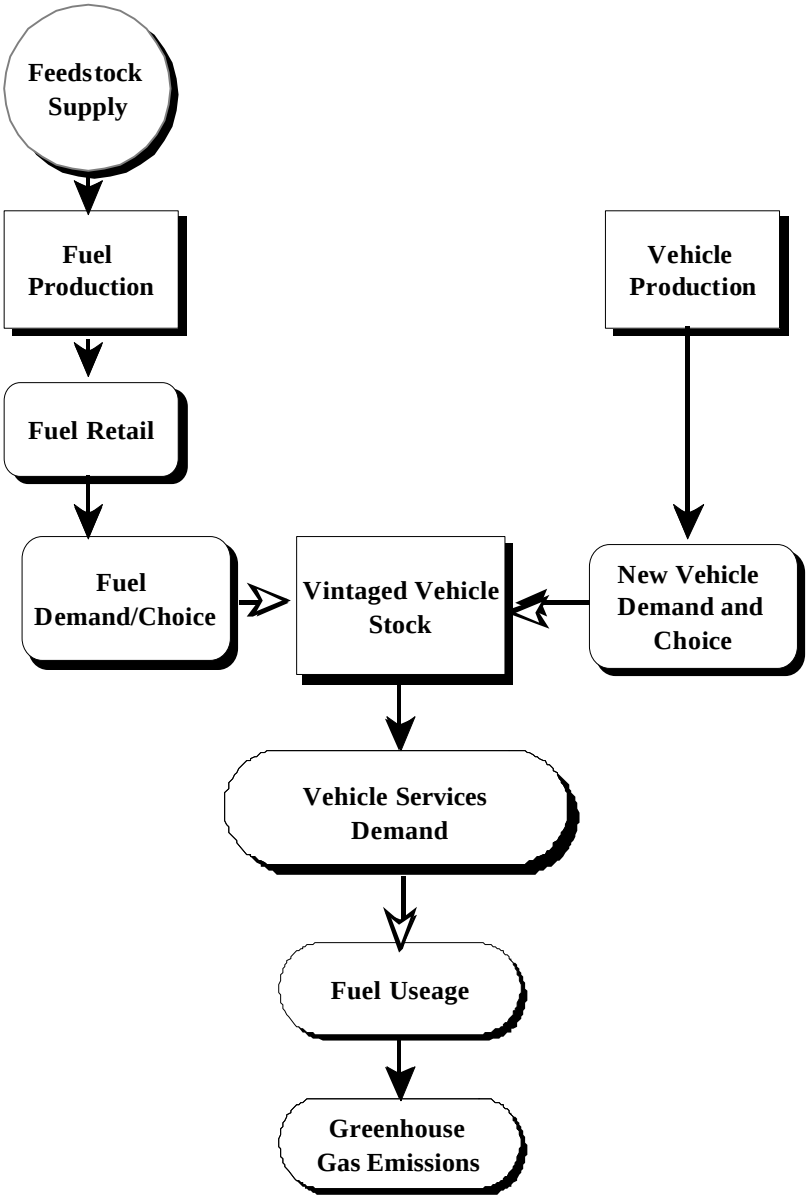

Table 1: Factors Influencing Fuel and Vehicle Choice

Factors considered in Fuel Choice	**Endogenous**	**Exogenous**
Fuel Price	X	
Fuel Availability (fraction stations offering fuel)	X	
Refueling Frequency (based on range)		X
Refueling Time Cost		X
Performance Using Fuel (HP-to-weight ratio changes)		X
Factors Considered in Vehicle Choice	**Endogenous**	**Exogenous**
Vehicle Price	X	
Fuel Cost (reflecting fuel economy and expected price)	X	
Performance (changes in HP-to-weight ratios)		X
Cargo Space (loss due to space required for fuel storage)		X
Vehicle Diversity (number of models offering AFV technology)	X	

Figure 3: Hybrid Vehicle Scale Economies imply much higher early production costs at lower volumes

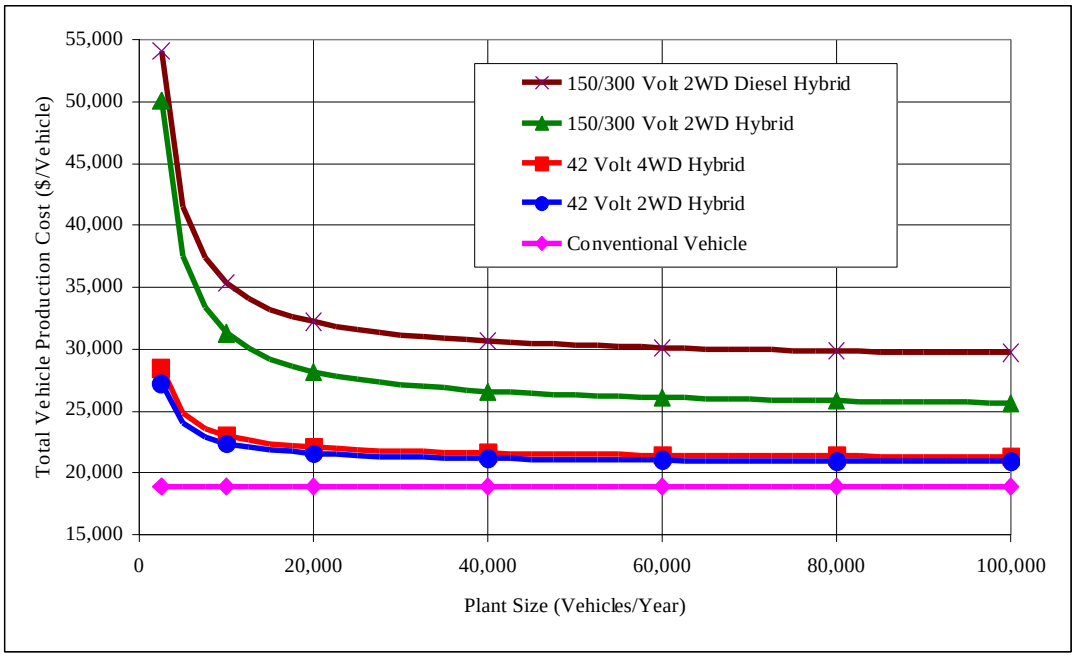

Figure 5: Costs of Policy Tools to Promote AFVs at Various Oil Price Levels.

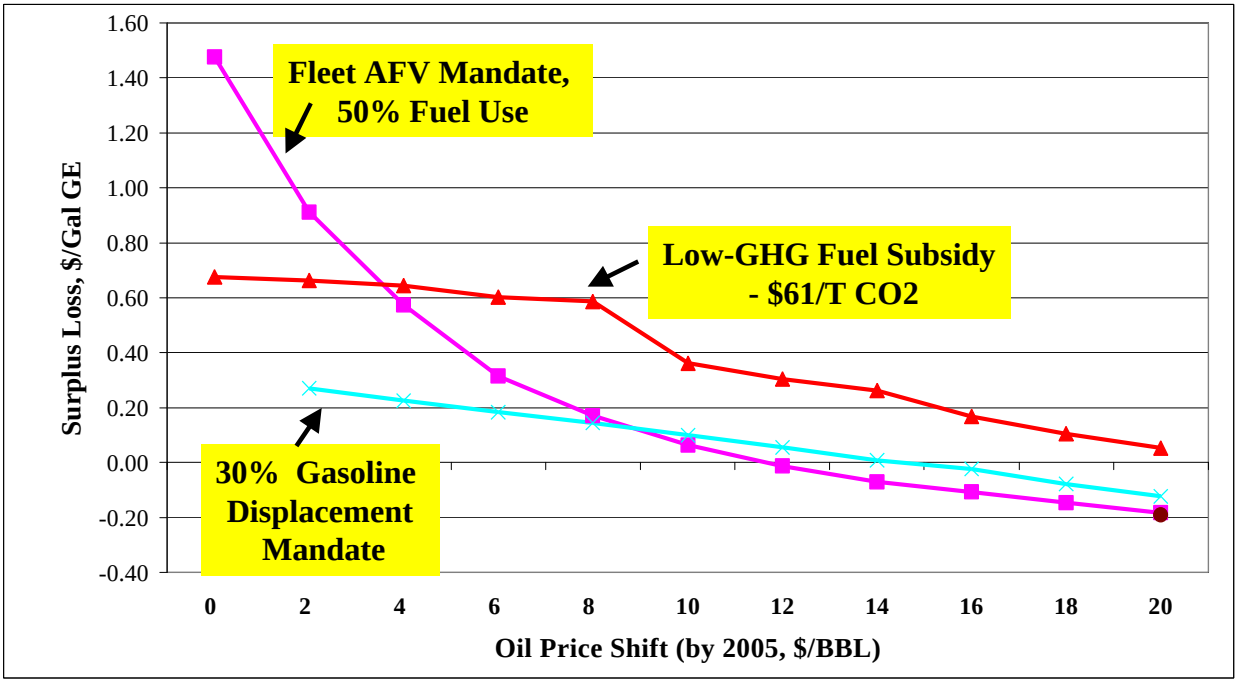

Figure 4: Effectiveness of Policy Tools at Different Oil Price Levels

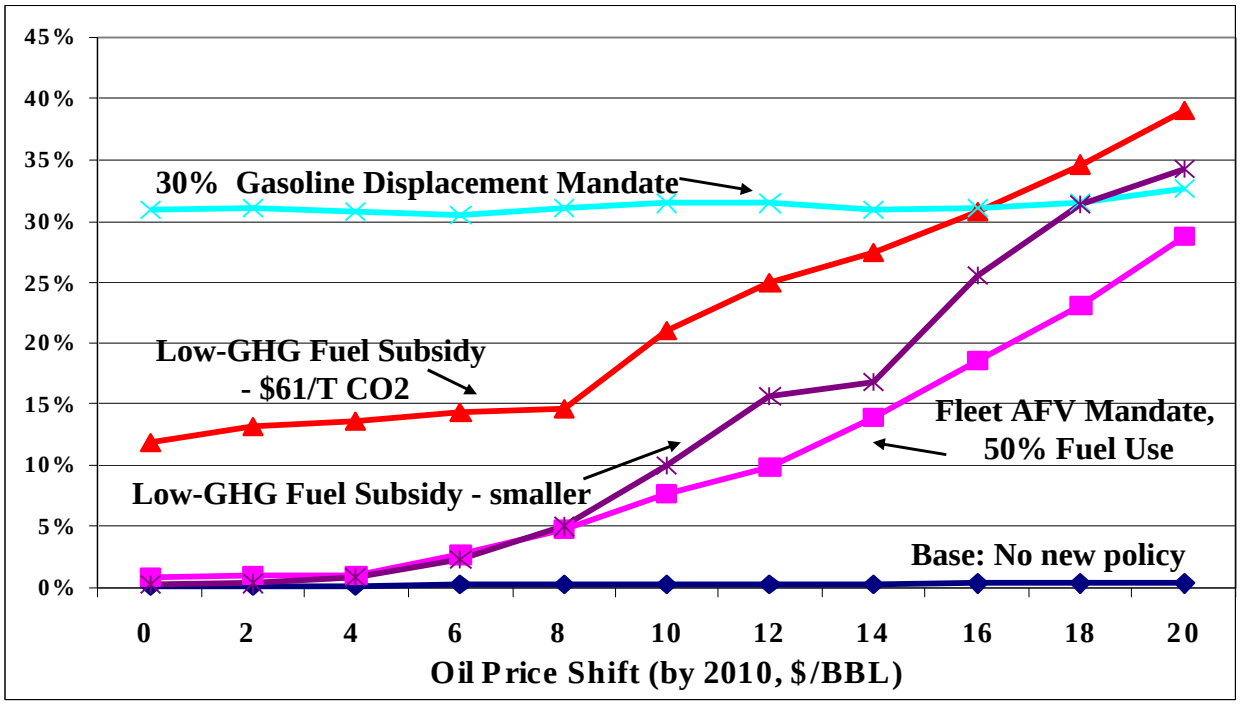

Figure 6: Effectiveness of Permanent and Temporary Subsidies to Induce Hybrid Sales *without* LBD ($2,400 Tax Credit, permanent, or 5-years in duration and phased out).

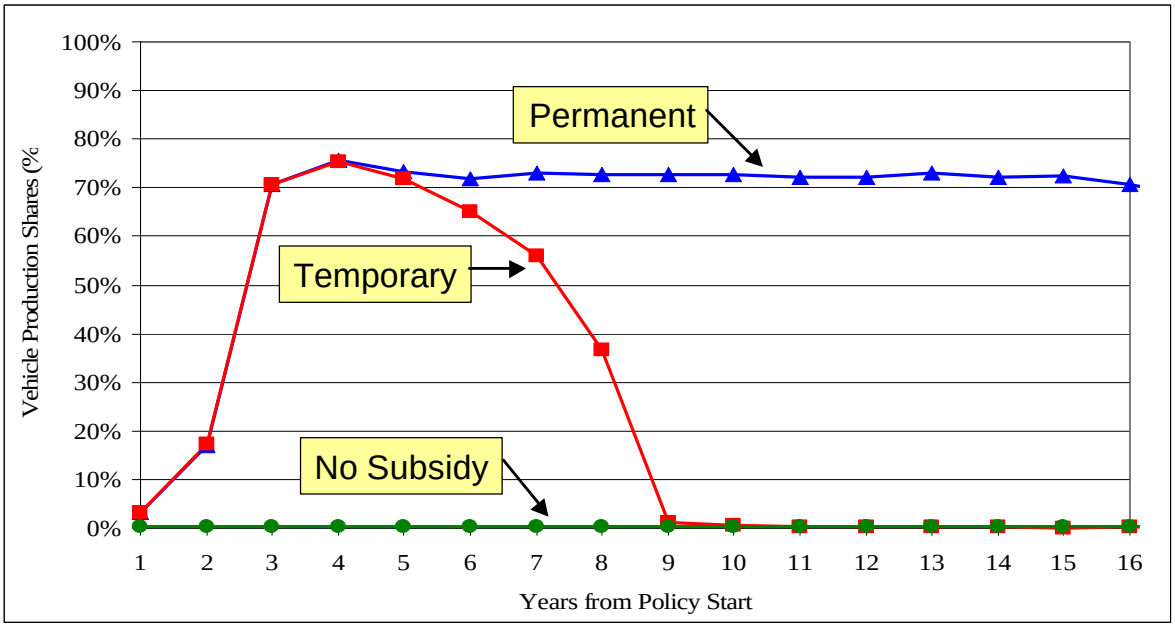

Figure 7: Hybrid Vehicle Production Shares With and Without LBD, Permanent and Temporary Subsidies, $2,400 Tax Credits

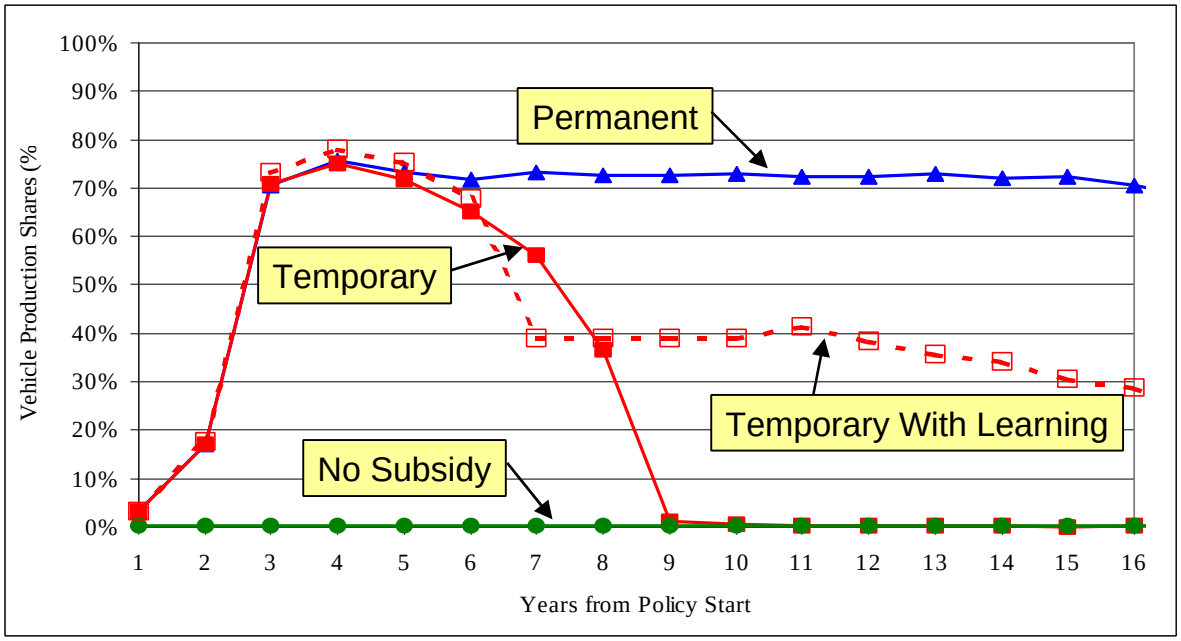
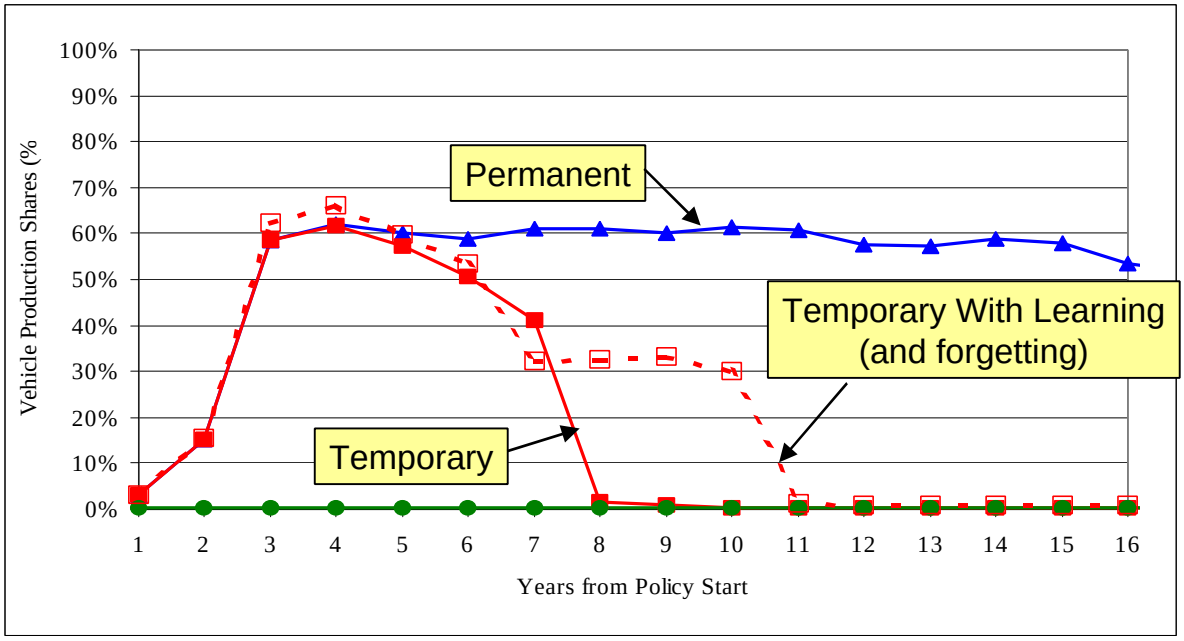
Figure 8: Hybrid Vehicle Production Shares With and Without LBD, Permanent and Temporary Subsidies, $2,000 Tax Credits