Tax Incidence with Endogenous Quality and Costly Bargaining: Theory and Evidence from Hybrid Vehicle Subsidies

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September 16, 2016

Abstract

Endogenous quality and bargaining are important features of many markets but are typically omitted from studies of incidence. We develop a model with product upgrades and costly bargaining and find that tax rate pass-through only partially characterizes the welfare impact of taxation; consumers may respond to a tax or subsidy by changing product quality or by changing their bargaining effort. We apply the insights of our theory to the study of subsidies for green goods, specifically hybrid electric vehicles in Canada. We utilize highly detailed transaction data and leverage panel variation in subsidies across provinces for identification. Our baseline estimate finds that prices rises by $575 for every $1,000 increase in the subsidy. But, this pass-through estimate substantially underestimates consumer gains because a majority of this price increase is due to increased product quality in the form of additional options and features. In fact, dealer margins rise by only $138.

Keywords: Incidence, Bargaining, Green Subsidies, Energy Efficient Technologies, Hybrid Electric Vehicles, Automobiles.
JEL Codes: H22, R48, Q48, L98.

We thank Werner Antweiler, Brian Copeland, Nisha Malhotra and participants at the AERE Annual Meeting (Banff) and Dauphine Université Paris for comments and discussion.

1 Introduction

Incidence is one of the foundational topics of public economics. When a tax, subsidy or implicit price wedge is added to a market, who bears the burden? We revisit this question so as to better understand the welfare implications of tax subsidies for energy-efficient automobiles. To accurately characterize the welfare impacts of subsidies in the automobile market, we argue that it is necessary to incorporate two considerations normally omitted from theoretical and empirical incidence studies—endogenous product quality and costly price negotiation. We show theoretically that the presence of either factor modifies the welfare interpretation of incidence; pass-through rates are not sufficient statistics for measuring changes in consumer surplus from marginal tax changes. We show empirically that these factors are quantitatively important for the study of automobile subsidies; incorporating these concerns raises our estimate of consumer welfare gains by at least 50%.

Our study focuses on subsidies for green goods, though our results have wider implications. Concerns ranging from energy security to climate change have led governments to promote energy efficient appliances and vehicles using financial incentives. These incentives take a variety of forms, including cash rebates, income tax credits, sales tax rebates, and subsidized loans.[1] In general, incidence is important for the design and evaluation of policies to the extent that policymakers weigh benefits to consumers differently than increased profits accruing to the owners of firms. For green subsidies in particular, incidence is central because the subsidies are often sold to voters as improving the environment while benefitting consumers.

In standard tax incidence models, the pass-through rate (the derivative of final price with respect to the tax wedge) is a sufficient statistic for assigning burden for marginal changes. These models, however, leave out two features essential to automobile purchases. First, a subsidy may induce upgrading: consumers may add features and options to their vehicle. Standard models that ignore upgrading, or that over-control for it comparing only identical products, understate consumer gains by ignoring valuable quality improvements. Second, automobile prices are determined in a bilateral bargaining processinvolving real resource costs only to determine a transfer. If a subsidy lowers the amount of bargaining that takes place, there are additional welfare benefits not embodied in the price.

Our empirical study concerns hybrid electric vehicles (HEVs), but many other markets have one or both of these features. Many durable goods—including automobiles, appliances, housing, or consumer electronics—and many services—like health or child care—have quality dimensions. Automobiles, housing, and a myriad of intermediate goods are subject to bilateral negotiations between buyers and sellers. Our analysis suggests a need for caution in interpreting pass-through rates to determine incidence in these markets.

Our analysis begins by deriving a theoretical model in which a consumer buying

[1] Gillingham, Newell, and Palmer (2006), Allcott and Greenstone (2012) and Rivers and Jaccard (2011) provide overviews of financial incentives adopted by American and Canadian governments and utilities as part of Demand Side Management programs which began in the 1970s, as well as more recent incentive programs; for specific incentive programs see also Allcott and Greenstone (2012), Chandra, Gulati, and Kandlikar (2010), Sallee (2011), Datta and Gulati (2014), and Bennear, Taylor, and Lee (2011).

a durable good chooses a level of quality for that good and negotiates the final price with the seller. We then introduce a subsidy, which can take the form of a reduction in an existing ad valorem tax, or as a lump-sum rebate. The model predicts that a tax reduction will affect transactions through both income and substitution effects. The substitution effect is straightforward: the reduction in the sales tax lowers the price of the good as well as any options installed at the time of purchase, inducing consumers to buy more options. Either a rebate or a sales tax reduction will also create income effects: the consumer uses her rebate to buy more normal goods, including upgrades to the product. Less haggling, in turn, translates to higher profits (margins) per unit. Collectively, our model suggests that subsidies raise transaction prices, the value of options purchased, and seller margins. Importantly, because of upgrading, price increases will exceed profit increases. We note also that, in the absence of liquidity constraints or mental accounting, we would expect the substitution and especially the income effects to be small, which makes the empirically large responses we find especially interesting.

We test the model's predictions using data regarding 9,661 individual HEV transactions in Canada from 2004-2009. The data include exhaustive information on the vehicle sold as well as financial characteristics of each transaction. During the sample period, there is significant variation in subsidies for HEVs at the provincial level. Of Canada's ten provinces, five have subsidies, and these change over time. The subsidies take the form of reductions in sales taxes, but the total savings is capped, so that some tax rebates act as lump-sum subsidies. Of the vehicles receiving a subsidy in our sample, the mean subsidy is $1,838, while the maximum exceeds $3,500.

Variables include vehicle trim, number of doors, engine type, transmission, the final price paid by consumers, the vehicle's invoice cost to the dealer (including the cost for options chosen), discounts, financing & leasing information, and allowances for the vehicle traded in (if any). There is also some nominal information on the dealer and customer, including the province of sale and a retailer identifying code.[2] We use this policy variation in a panel fixed effects research design, which controls for unobservable attributes of each HEV model and national shocks to the HEV market, to estimate how an increase in the subsidy affects transaction prices, upgrading and dealer profits.

We find that a $1,000 HEV rebate raises the final transaction price, inclusive of all features and options, for a particular year-model by $575. Taken at face value, the subsidy we study seems to have a much larger effect on transaction price than those studied by Busse, Silva-Risso, and Zettelmeyer (2006) and Sallee (2011). Busse et al. (2006) finds that customer cash incentives from manufacturers raise transactions prices by 10-30% of the rebate. Sallee (2011) finds cash rebates had no effect on U.S. Prius prices during the mid-2000s. This would seem to suggest that consumers benefited less from Canadian HEV subsidies than the incentives studied in prior research.

The picture changes substantially, however, when considering upgrading. Our data do not include details on specific options installed by the original equipment manufacturer (OEM) in each model. It does, however, include a measure of the dealer's *cost* of each vehicle, which will encompass the full suite of factory-installed options. Thus, we examine how subsidies affect the dealer's *vehicle cost* to detect upgrading. Note that,

[2] All values are reported in Canadian dollars. During our study period, the Canadian dollar was worth between 0.73 and 1.07 US dollars and had an average value of 0.87 US dollars.

because OEMs generally set invoice schedules uniformly across dealerships and over the model year, our measure of dealer cost picks up changes in the features installed rather than changes in the prices set for dealers. Canadian HEV subsidies had a large effect on vehicle cost. Our results indicate that a $1,000 increase in the HEV rebate induces consumers to spend an additional $412 on options, while dealer margins rise by only $138.

Our results indicate that the pass-through rate for a product with variable quality is a poor indicator of the incidence of consumer subsidies. If we ignored the change in options purchased, our data would suggest consumers keep less than half of HEV subsidies in Canada. Upon accounting for upgrading, our data tell a different story: two-thirds of the increase in transaction price comes from upgrading. To the extent that these upgraded options impart use-value to the consumer, it seems clear that consumers enjoy a larger share of subsidy benefits than would be suggested by analyzing transaction price alone. Moreover, although we do not have a direct estimate of negotiating costs in our data, our theory allows us to sign the bias from ignoring costly negotiation. Reductions in costly negotiations will also increase consumer benefits, implying that even our upgrade-adjusted estimates understate consumer gains.

There is a rich tradition of tax incidence analysis in economics (see Kotlikoff and Summers (1987) and Fullerton and Metcalf (2002) for reviews). A key finding is that, for marginal changes in a tax, a price change (tax rate pass-through) is a sufficient statistic for changes in consumer surplus. Weyl and Fabinger (2013) demonstrate that this property, long understood to apply in competitive markets, is actually quite general and holds irrespective of the form of competition. We contribute to this literature by showing how both costly bargaining and endogenous product quality complicate the interpretation of tax rate pass-through, and by deriving welfare results in a model with those features.

Our paper also contributes to a more specific growing body of research on subsidies for energy efficient automobiles. A number of studies have sought to analyze the impacts of subsidies on sales in the US (Gallagher and Muehlegger, 2011; Beresteanu and Li, 2011), Canada (Chandra et al., 2010; Rivers and Schaufele, 2016), and Europe (Adamou, Clerides, and Zachariadis, 2014; D'Haultfoeuille, Givord, and Boutin, 2014; Huse and Lucinda, 2014; Linn and Klier, 2015; Jimenez, Perdigeuro, and Garcia, 2016; Kaul, Pfeifer, and Witte, 2016). Others have studied scrappage programs that have an environmental component (Li, Linn, and Spiller, 2013; Busse, Knittel, and Zettelmeyer, 2012). Only Sallee (2011), which is focused on a federal income tax subsidy, and Busse et al. (2012) and Kaul et al. (2016), which both consider short-term temporary scrappage programs, study the price effects of policies in this domain.[3] We thus add to the empirical literature, both by providing new insight into how estimated price changes should be interpreted, and by providing an additional assessment of price responses, this time in the Canadian market, with a focus on longer-term provincial policies.

[3] Jimenez et al. (2016) also studies prices around a policy in Spain, but it is limited by data to a study of list prices, not actual transaction prices.

2 Model

We develop here a model of tax incidence that allows for endogenous product quality and costly bargaining. Our focus is on understanding the effect of a subsidy. We consider both a lump-sum subsidy and a subsidy that takes the form of a reduction in a pre-existing sales tax rate.

A customer and a dealer haggle over the price P of an automobile. An automobile is a composite good that includes a baseline vehicle plus extra features—i.e., *options*—ranging from spoilers to stereo upgrades. Let x denote the number of options chosen. For simplicity we'll treat options as a continuous variable with retail price m per unit; we examine the case of lumpy options in an appendix (see A.1). Let M denote the Manufacturer's Suggested Retail Price (MSRP) for a baseline vehicle. We model the (pre-tax) transaction price P for an auto with options x as

$$P = M + mx - D \tag{1}$$

where D represents any discount the customer receives.

Intuitively, we expect D to be higher when the consumer puts more effort h into haggling, and smaller when the dealer's opportunity cost C for the baseline vehicle is higher; assume $C < M$. In the spirit of Nash Bargaining, we assume

$$D = \alpha(h)[M - C] \tag{2}$$

where α is the consumer's share of the gap between a baseline vehicle's suggested price and the dealer's opportunity cost. Notably, we assume the discount obtained through haggling effort h is independent of how many options she selects. Letting $c > 0$ denote the dealer's marginal cost of installing one more option, with $m > c$; we are thus effectively assuming that the dealer's per-option margin on upgrades is non-negotiable.[4]

For tractability we further assume

$$\alpha(h) = 1 - e^{-h}. \tag{3}$$

This functional form has several desirable properties: haggling increases the consumer's share of the gap but with diminishing returns; a consumer who refrains from haggling pays MSRP; capturing the entire surplus would take infinite haggling effort. Mathematically, $\alpha'(h) > 0 > \alpha''(h)$, $\alpha(0) = 0$, $\lim_{h\to\infty} \alpha(h) = 1$.

A customer finances a car purchase out of budget B plus any transfers received, such as a cash subsidy S. Let Y denote the residual, i.e., funds left over after the transaction:

$$Y = B + S - \tau P \tag{4}$$

where $\tau - 1 = t - r$ is the net rate of tax levied on the vehicle purchase, t is the sales tax and r the sales tax rebate. τP is thus the customer's tax-inclusive price for the entire vehicle.

[4]We relax this assumption in Appendix A.1, where we assume that upgrades come pre-installed and a consumer negotiates over the price of the entire package.

Let U denote the customer's utility when she buys a car[5] with options x:

$$U = \bar{u} + u(x) + v(Y) - H(h). \tag{5}$$

In (5), $\bar{u} + u(x)$ represents the customer's payoff from consuming a car with options x. $v(Y)$ measures her payoff from residual savings; assume $v' > 0 \geq v''$. $H(h)$ measures her disutility from haggling, with $H' > 0 < H''$. Substituting in for Y using (1) and (2) gives the consumer's objective function:

$$\max_{h,x} \bar{u} + u(x) + v\left(B + S - \tau\left[M[1 - \alpha(h)] + mx + \alpha(h)C\right]\right) - H(h).$$

The first order conditions for an interior optimum are as follows:

$$u'(x) - \tau m v'(Y) = 0, \tag{6}$$

$$v'(Y)\tau\alpha'(h)[M - C] - H'(h) = 0. \tag{7}$$

Define $\tilde{P} \equiv M - D$ as the effective price of a baseline vehicle in equilibrium. Given (2),

$$\tilde{P} = M[1 - \alpha(h)] + \alpha(h)C, \tag{8}$$

while the equilibrium transaction price for a vehicle with options x will be $P = \tilde{P} + mx$. Together equations (1) - (8) define the endogenous variables h, x, $\tilde{P}$ and P as functions of the exogenous parameters τ, t, r, S, B, M, m, and C.

2.1 Tax Rebates

Sales tax rebates have been popular government policies for promoting green goods, including HEVs. To see how raising r affects equilibrium values, we differentiate the system formed by equations (1) - (8) with respect to r and rearrange to get

$$\frac{dh}{dr} = -\frac{\mu}{rx\Gamma}\left[\frac{r}{\tau} + \zeta\frac{rP}{Y}\right] < 0, \tag{9}$$

where $\mu \equiv -\frac{u''x}{x'}$ and $\zeta \equiv -\frac{v''Y}{v'}$ are the elasticities of marginal utility from options and the residual, respectively (both of which are non-negative by concavity of u and v), while $\Gamma \equiv [M - C]\alpha'\frac{\zeta}{Y}\frac{\mu}{x}\tau + \left[\frac{\zeta\tau m}{Y} + \frac{\mu}{x}\right]\left[1 + \frac{H''}{H'}\right] > 0$.

Equation (9) tells us that a tax rebate will induce customers to haggle less. There are two complementary forces driving this result, which can be interpreted as substitution and income effects. The substitution effect is as follows: a rebate shrinks the tax-inclusive value, τD, of any discount achieved, making haggling less productive. The income effect works in the same direction; the rebate enriches the consumer, who uses the windfall to get more of what she likes, including time free from haggling. Both effects incline the consumer to haggle less overall and so $\frac{dh}{dr} < 0$. This result seems uncontroversial: given most consumers' distaste for haggling, it isn't surprising they

[5] For completeness, we assume the consumer's utility is simply $v(B)$ if she neither buys a car nor haggles.

would allocate a portion of their auto-related subsidies to finance some relief from the exercise.[6]

A consequence of the consumer haggling less is that her share of the gap between MSRP and the dealer's opportunity cost declines, raising the equilibrium transaction price of a baseline vehicle, as shown by differentiating the system (1) - (8) to get

$$\frac{d\tilde{P}}{dr} = \frac{\mu[M-C]\alpha'}{rx\Gamma}\left[\frac{r}{\tau} + \zeta\frac{rP}{Y}\right] > 0. \tag{10}$$

Thus, prices rise in response to a sales tax rebate, but this cannot be interpreted as a complete loss to consumers, as the decline in costly bargaining offsets some of the loss. (More details about welfare are provided below.) A proportional rebate also impacts spending on options. Differentiating (1) - (8) with respect to r yields

$$\frac{dx}{dr} = \frac{1+\frac{H''}{H'}}{r\Gamma}[\underbrace{\frac{r}{\tau}}_{\text{substitution effect}} + \underbrace{\zeta\frac{rP}{Y}}_{\text{income effect}}] > 0. \tag{11}$$

As with haggling, there is a substitution effect: the tax rebate makes options cheaper, making them more attractive. There is also an income effect: the consumer spends her windfall on normal goods like an upgraded stereo and other features that buy her a nicer car. Combined, these channels comprise an *upgrading* effect, whereby tax rebates induce consumers to upgrade the attributes of the good purchased.

It's worth pausing here to address how strong the aformentioned substitution and income effects are likely to be. As evidenced in equation (11) by the r/τ term, the price effect of a proportional-rebate program will be greater when the rebate rate is large. For example, if a rebate program only lowers the marginal cost of upgrading a vehicle's stereo system by a small amount (i.e., r/τ is small), then we wouldn't expect the substitution channel to have a large impact on the number of options purchased. Indeed, for the Canadian HEV sales tax rebates we discuss in later sections, the policies in question lowered the price of add-ons by only 6 to 8 percent. This is somewhat small compared to some other proportional-rebate programs that have been implemented in North America. For example, the U.S.' Residential Renewable Energy Tax Credit program provides households with tax credits equal to 30% of expenditures on residential solar-electric systems, solar water heaters, wind turbines, and geothermal heat pumps.[7]

Whether the income channel is strong similarly depends on relative magnitudes. As indicated by the $\zeta\frac{rP}{Y}$ term in (11), the income channel will be stronger when the rebate is large relative to the residual, and when the marginal utility from that residual is highly elastic. With these parameters in mind, consider, for example, a neoclassical consumer who regards B as equal to the sum of all of her liquid assets, and who allocates any rebates back to that same pool of funds; unless the auto purchase uses up most of her remaining assets, $\zeta\frac{rP}{Y}$ may well be small.

[6] Zettelmeyer, Morton, and Silva-Risso (2006) provide direct evidence of consumer's distaste for price negotiations. Busse, Simester, and Zettelmeyer (2010) also present evidence that during an employee pricing sales event in 2005, many customers cited "no need for bargaining" as a reason to purchase vehicles during that time.

[7] U.S. IRC 25D - Residential energy efficiency property; see also http://www.energystar.gov/taxcredits. See Borenstein and Davis (2016) for a description of various green U.S. tax credits.

But the opposite may be true for consumers who face binding liquidity constraints, or who employ budgeting heuristics like mental accounting (Thaler, 1999). Suppose a consumer engages in the following exercise: she compartmentalizes her intended spending into mental accounts with associated budgets, and assigns to those accounts any relevant windfalls. Thus, a rebate on the sales tax paid for an auto is assigned back to the auto-buying budget. If the consumer engages in this form of mental accounting, the income effect of a tax rebate could be large: the residual Y from an auto purchase will be small even if the consumer is wealthy. Moreover, if the consumer suffers extra disutility from closing an account that is in arrears, then the marginal utility of a dollar of residual income may vary considerably depending on whether the customer is close to exhausting the funds available in a particular account; this would suggest ζ may be large. Under these circumstances, a consumer who views extra speakers, for example, as frivolous under normal circumstances may consider them a justifiable indulgence when her vehicle account is bolstered by a rebate. To foreshadow our results, our empirical estimates of upgrading are of a different order of magnitude than income effects out of general wealth. This implies that either a liquidity constraint or a behavioral phenomenon, such as mental accounting, plays a large role in upgrading.

Finally, with an eye to generating testable predictions, we derive here the total effects of a change in r on the consumer's final price, product cost and dealer profit. We define $\hat{P} = \bar{C} - cx$ as the dealer's vehicle cost, where $\bar{C}$ is the price charged by the manufacturer to the dealer for a baseline vehicle and c is the dealer's marginal cost of installing one more option (with $\bar{C} < M$ and $c < m$). Further, we define $\pi = P - \hat{P}$ as the dealer's profit—commonly referred to as the dealer's *margin*. Our theory predicts P, $\hat{P}$ and π all rise with r:

$$\frac{dP}{dr} = \frac{d\tilde{P}}{dr} + m\frac{dx}{dr} = \left[\frac{r}{\tau} + \zeta\frac{rP}{Y}\right]\frac{mx[1 + \frac{H''}{H'}] + \mu\alpha'[M - C]}{rx\Gamma} > 0, \tag{12}$$

$$\frac{d\hat{P}}{dr} = c\frac{dx}{dr} = c\frac{1 + \frac{H''}{H'}}{r\Gamma}\left[\frac{r}{\tau} + \zeta\frac{rP}{Y}\right] > 0, \tag{13}$$

$$\frac{d\pi}{dr} = \frac{dP}{dr} - \frac{d\hat{P}}{dr} = \left[\frac{r}{\tau} + \zeta\frac{rP}{Y}\right]\frac{[m - c]x[1 + \frac{H''}{H'}] + \mu\alpha'[M - C]}{rx\Gamma} > 0. \tag{14}$$

2.2 Incidence of Tax Rebates

We complete this analysis by assessing the incidence of a tax rebate; that is, we describe the welfare implications. When analyzing rebate programs, the profession tends to treat the retail price as a sufficient statistic for incidence, infering that, if the retail price of the subsidized good rises, then the consumer loses part of the benefit of the subsidy.

However, when the quality of the good is endogenous, the change in the transaction price doesn't tell the whole story. It could well be that transaction prices rise because the consumer upgrades to a higher quality product, which raises her utility from consuming the good.

The extent to which price changes are insufficient statistics for incidence can be illustrated using the theoretical model. For this we assume the Dealer's opportunity cost is unaffected by r. This implies that the consumers gets the full benefit (as supply is perfectly elastic). We use this simplification to explain how changes in product quality and bargaining affect welfare and the pass-through, as these lessons apply to the more general case.

Let $x(r)$ and $h(r)$ be the values of x and h that maximize the consumer's utility from the transaction and define $P(r) = M + mx(r) - \alpha(h(r))[M - C]$ as the pre-tax transaction price. Using these, we can define the consumer's maximized utility as $\check{V}(P(r), x(r), h(r), r) = \bar{u} + u(x(r)) + v(B + S - \tau P(r)) - H(h(r)))$ and the Dealer's resulting profit as $\pi(r) = P(r) - C - cx(r)$.

If we focused only on the direct and price effects of a rebate—i.e. if we ignored how rebates affect equilibrium haggling effort and choice of options—we would erringly calculate the change in consumer benefit as $\frac{\partial \check{V}}{\partial \tau}\frac{d\tau}{dr} + \frac{d\check{V}}{\partial P}\frac{dP}{dr}$ when, in fact,

$$\frac{d\check{V}}{dr} = \frac{\partial \check{V}}{\partial \tau}\frac{d\tau}{dr} + \frac{d\check{V}}{\partial P}\frac{dP}{dr} + \underbrace{\underbrace{\frac{\partial \check{V}}{\partial x}}_{=u'>0}\underbrace{\frac{dx(r)}{dr}}_{(+)}}_{(+)} + \underbrace{\underbrace{\frac{d\check{V}}{\partial h}}_{=-H'<0}\underbrace{\frac{dh(r)}{dr}}_{(-)}}_{(+)} \tag{15}$$

Indeed, in our simple model, the consumer does actually get the benefit of the full subsidy. The consumer takes some of the windfall from the subsidy in the form of a lower tax-inclusive price, some in the form of more options, and some in the form of less stress from haggling. This means that the consumer pockets less cash than the full amount of the effective subsidy, but the full value to the consumer of all she receives—cash + more options + less haggling—is as great as if she had kept x and h unchanged and pocketed all of the effective subsidy. A simple mathematical proof of this claim follows from first recognizing that a marginal increase in the rebate rate corresponds to an effective subsidy of P, and then invoking the envelope theorem to simplify (15):

$$\begin{aligned}\frac{d\check{V}}{dr} &= \frac{\partial \check{V}}{\partial \tau}\frac{d\tau}{dr} + \underbrace{\frac{d\check{V}}{\partial P}\frac{dP}{dr} + \frac{\partial \check{V}}{\partial x}\frac{dx(r)}{dr} + \frac{d\check{V}}{\partial h}\frac{dh(r)}{dr}}_{\substack{=\ 0 \\ \text{by first order conditions} \\ \text{for consumer optimization}}} \\ &= v'(Y)P. \end{aligned} \tag{16}$$

Even though raising r gives the buyer the same size welfare-gain as she would have received *if* she had pocketed all of the effective subsidy, the fact that she instead chooses to forego some of the cash in exchange for more options and less haggling ends up benefiting the Dealer as well. Differentiating π with respect to r reveals that the Dealer benefits from r through two channels:

$$\frac{d\pi(r)}{dr} = \underbrace{\alpha'(h)[M - C]\left[-\frac{dh(r)}{dr}\right]}_{\text{rent restoration}} + \underbrace{[m - c]\frac{dx(r)}{dr}}_{\text{upgrading}} > 0.$$

First, as the consumer dials down her efforts to get a deal, some of the Dealer's potential rents from selling a baseline vehicle are restored. Second, the Dealer is able to sell more options, earning the margin $m - c$ on each.

There's a simple reason why the dealer can benefit from the rebate even though the consumer gets the benefit of the full value of the effective subsidy: the rebate reduces deadweight losses arising from market inefficiencies. One of the inefficiences is that the consumer's discount, D, is simply a transfer from the Dealer; however this transfer is obtained through costly haggling, which creates a deadweight loss. When the consumer allocates some of her windfall to haggle-free time, the reduced deadweight loss accrues to the Dealer. The other inefficiency arises because options are priced above their marginal cost (c), and so they are under-consumed. Through upgrading, the rebate eliminates some of the deadweight loss from under-consumption of options; this gain also accrues to the seller.

In summary, a tax rebate can mitigate some of the market inefficiencies that accompany costly haggling and above-cost pricing, and so the value of a rebate may exceed its dollar value. In our model, the consumer and retailer share the benefit, with the consumer's share being at least as large as it would have been if she had pocketed the cash directly, even though the transaction price rose.

2.3 Lump-sum Subsidies

Like proportional-rebates, lump-sum subsidies also reduce haggling, with implications for options purchased and transaction price. Differentiating the system formed by equations (1) - (8) with respect to S and rearranging terms gives

$$\frac{dh}{dS} = -\zeta \frac{S}{Y} \frac{\mu}{x} \frac{1}{S\Gamma} \leq 0, \tag{17}$$

$$\frac{d\tilde{P}}{dS} = \zeta \frac{S}{Y} \frac{\mu}{x} \frac{[M-C]\alpha'}{S\Gamma} \geq 0, \tag{18}$$

and

$$\frac{dx}{dS} = \zeta \frac{S}{Y} \frac{1 + \frac{H''}{H'}}{S\Gamma} \geq 0. \tag{19}$$

As with an increase in the rebate rate, an increase in the fixed subsidy has an income effect, whereby the consumer allocates some of her windfall gain to residual savings, some to additional options, and some to release from the unpleasantness of haggling. Notably, an increase in S has no substitution effect on the consumer's decisions: because the amount of the subsidy is independent of how much the consumer spends on a hybrid electric vehicle, it does not distort her option choice through a price channel. The income effect of a rise in S causes an unambiguous increase in transaction price, vehicle cost, and dealer's margin provided $\zeta > 0$:

$$\frac{dP}{dS} = \zeta \frac{S}{Y} \frac{[M-C]\alpha'\mu + mx\left[1 + \frac{H''}{H'}\right]}{Sx\Gamma} \geq 0,$$

$$\frac{d\hat{P}}{dS} = c\zeta \frac{S}{Y} \frac{1 + \frac{H''}{H'}}{S\Gamma} \geq 0,$$

and

$$\frac{d\pi}{dS} = \zeta \frac{S}{Y} \frac{[M-C]\alpha'\mu + [m-c]x\left[1 + \frac{H''}{H'}\right]}{Sx\Gamma} \geq 0.$$

When the primary effects of a tax rebate are the substitution effects, one would expect a key difference in impacts between a sales tax reduction and a lump-sum subsidy. However, when the income effects dominate, which is more plausible when there is a liquidity constraint or mental accounting, then we would expect these effects to be more similar across instruments. Many policies take the form of a sales tax reduction, but they are often taxed at binding values. When that happens, the policies act as lump-sum subsidies.

2.4 Dealer's opportunity cost

A feature of early HEV markets was short supply of some makes and models. In such a market, a dealer's opportunity cost for a baseline vehicle may be more than just the wholesale cost $\bar{C}$ if, for example, selling a vehicle now means the dealer might not have another unit to sell to a potential customer arriving later in the sales period. To assess how an increase in the dealer's opportunity cost affects equilibrium values, we differentiate the system formed by equations (1) - (8) with respect to C to get the following:

$$\frac{d\tilde{P}}{dC} = \left[\zeta\frac{\tau m}{Y} + \frac{\mu}{x}\right]\frac{\left[1+\alpha\frac{H''}{H'}\right]}{\Gamma} > 0, \tag{20}$$

$$\frac{dx}{dC} = -\zeta\frac{\tau}{Y}\frac{\left[1+\alpha\frac{H''}{H'}\right]}{\Gamma} < 0, \tag{21}$$

$$\frac{d\hat{P}}{dC} = -\zeta\frac{\tau c}{Y}\frac{\left[1+\alpha\frac{H''}{H'}\right]}{\Gamma} < 0, \tag{22}$$

$$\frac{dP}{dC} = \frac{\mu}{x}\frac{\left[1+\alpha\frac{H''}{H'}\right]}{\Gamma} > 0, \tag{23}$$

and

$$\frac{d\pi}{dC} = \left[\zeta\frac{\tau c}{Y} + \frac{\mu}{x}\right]\frac{\left[1+\alpha\frac{H''}{H'}\right]}{\Gamma} > 0. \tag{24}$$

Intuitively, as C rises, the surplus to be split between the consumer and dealer shrinks; as shown in (20), this puts upward pressure on $\tilde{P}$. In turn, a higher baseline price makes the consumer poorer, inducing her to reduce her consumption of other normal goods such as options: $dx/dC < 0$ (see equation 21). As the number of options declines, so too does vehicle cost: $d\hat{P}/dC < 0$ as per (22). Although fewer options are sold, the equilibrium transaction price and dealer's margin rise nonetheless, as confirmed by equations 23 and 24.

3 Data and Policy

We use data collected from automobile dealers by a major market research firm. The data include information from each recorded vehicle transaction, including (a) vehicle characteristics (vehicle trim, number of doors, engine type, transmission), (b) transaction characteristics (suggested retail price, transacted price, cost of the vehicle to the

Table 1: Summary Statistics for Hybrid Vehicles Across Vehicle Segments

Segment	Mean				Median			
	Cust Price	Veh Cost	Dealer Marg	Days to Turn	Cust Price	Veh Cost	Dealer Marg	Days to Turn
Compact (n=3,472)	$30,768	$28,855	$1,967	29.5	$30,502	$28,465	$1,947	8
Luxury (n=90)	$81,862	$77,056	$5,792	42.3	$76,057	$69,654	$6,128	10
Midsize (n=3,818)	$32,832	$30,516	$2,331	27.3	$32,646	$30,584	$2,297	8
Pickup (n=10)	$42,097	$40,226	$1,871	10.1	$39,070	$38,035	$1,035	7
SUV (n=2,271)	$50,820	$47,726	$3,580	35.5	$52,880	$49,324	$3,612	9
Total (n=9,661)	$36,785	$34,415	$2,526	30.1	$32,899	$31,023	$2,275	8

Source: Authors' Calculations

dealer including factory- and dealer-installed accessories, the price for extended warranties bought, whether the vehicle was financed, leased or a cash purchase, rebates offered, province of purchase, and how long the vehicle was on the dealer's lot), and (c) trade-in characteristics (the price of the trade-in vehicle, and its under- or over-valuation).

As dealers must agree to be included in the database, their selection is not random. However, the database is the most comprehensive dataset on vehicle purchase transactions in Canada.[8] The database includes approximately 20% of new vehicle sales in Canada from May 1st, 2004 to April 15th, 2009.[9] We restrict our attention to transactions involving the purchase of new hybrid electric vehicles (HEVs). Canada has ten provinces and three territories. Although hybrid electric vehicles are sold in all Canadian jurisdictions, the dataset has adequate representation of HEV sales in only the four most populous provinces: Alberta (AB), British Columbia (BC), Ontario (ON), and Quebec (QC); in total, only 231 HEV transactions are reported for the other nine provinces and territories. Accordingly, we use only the observations from Alberta (1,696 transactions), British Columbia (1,311), Ontario (5,322) and Quebec (1,332)—a total of 9661 transactions—for our analysis.

Table 1 presents the distribution of HEV sales across vehicle segments; the bottom row presents summary statistics for the entire sample of HEV transactions. Most HEV sales are from the midsize, compact, or sport utility vehicle (SUV) segments. Also represented in our sample are sales from the luxury and pickup segments; together, these latter two segments comprise just over 1% of the HEV sales.

The median HEV sold for $32,899, generated $2,275 in margin for the dealer, and was on the lot (days to turn) for 8 days. Most HEVs sold were in the Midsize category, including the best-selling Toyota Camry. Compact and SUV segments are two other segments where significant numbers of HEVs are sold. Toyota Camry is the leading

[8] The Canadian and US automobile markets are very similar: makes and models are almost identical across the two markets, and in both markets, customers negotiate with dealers over the price of new cars. Thus, our findings have relevance for the US automobile industry.

[9] The full database reports on 1,137,573 transactions.

Table 2: HEV Sales Across Manufacturers

Manufacturer	No.	Column %
Toyota	7,923	82.0
Honda	854	8.8
Ford	499	5.2
GM	274	2.8
Nissan	102	1.1
Chrysler	9	0.1
Total	9,661	100.0

Source: Authors' Calculations

HEV sold in our data, followed by the Prius, the Highlander Hybrid, and the RX 400H, all of which are made by Toyota or Lexus. Most HEVs in our dataset were sold in the province of Ontario (over 55%), followed by Alberta, Quebec, and British Columbia.

Table 2 reports the distribution of HEV sales across manufacturers. Notably, 82% of HEV sales in our sample are from Toyota (including Lexus).[10] Consequently, our analysis largely utilizes variation across and within the most populous provinces in Canada.[11]

We illustrate how transactions for the same vehicle differ across jurisdictions in Table 3. Because it was the best selling HEV in our dataset, we focus on the Toyota Camry. In the four provinces we study, median prices were highest in Alberta (at $33,385). Quebec had the lowest median price ($32,092) and highest median dealer margin (at $3,090). Ontario had the lowest median dealer margin ($2,160). Alberta has never offered a rebate, while Ontario, Quebec, and British Columbia all offered rebates for HEVs during the period we analyze. Interestingly, the province with the highest average rebate for the Camry, Ontario, also had the lowest average prices and dealer margins.

3.1 Provincial Rebates

During the first decade of the 2000s, many governments in the United States and Canada introduced incentives encouraging hybrid electric vehicle adoption (Gallagher and Muehlegger, 2011). Some have since expired, but many have been replaced by similar programs for electric vehicles. Starting with British Columbia, several provincial governments in Canada (Ontario, Manitoba, Quebec, and Prince Edward Island) provided incentives for purchasing hybrid electric vehicles. In Table 4 we provide details of vehicle eligibility, rebates, limits, and the time horizon for the programs present in BC, ON and QC. Mostly, provinces rebated their provincial sales tax (PST) up to a specified ceiling; ceilings varied across provinces and years. Rebate programs in BC,

[10] In contrast, only 20% of transactions in the full database are for Toyota/Lexus vehicles.

[11] Our estimating strategy (which we elaborate in Section 4) focuses on *within* model (and year) effects. We also discuss the robustness of our results when only *within* province, model, and year effects are considered.

Table 3: Transaction Statistics for the Camry Hybrid Across Provinces

Province	Mean				Median			
	Cust Price	Dealer Marg	Rebate	Days to Turn	Cust Price	Dealer Marg	Rebate	Days to Turn
AB (n=458)	$33,481	$2,284	$0	24.6	$33,385	$2,289	$0	10
BC (n=270)	$33,388	$2,712	$1,864	24.6	$33,049	$2,832	$2,000	6
ON (n=2,303)	$32,482	$2,215	$1,920	22.2	$32,227	$2,160	$2,000	8
QC (n=427)	$32,838	$3,158	$1,673	30.0	$32,092	$3,090	$2,000	8
Total (n=3,458)	$32,729	$2,375	$1,631	23.7	$32,478	$2,332	$2,000	8

Source: Authors' Calculations

Ontario and Quebec were ended after our sample period.

Of the 9,661 HEV transactions in our data, 77% were eligible to receive subsidies/rebates. The value of the actual rebate associated with an individual transaction is not reported. Based on the policies set by each provincial government, we calculate the rebate associated with transaction i as follows:

$$r_{ivmt} = \min\{\eta_{mvt}(PST_v * (P_{ivmt} - Tamt_{ivmt})), Limit_{vt}\}, \tag{25}$$

where m indicates the model of the vehicle purchased, v the province in which the transaction took place and t the date. η_{vt} is the proportion of provincial sales tax returned on the purchase of an HEV. This proportion varies across provinces, date, and sometimes across models (certain provinces offer rebates on selected models). In all provinces offering rebates, sales taxes are determined on customer outlay—the difference between the transacted price, P_i, for the new vehicle and the amount paid by the dealer to the customer for any vehicle traded-in, $Tamt_i$. Finally, all provinces impose an upper limit on rebates. $Limit_{mvt}$ denotes the maximum sales tax rebate possible in province v at date t for model m.[12]

In Table 5 we separate our transactions by rebate status. 77% of our transactions received a provincial rebate; the mean value of a rebate was $1,838 (median rebate was $2,000). Mean and median prices paid by the customer were lower for vehicles receiving rebates ($36,027 and $32,500) than for those that did not ($39,346 and $34,870). Vehicles receiving rebates also generated a smaller median margin ($2,242) than those

[12]From March 31st 1993 until June 30th 2010, British Columbia also charged a graduated PST known as the Luxury Vehicle Surtax. HEVs sold in BC were allowed an additional $7,000 in vehicle price before the graduated PST was applied. E.g., if the luxury surtax applied at prices greater than $49,000 for regular vehicles, it applies only after $56,000 for HEVs. For all BC vehicles in the relevant transaction price range, we adjust the rebate to add the exemption of the luxury vehicle surtax from being a HEV; Figure 1 shows the average rebate earned over time for each province. This average is higher for BC due to the exemption from the luxury vehicle surtax. Sometimes the average is higher than the maximum advertized rebate, due to the same reason. The tax rate (including the surtax) was determined by the transaction price of the vehicle purchased; the tax was paid on the difference between the transaction price for the new vehicle being purchased and the value of the old vehicle being traded-in (trade-in value). While the base rate and the increment structure for this surtax remained constant for its lifetime, the initial threshold was adjusted several times after the surtax's introduction in 1993. Table A.2 in Appendix A.2 provides more detail.

Table 4: Tax Rebates for Hybrid Vehicles in Select Canadian Provinces

Province, Tax Rate, & Vehicle Eligibility	Rebate Amounts and Timing
British Columbia PST rate: 7%, with graduated increases for vehicles over $55,000 Eligibility: All hybrid vehicles with regenerative breaking	August 2000-July 31, 2001: 30% of PST paid up to $500; August 1, 2001-Feb 15, 2005: 30% of PST paid up to $1,000; Feb 16, 2005-July 2010: all PST up to $2,000. HEVs with transaction prices in excess of $55,000 also faced higher thresholds for graduated PST rates.[1]
Ontario PST rate: 8% Elibility: All hybrid passenger cars with regenerative braking; hybrid SUVs and trucks eligible 2002	May 10, 2001-June 17, 2002: all PST rebated up to $1,000 (hybrid cars only); June 18, 2002: all PST rebated up to $1,000 (all hybrid cars, SUVs and trucks March 23, 2006-July 2010: all PST rebated up to $2,000.
Quebec QST rate: 7.875% Eligibility: By model/year [2]	March 23, 2006-February 21, 2007: all Quebec Sales Tax (QST) paid to a maximum of $1,000; February 22, 2007-December 31, 2011: all QST paid to a maximum of $2,000; January 1, 2012-December 2013: all QST paid to a maximum of $1,000.

Notes: [1] BC Customers buying non-HEV light vehicles with transaction prices exceeding a threshold of $55,000 face a graduated PST rate of one percentage point higher on each $1,000 of price above the threshold, to a maximum of 10%. For example, a non-HEV vehicle with a transaction price of $100,000 will face the following PST schedule: 7% on the first $55,000, 8% on the first $1,000 over $55,000, 9% on the next $1,000, and 10% on the portion above $57,000. For hybrid vehicles, the graduated increase is not triggered until the transaction price exceeds $62,000. [2] Cars eligible for a rebate in Quebec are as follows: 2005-2006 Honda Insight, 2005-2007 Toyota Prius, 2007 Toyota Camry Hybrid, 2008 Ford Escape Hybrid (two-wheel drive), 2005-2007 Honda Civic Hybrid, 2005 Honda Accord Hybrid, and the 2007 Nissan Altima Hybrid.

Table 5: Summary Statistics Across HEV Rebate Status

Rebate status	Mean					Median				
	Cust Price	Veh Cost	Dealer Marg	Rebate	Days to Turn	Cust Price	Veh Cost	Dealer Marg	Rebate	Days to Turn
Unrebated (22%)	$39,346	$36,751	$2,723	$0	36.1	$34,870	$32,553	$2,394	$0	12
Rebated (77%)	$36,027	$33,717	$2,467	$1,838	28.4	$32,500	$30,309	$2,242	$2,000	8
Total (100%)	$36,785	$34,415	$2,526	$1,418	30.1	$32,899	$31,023	$2,275	$2,000	8

Source: Authors' Calculations

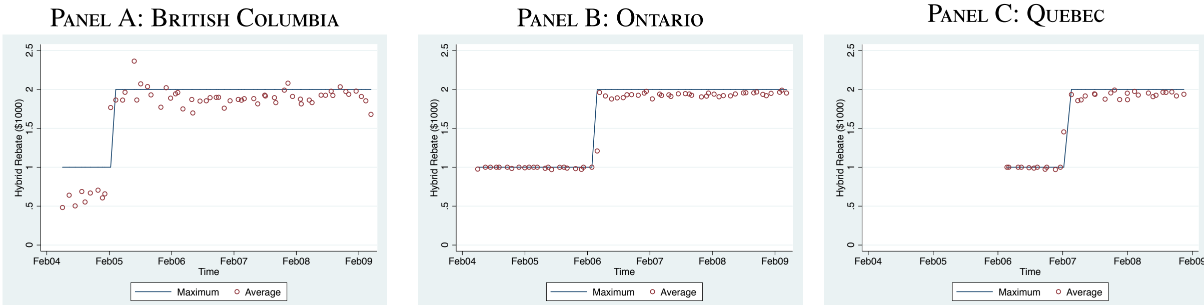
not receiving rebates ($2,394). On the other hand, those rebated were on dealers' lots for fewer days than non-rebated vehicles. Rebate status varies across provinces.

Of the 7,439 transactions receiving rebates, 82% (6,064) received a rebate equal to the rebate ceiling. Of 1,375 transactions receiving less than the maximum, 83% (1,137 transactions) included a trade-in vehicle, with a mean trade-in value of $12,445. These features of the rebates—rebates were capped by governments and curtailed by high trade-in values—render rebate values non-monotonic in transaction prices, and so we are not worried that our estimates will reflect reverse causation.[13]

In Figure 1 we illustrate the provincial rebate variable for BC, Ontario and Quebec, with rebate value on the vertical axis and transaction date on the horizontal axis. All three provinces had a discrete change in policy during the period of analysis. For instance, in BC the maximum advertised rebate changed from $1,000 to $2,000 on Feb 16th, 2005; note that a waiver of the graduated PST allowed some vehicles to effectively get a bigger break in their provincial sales tax than the advertised maximum of $2,000. This impacts the average rebate earned by eligible vehicles.

Figure 1: Hybrid Rebates Over Time and Province

Panel A: British Columbia — Panel B: Ontario — Panel C: Quebec



Notes: Solid line plots the maximum rebate over time in the three provinces in our sample that had rebates. Each dot represents the average rebate received on eligible vehicles in each month.

4 Estimation Strategy

Standard models of incidence suggest that the introduction of a subsidy will cause final prices to rise, and also to increase producer profit. Our theoretical model also suggests the possibility of an important role for upgrading. At the same time, we argued that upgrading effects might plausibly be small in the absence of a liquidity constraint or some form of mental accounting. We now use our data and panel variation in the availability of subsidies to estimate the effects of a subsidy for HEVs on final consumer price, dealer profit, and upgrading, as measured by vehicle cost.

[13]We think it unlikely that a purchaser's decision to trade-in a used vehicle will be affected by the presence of the rebate. That decision will depend on the price received (mean value $12,445 for transactions receiving a rebate below advertised maxima) for the trade-in, and on the reluctance of the customer to do the work associated with selling a car in the private market.

We test our model's empirical predictions by estimating the reduced form relationship in which the unit of observation is an individual transaction i:

$$\mathrm{Y}_{ivmtd} = \beta_0 + \beta_1 \mathrm{r}_{ivmtd} + \beta_2(365 - \mathrm{DTT}_{mt}) + \beta_3 \mathbf{X}_{ivmtd} + \tau_m + \mu_d + \lambda_t + \epsilon_{ivmtd} \tag{26}$$

where Y_{ivmt} is a dependent variable for transaction i, in province v, of model m, in time t, at dealership d; $\beta_0, \beta_1, \beta_2, \beta_3$ are coefficients to be estimated; r_{ivmt} measures the HEV rebate received for that transaction; DTT_{mt} is the national-average days to turn for model m in the quarter-year in which the observation occurs; $\mathbf{X}_{ivmtd}$ is a vector of characteristics for the observation; τ_m is a model-year fixed effect; μ_d is a dealer-fixed effect; λ_t is a time (month, year, or both) fixed effect, and ϵ_{ivmtd} is the error term for this transaction.[14] We describe each of these variables in greater detail below, starting with the set of dependent variables.

Dependent Variables

We use three different dependent variables: log of *customer price*, log of *vehicle cost*, and log of *dealer margin*. The customer price we use is the total amount paid for the vehicle, minus any cash rebates, plus any cost of extended warranties, accounting for any discount applied on a trade-in. This trade-in adjustment accounts for any gap between what the dealer records as the actual value of the trade-in and the amount written on the contract. Our customer price variable includes all options installed, but it excludes taxes, title fees and insurance. This is the price before taxes, which are determined by both the standard tax rate and any applicable HEV subsidies.

To detect upgrading, we also study the effect of subsidies on *vehicle cost*. This variable comes directly from our data provider and it includes transportation cost as well as all factory and dealer installed options. This variable poses a minor discrepancy from the customer price variable because it does not include a cost measure for any service contracts. That information is unavailable to us. Based on discussions with several dealers, we believe that dealers' invoice prices do not vary across Canada for a given model-year and set of factory-installed accessories. Only transportation costs differ. Instead of varying invoice prices across dealers, manufacturers can favor specific dealers through the structure of hold-back contracts, which specify bonuses contingent on a dealer's monthly, quarterly, or annual sales, rather than than the sale of a particular vehicle.

Finally, the *dealer margin* represents the profit that the dealership books on each sale. It is the difference between the vehicle price, inclusive of all options but excluding extended warranties, and vehicle cost. Note that the full profits to the dealer may be altered by the aforementioned holdback and quantity-contingent bonuses, which operate in the background and for which we have no direct measures.

[14]Our reduced form has the same flavor as that in Busse, Knittel, and Zettelmeyer (2013), where a vehicle price equation is estimated by regressing it on demand (X_D) and supply covariates (X_S),

$$P = \alpha_0 + X_D\alpha_1 + X_S\alpha_2 + \nu. \tag{27}$$

In our setting, the rebate dummies and DTT variables can be interpreted as determinants of demand and supply.

Independent Variables

The key independent variable is the amount of rebate received at the time of purchase as calculated using equation (25); this variable was discussed at length in section 3.1.

Other independent variables include a measure of excess demand for different models of HEVs. Our data provides information on days to turn for every vehicle transacted. However, the number of days a particular vehicle spends on the lot may be dependent of the price for which that vehicle ultimately sells. Thus, we average across all transactions in our four provinces to arrive at DTT_{mt}, which measures the average days to turn for the model during the quarter of the transaction. This average proxies for relative popularity of the model across Canada. As there are several transactions in a quarter, it is unlikely that the particular transaction analyzed influences the national average. We subtract DTT_{mt} from 365 to create a variable that increases with a model's popularity.

Recent analyses of US transaction data (Busse et al., 2013; Chandra, Gulati, and Sallee, 2016) indicate that transaction characteristics influence both price and dealer profits. These characteristics include binary measures for whether the vehicle was leased, financed or paid in full, whether the vehicle was bought at month- or year-end, and whether there was a trade-in vehicle associated with the transaction. If vehicles receiving rebates have a different distribution over these transaction characteristics than the rest of the population, omitting these characteristics would bias our results. We include indicator variables for each of these characteristics for each transaction.

Our regressions also include a number of fixed effects. Model-year fixed effects, τ_m, absorb price, cost, and margin averages for a model-year across Canada. Dealer fixed effects, μ_d, absorb time-invariant features of a dealership and its local market; if, for example, a dealer is systematically able to extract high transaction prices from customers because there are no competitors located nearby, the Dealer fixed effect will account for it. Month-year fixed effects, λ_t, capture trends or cyclical effects in the HEV automobile market.

5 Results

5.1 Price, Cost, and Margin Regressions

We present results from estimating variants of Equation 26. We list results from our preferred regression model for the three dependent variables in Table 6; the natural log of Customer Price is the dependent variable in the first column, the natural log of Vehicle Cost is the dependent variable in the second column, and the natural log of Dealer Margin is the dependent variable in the third column. All three regressions include the same independent variables. All regressions have standard errors clustered by model-year.

Our main variable of interest is the HEV Rebate, whose coefficient is positive and significant in all three regressions. A thousand dollar increase in the hybrid rebate increases customer price by 1.6%, vehicle cost by 1.2%, and dealer margin by 5.9%. The positive impact is consistent with the predictions described by equations 13-14.

Table 6: Regressions for Customer Price, Vehicle Cost, and Dealer Margin

	(1) Ln(Cust_Price)	(2) Ln(Veh_Cost)	(3) Ln(Dlr_Marg)
HEV Rebate ($1,000)	0.0158[a]	0.0122[a]	0.0585[b]
	(0.004)	(0.004)	(0.024)
365-Avg DTT	0.0006[a]	0.0004[a]	0.0041[a]
	(0.000)	(0.000)	(0.001)
Cash Purchase Indicator	-0.0040	0.0003	-0.0349[a]
	(0.003)	(0.002)	(0.013)
Leased Indicator	0.0074[b]	0.0083[a]	0.0405[b]
	(0.003)	(0.003)	(0.016)
Sat or Sun FE	-0.0004	0.0004	0.0094
	(0.002)	(0.002)	(0.016)
Last 5 days of month FE	0.0007	0.0017	-0.0229[c]
	(0.001)	(0.002)	(0.013)
Last 5 days of Yr FE	-0.0275[a]	-0.0168[b]	-0.2753[a]
	(0.007)	(0.007)	(0.086)
Observations	9,661	8,916	8,732
r2	0.9205	0.9320	0.4407

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. All regressions include model-year, year-month, and retailer fixed effects. Standard errors in parenthesis, are clustered by model-year.

We can interpret the regression coefficient on increasing HEV rebates as average dollar effects. In Table 7 we list the mean and median effects of increasing the HEV rebate by $1,000 on the customer price, vehicle cost, and dealer margin. For a $1,000 increase in the rebate, the average price of all hybrids sold in our sample rose by $574. 72% of the price rise comes from an increase in vehicle cost ($411), consistent with the upgrading effect identified by our theoretical model.

The corresponding increase in vehicle cost was approximately $411, and the increase in dealer margin was approximately $138. Median values are $518, $369, and $127. Note that these effects differ by manufacturer as prices, costs, and margins differ.

Overall, we interpret these baseline regressions as showing three key facts. First, as predicted by our model and any standard model, customer price increases in response to the subsidy. Second, this increase, however, is largely due to an increase in options and accessories that raise the cost of the product, which is consistent with a large upgrading effect in terms of our model. Third, consistent with that, we find that dealer profits rise by considerably less than customer price, which further confirms the notion that much of the price increase is due to upgrading.

Before proceeding, we note briefly that the other coefficients in our regressions are consistent with the literature. The coefficient on our demand proxy, $365 - \text{avg DTT}$, is also positive and significant for all three regressions. A reduction in one day to turn (on average for all sales of that model for a given quarter) raises customer price by 0.06% and dealer margin by 0.04%. These results are consistent equations 23 and 24: more popular vehicles sell for a higher price and generate more profits for deal-

Table 7: Rebate Effects on Price, Cost, and Dealer Margin ($1,000 increase)

Make	Mean						Median					
	Price Eff	Price %	Cost Eff	Cost %	Marg Eff	Marg %	Price Eff	Price %	Cost Eff	Cost %	Marg Eff	Marg %
GM (n=179)	$655	1.6%	$471	1.2%	$131	5.8%	$493	1.6%	$343	1.2%	$117	5.8%
Chrys (n=4)	$803	1.6%	$601	1.2%	$95	5.8%	$812	1.6%	$597	1.2%	$107	5.8%
Toyota (n=6,388)	$584	1.6%	$417	1.2%	$147	5.8%	$519	1.6%	$371	1.2%	$133	5.8%
Ford (n=360)	$567	1.6%	$416	1.2%	$105	5.8%	$563	1.6%	$410	1.2%	$95	5.8%
Honda (n=593)	$464	1.6%	$339	1.2%	$66	5.8%	$441	1.6%	$319	1.2%	$70	5.8%
Nissan (n=81)	$525	1.6%	$391	1.2%	$92	5.8%	$533	1.6%	$392	1.2%	$77	5.8%
Total (n=7,605)	$575	1.6%	$412	1.2%	$138	5.8%	$518	1.6%	$371	1.2%	$127	5.8%

Source: Authors' Calculations

ers. Our estimates indicate that lowering days to turn by one day raises vehicle cost by 0.04%. A negative coefficient on the demand proxy is inconsistent with equation 21: in our theoretical model, a higher opportunity cost for the dealer—which should logically accompany greater demand for a particular make and model—should translate to customers selecting fewer upgrades. However, as shown in an appendix (see section A.1), the same may not be true when options come pre-installed. Consumers may be more willing to substitute toward vehicles with more pre-loaded options if highly-accessorized units are relatively more abundant; vehicle cost may therefore rise with a model's excess demand, as suggested by the positive coefficient on our demand proxy, $365 - \text{avg DTT}$, in Table 6, column 2.

Leased vehicles sell for a higher price, tend to cost more, and generate higher margins than those financed at the dealer (the omitted category is financed). Transactions classified as 'Cash'—these are vehicles that are not leased, or financed from the dealer—generate smaller dealer margins than those financed at the dealer. Vehicles sold during the last five days of the month generate lower dealer margins than those sold earlier in the month, and vehicles sold at the end of the year sell for a lower price, cost less, and generate smaller profits than those sold earlier. These results are consistent with those in the literature (see Busse et al. (2013) and references therein).

5.2 Robustness

In Appendix A.3 we present a variety of robustness checks for our main specification. We quickly summarize those results here.

Level Regressions

First, we run our specification with level (rather than logged) dependent variables (see Table A.4). Our estimates are quite similar to the results we obtain when transforming the logged coefficients into levels at average dollar amounts. One notable difference is that we lose precision on the estimate of dealer margin. In the level specification we cannot rule out that dealer margins do not rise at all, but we also cannot rule out the point estimate from the logged specification.

Model-Province-Year Fixed Effects

Next, we replace model-year fixed effects with model-province-year fixed effects (see Table A.5). The main reason to estimate effects within a model-province-year is that manufacturers tend to manage vehicle sales, and manufacturer-to-dealer incentives, regionally; vehicle regions typically include two or more provinces. We find that coefficients on the HEV rebate fall slightly. A thousand dollar increase in the hybrid rebate increases customer price by 1.3%, vehicle cost by 1.1%, and dealer margin by 1%. Like in the level regression, the coefficient on dealer margin becomes statistically insignificantly different from zero. The cost and price effects remain statistically significant and are quite close to their original values.

Cash Rebates

Our third test for robustness uses manufacturer sponsored customer cash rebates instead of sales tax rebates. Table A.3 presents the distribution of customer cash rebates across manufacturers. These rebates can be offered across all types of vehicles; most HEVs did not receive cash rebates during our period of analysis. Cash rebates have a similar theoretical effect on purchases and dealer margins as HEV rebates. There is one important difference: determined by individual manufacturers, cash rebates likely counter low demand for a model. This is in contrast to HEV rebates which are exogenous to the manufacturer, and unrelated to initial model demand. However, as long as equilibrium demand/supply concerns mainly drive cash rebates, including [365-average DTT] should ensure that the regression coefficient on customer cash rebates is unbiased. A similar exercise was conducted by Busse et al. (2006). Our empirical specification is closest to their difference-in-difference estimator.

In Table A.6, we list the results of three regressions where instead of the HEV rebate, we use the Customer Cash Rebate as a regressor. Similar to the regression in Busse et al. (2006), we include model-trim-year fixed effects. We find coefficients fairly similar to our preferred regression. Note that the dependent variable in the regression reported in the first column is log Vehicle Price. We use Vehicle Price rather than Customer Price as the latter is constructed by subtracting the Customer Cash Rebate from Vehicle Price. We also use a different sample than in previous regressions. Cash rebates for HEVs were uncommon during our study period, and so Table A.6 reports coefficients estimated using the full data set of HEV and non-HEV vehicles (for a total of 995,287 transactions). The coefficients for all three regressions are positive and statistically significant. We find that a thousand dollar increase in the customer cash rebate increases vehicle price by 1.55%, vehicle cost by 1.11%, and dealer margin by 3.42%. Our results are consistent with Busse et al. (2006), who find that the transaction price for a vehicle-trim rises by approximately 10-30% of the rebate.

Model-Trim-Year Fixed Effects

In our preferred regression, we aggregate across trims. This allows us to capture the full extent of the upgrading effect via substitution toward higher-value trims. For several HEV models, aggregation across trims is irrelevant, as multiple trims were not available.[15] Even so, in Table A.7 we present results after replacing model-year fixed effects with model-trim-year fixed effects. The results are quite similar to our baseline.

Days to Turn

Our preferred regressions each include national average days to turn as an independent variable. This variable proxies for national demand for each model, but may not capture variations in demand specific to each province or municipality. Because some models have very small sales counts at the provincial level, utilizing provincial or municipality-level averages instead isn't viable. However, if there are localized surges in demand for particular models, then this should be reflected in days to turn for an individual vehicle. Table A.8 reports regressions in which the demand proxy is 365-DTT_i, where DTT_i is the days on the lot for the individual vehicle transacted. We find that using vehicle-specific DTT, instead of national averages, has little effect on the size or significance level of the rebate coefficient in any of the regressions.

One remaining concern is that days to turn variable is itself endogenous, even when measured as a national average. What if a rebate program spurs demand for a particular model, which in turn raises the Dealer's opportunity cost for individual vehicles, raising the transaction price as per equation 23? If this were the case, then the rebate coefficient would underestimate the extent to which rebate programs raise transaction prices and such. Table A.9 reports tests of whether the number of days an individual vehicle spends on the lot is affected by the advertised maximum rebate available in the customer's province in the year when she purchases her vehicle. Results are reported for two specifications: in the first we include model-year fixed effects; in the second we include model-trim-year fixed effects. Both specifications include time-of-sale fixed effects (e.g. transactions occuring at the end of the calendar year), as well as province, year, and retailer fixed effects. As indicated in Table A.9, advertized rebate values do not have statistically significant impacts on days to turn.

6 Conclusions

In this paper, we develop a simple model of negotiation between an auto dealer and prospective customer. The model offers insight into how green subsidies affect purchases of new hybrid electric vehicles, which is the concern of our empirical analysis. The model, however, also makes broader points about the welfare impacts of taxation for goods that have endogenous quality and that feature costly bargaining. In such markets, price effects will understate consumer gains from tax subsidies.

[15]For the best selling HEVs in our data—the Camry Hybrid and the Prius—only one trim was available. Amongst all HEVs with more than 100 sales, only the Highlander Hybrid and the Accord Hybrid offered customers a choice between trims.

Empirically, we validate the importance of upgrading in our analysis of HEV subsidies in Canada. We show that a $1,000 subsidy raises prices by $575, but more than two-thirds of that increase is due to upgrading. Moreover, our model implies that a further benefit is gained by consumers in the form of reduced haggling costs, though we have no direct estimates of this magnitude. Together, this implies that a naïve look at price effects will significantly understate consumer gains from green subsidies. This difference is relevant for policy evaluation, given that a stated goal of many green subsidies is to aid the environment while helping consumers.

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A Appendix

A.1 Lumpy Options

The theoretical model outlined in section 2 treats x as smooth: consumers can upgrade the baseline vehicle in a piecemeal fashion, buying exactly as many options as they would like. In contrast, many established vehicle models are often sold with bundles of pre-installed options; a baseline vehicle together with a particular set of pre-installed options is called a trim.[16] The manufacturer's suggested retail price for a particular trim is inclusive of the pre-installed options and consumers are generally able to negotiate with the dealer over the total price of the vehicle. To address how tax rebates impact prices when options are lumpy, we adapt the model from section 2 as follows. Let M_i denote the MSRP for a vehicle with pre-installed trim features x_i; let C_i measure the dealer's opportunity cost for such a vehicle. To keep things simple, in this section we assume additional add-ons are unavailable.

As mentioned, we assume the consumer is able to negotiate the total price of a vehicle with pre-installed options. As before, her discount, D, is a function of her haggling effort and the gap between MSRP and the dealer's opportunity cost; this gives $D_i = \alpha(h)[M_i - C_i]$. The pre-tax transaction price for trim i can be expressed as a function of trim attributes x_i and haggling effort h:

$$P(x_i, h) = [1 - \alpha(h)]M_i + \alpha(h)C_i. \tag{A.1}$$

Define $h(x_i)$ as the amount of haggling that maximizes utility U and define $V(x_i)$ as the maximized value of utility given x_i. Using (A.1) to substitute in for P when options are lumpy yields

$$\begin{aligned} V(x_i) &\equiv max_h\,[\bar{u} + u(x_i) + v(B + S - \tau P(x_i, h)) - H(h)] \\ &= \bar{u} + u(x_i) + v(B + S - \tau P(x_i, h(x_i)) - H(h(x_i)). \end{aligned} \tag{A.2}$$

Straightforward optimization indicates that $h(x_i)$ solves

$$\tau v'(B + S - \tau P(x_i, h(x_i))\alpha'(h(x_i))[M_i - C_i] = H'(h(x_i)). \tag{A.3}$$

Suppose the consumer can choose between two trims, a mid-range trim we'll name *Gold* and a luxury trim named *Titanium* (denoted G and T), with $x_T > x_G$, $M_T > M_G$, $C_T > C_G$. A consumer will choose Titanium if and only if[17] $V(x_T) > V(x_G)$. As in section 2, we want to know whether increasing r raises the transaction price and/or vehicle cost. When x is lumpy, we must consider two scenarios. In the first, the consumer's trim choice is unaffected by the rise in r. In this scenario, vehicle cost will be unaffected and thus the only force affecting P will be changes in h. Differentiating (A.1) and (A.3) with respect to r gives

$$\frac{dh(x_i)}{dr} = -\frac{\frac{1}{\tau} + \frac{\zeta P}{Y}}{1 + \frac{H''}{H'} + \frac{\zeta\tau}{Y}\alpha'[M_i - C_i]} < 0. \tag{A.4}$$

[16] During the period covered by our data, most HEV models offered as single trims only; only 10% of our transactions concern models that were available in multiple trims. Nevertheless, we offer here an analysis of the scenario in which options are lumpy, since dealers sometimes have extra features installed at the factory.

[17] We assume an indifferent consumer chooses Gold.

Define $P(x_i) = P(x_i, h(x_i))$ and differentiate to get

$$\frac{dP(x_i)}{dr} = -\alpha'(h(x_i))[M_i - C_i]\frac{dh(x_i)}{dr} > 0$$

which is positive given $\frac{dh(x_i)}{dr} < 0$: raising r unambiguously raises the transaction price of a given trim.

Now consider the second scenario; in this scenario raising r causes the consumer to choose a different trim. Recall the consumer chooses Titanium if and only if $V(x_T) > V(x_G)$. This is equivalent to the condition

$$\begin{aligned}&\bar{u} + u(x_T) - [\bar{u} + u(x_G)] \\ &\quad > v(B + S - \tau P(x_G)) \quad - \quad H(h(x_G)) - [v(B + S - \tau P(x_T)) - H(h(x_T))]\,.\end{aligned} \tag{A.5}$$

The left hand term, $\bar{u} + u(x_T) - [\bar{u} + u(x_G)]$, is independent of r. Thus, whether a rise in r makes T more attractive depends only on how the right hand side of (A.5) varies with r. The derivative of the right hand side of (A.5) with respect to r is

$$\begin{aligned}v'(B + S - \tau P(x_G))\, P(x_G) - v'(B + S - \tau P(x_T))\, P(x_T) \\ + \underbrace{\frac{\partial}{\partial h}[v(B + S - \tau P(x_G)) - H(h(x_G))]}_{=0}\frac{dh(x_G)}{dr} \\ - \underbrace{\frac{\partial}{\partial h}[v(B + S - \tau P(x_T)) - H(h(x_T))]}_{=0}\frac{dh(x_T)}{dr}\end{aligned} \tag{A.6}$$

where the third and fourth terms are zero by the first order conditions defining $h(x_G)$ and $h(x_T)$ respectively. It is straightforward to show that $P(x_T) > P(x_G)$; combined with concavity of v, $P(x_T) > P(x_G)$ implies (A.6) is unambiguously positive. Consequently, equation (A.5) is more likely to be satisfied when r is higher. This means raising r will cause consumers who are somewhat indifferent between Titanium and Gold trims to upgrade to the higher value vehicle. Stated differently—and slightly outside the structure of our model—, raising r increases the probability that a consumer chooses the higher value trim.

Together, the comparative statics from these two scenarios reinforce what we found in section 2.1 regarding rebates and transaction prices: increasing the rebate rate raises the transaction price for a given vehicle. As before, this positive correlation arises in part because the consumer haggles less for a given trim when r is higher. In the lumpy-options case, the positive correlation also arises because rebates make it more probable the consumer will upgrade her trim choice. Our analysis in the lumpy-options case also suggests a non-negative relation between tax rebates and vehicle cost: raising r makes upgrading more attractive, which raises vehicle cost whenever consumers do indeed switch to more valuable trims.

Before concluding this section, we ask how a change in the dealer's opportunity cost affects equilibrium values when options come pre-installed. Results are predictable in the first scenario, so we won't analyze it formally; more interesting is the second scenario in which a consumer switches from one trim to another. Differentiating (A.2) with respect to C_i confirms that maximized consumer utility from trim i is decreasing in the dealer's opportunity cost for that trim:

$$\frac{dV(x_i)}{dC_i} = \left[\underbrace{\tau v'(Y)\alpha'(h(x_i))[M_i - C_i] - H'(h(x_i))}_{=0 \text{ by envelope theorem}}\right]\frac{dh(x_i)}{dC_i} - v'(Y)\tau\alpha(h(x_i)) \quad (A.7)$$

$$= -v'(Y)\tau\alpha(h(x_i)) < 0. \quad (A.8)$$

Consequently, if the dealer's opportunity cost for a particular trim rises, then consumers who were previously indifferent between that trim and another will cease to be ambivalent. An interesting possibility follows—a possibility that contradicts one of our earlier results. Suppose, for example, that there is an increase in general demand for the Gold trim, but not for the luxury trim. For a consumer who was initially indifferent between G and T—i.e., for whom $V(x_G) = V(x_T)$—, an increase in C_G causes $V(x_G)$ to fall and so the consumer now prefers the luxury trim with its higher price and more luxurious options. Vehicle cost rises accordingly, which is opposite the prediction from equation (22). Specifically, the analysis of smooth, endogenous options in section 2 suggested that an increase in the dealer's opportunity cost reduces vehicle cost; in contrast, when options are pre-installed, an (asymmetric) increase in dealer's opportunity cost can lead to higher vehicle cost. Although our analysis has been framed in the context of preset trims, similar logic may hold within trims. Within a given trim, some units come pre-installed with particular options that are not easily removed, e.g. a moon roof. A consumer arriving at the dealership looking for a Gold trim, for example, might be induced to purchase the augmented unit if the dealer's opportunity cost for that particular unit is lower than for unaugmented units. This reasoning suggests that it is possible that an asymmetric increase in vehicle demand could lead to an increase in options purchased *even within trims*.

A.2 Additional Summary Tables

In this subsection we include summary tables referenced in the text. In Table A.1 we illustrate the distribution of sales across HEV models in our data. This also illustrates, and mimics the distribution across manufacturers. Some models have very small numbers sold in our sample, consider for example, the Aspen Hybrid, or the Honda Insight. Both these model sold fewer than 10 numbers in our sample.

In Table A.2 we present the thresholds for the British Columbia Luxury Vehicle Surtax. Understanding the threshold is important to correctly calculate the HEV rebate in BC. Some transactions obtain more than the advertized maximum rebate of \$2,000. This is because purchasers did not pay the luxury surtax because of the vehicle was an HEV. HEVs sold in BC were given an additional \$7,000 before the luxury surtax was applied. If the luxury surtax applied at prices greater than \$49,000 for regular vehicles, it applied only after \$56,000 for HEVs. The tax rate (including the surtax) was determined by the transactions price of the vehicle purchased. As with PST, the tax was paid on the difference of the vehicle bought minus the trade-in. We add the tax saved from this exemption to the HEV rebate, as it effectively functions like a point of

Table A.1: Distribution of Sales Across Models

Model Name	No.	Column %
Camry Hybrid	3,458	35.8
Prius	2,784	28.8
Highlander Hybrid	826	8.5
RX 400H	765	7.9
Civic Hybrid	684	7.1
Escape Hybrid	499	5.2
Accord Hybrid	166	1.7
Altima Hybrid	102	1.1
Malibu Hybrid	83	0.9
VUE Hybrid	77	0.8
GS 450H	74	0.8
Tahoe Hybrid	44	0.5
Yukon Hybrid	42	0.4
LS 600H L	16	0.2
Silverado 1500 Hybrid	10	0.1
Aspen Hybrid	9	0.1
Aura Hybrid	9	0.1
Escalade Hybrid	9	0.1
Insight	4	0.0
Total	9,661	100.0

Source: Authors' Calculations

sale rebate. The luxury tax threshold was altered two times during the period of our analysis, and we adjust the rebates accordingly.

In Table A.3 we present the distribution of customer cash rebates offered across aggregated manufacturer groups.[18] These rebates range from a minimum of $65 to a maximum of $11,325. The highest average rebate is offered by Chrysler, followed by Korean manufacturers (Hyundai and Kia). The lowest average rebate is offered by Toyota followed by Volkswagen. As expected, Toyota also had the lowest days on lot

[18] We aggregate make to create an aggregate manufacturer category. **General Motors (GM)**: Buick, Cadillac, Chevrolet, GMC, Hummer, Oldsmobile, Pontiac, Saturn. **Chrysler**: Chrysler, Dodge, Jeep. **Toyota**: Lexus, Scion, Toyota. **Ford**: Ford, Lincoln, Mercury. **Honda**: Acura, Honda. **Nissan**: Infiniti, Nissan. **Volkswagen (VW)**: Audi, Volkswagen. **Korea**: Hyundai, Kia. **Bavarian Motor Works (BMW)**: BMW. **Mazda**: Mazda. **Japan**: Mitsubishi, Subaru, Suzuki. **Europe**: Mercedes-Benz, Mini, Porsche, Saab, Volvo.

Table A.2: Luxury Vehicle Surtax Thresholds in British Columbia

Relevant Date	**8% Threshold**	**9% Threshold**	**10% Threshold**
Before Feb 15, 2005	$47,000	$48,000	$49,000
After Feb 15, 2005	$49,000	$50,000	$51,000
After Feb 22, 2006	$55,000	$56,000	$57,000
After July 1, 2010	No Luxury Tax		

Table A.3: Customer Cash Rebates Across Manufacturers – including non-HEVs

Manufacturer	Mean		Min	Max
	Cust Cash	Days on Lot	Cust Cash	Cust Cash
GM (n=51,330)	$1,445	58	$65	$11,325
Chrysler (n=23,194)	$2,367	71	$241	$11,250
Toyota (n=11,071)	$925	38	$215	$8,375
Ford (n=13,435)	$1,231	55	$195	$11,000
Honda (n=1,081)	$1,724	41	$202	$8,000
Nissan (n=5,048)	$1,452	43	$200	$11,000
VW (n=895)	$1,017	56	$250	$9,000
Korea (n=8,222)	$2,606	52	$250	$9,000
Mazda (n=4,910)	$1,405	43	$250	$11,000
Japan (n=1,810)	$1,642	67	$250	$8,000
Europe (n=206)	$2,000	41	$400	$8,500
Total (n=121,202)	$1,631	57	$65	$11,325

Source: Authors Calculations

for their vehicle, in other words, their cars sold quicker than other brands reducing their need to provide cash rebates. Similarly, Chrysler vehicles stayed on dealer lots for the longest time.

A.3 Robustness Regressions

In this section we present regression tables as referred to in the robustness subsection from Section 5. In Table A.4 we repeat our preferred specification without logging the dependent variable. In Table A.5 we repeat our preferred specification with model-province-year fixed effects. In Table A.6 we repeat our preferred specification with customer cash rebates in place of HEV rebates. Table A.7 reports results when we replace model-year fixed effects with model-trim-year fixed effects. In Table A.8 we repeat our preferred specification with a vehicle specific days to turn variable (instead of the national average). Finally, in Table A.9 we present a regression estimating the impact of provincial advertized rebates on the Days to Turn for Hybrid Vehicles.

Table A.4: Regressions for Customer Price, Vehicle Cost, and Dealer Margin—Levels(no logged dependent variables)

	(1) Ln(Cust_Price)	(2) Ln(Veh_Cost)	(3) Ln(Dlr_Marg)
HEV Rebate ($ 1000)	569.7050[a]	458.9213[a]	53.1020
	(183.740)	(167.746)	(62.251)
365-Avg DTT	20.7724[a]	12.4062[a]	7.3369[a]
	(4.208)	(3.821)	(1.418)
Cash Purchase Indicator	-2.3e+02[c]	-62.5563	-44.4963[c]
	(133.080)	(95.940)	(23.144)
Leased Indicator	198.6185	215.8580[b]	77.0031[b]
	(125.802)	(99.819)	(35.924)
Sat or Sun FE	-57.2321	-18.4644	-38.7905[c]
	(82.827)	(95.790)	(22.362)
Last 5 days of month FE	25.6218	63.1865	-35.8705
	(46.551)	(51.878)	(23.641)
Last 5 days of Yr FE	-1.0e+03[a]	-5.9e+02[b]	-4.6e+02[a]
	(260.040)	(236.398)	(118.507)
Observations	9661	8916	8916
r2	0.9364	0.9455	0.5606

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. All regressions include model-province-year, year-month, and retailer fixed effects. Standard errors in parenthesis, are clustered by model-year.

Table A.5: Regressions for Customer Price, Vehicle Cost, and Dealer Margin—Within Province

	(1) Ln(Cust_Price)	(2) Ln(Veh_Cost)	(3) Ln(Dlr_Marg)
HEV Rebate ($ 1000)	0.0132[a]	0.0114[a]	0.0101
	(0.003)	(0.003)	(0.025)
365-Avg DTT	0.0005[a]	0.0003[a]	0.0038[a]
	(0.000)	(0.000)	(0.001)
Cash Purchase Indicator	-0.0038	0.0004	-0.0360[a]
	(0.003)	(0.002)	(0.012)
Leased Indicator	0.0074[b]	0.0081[a]	0.0389[b]
	(0.003)	(0.003)	(0.016)
Sat or Sun FE	-0.0009	-0.0003	0.0042
	(0.002)	(0.002)	(0.015)
Last 5 days of month FE	0.0008	0.0020	-0.0240[c]
	(0.001)	(0.002)	(0.013)
Last 5 days of Yr FE	-0.0298[a]	-0.0196[a]	-0.2834[a]
	(0.007)	(0.007)	(0.093)
Observations	9661	8916	8732
r2	0.9226	0.9337	0.4623

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. All regressions include model-province-year, year-month, and retailer fixed effects. Standard errors in parenthesis, are clustered by model-year.

Table A.6: Regressions for Vehicle Price, Vehicle Cost, and Dealer Margin—Customer Cash Rebate

	(1) Ln(Cust_Price)	(2) Ln(Veh_Cost)	(3) Ln(Dlr_Marg)
Customer Cash Rebate ($ 1000)	0.0155[a]	0.0114[a]	0.0342[a]
	(0.001)	(0.001)	(0.005)
365-Avg DTT	0.0002[a]	0.0002[a]	0.0017[a]
	(0.000)	(0.000)	(0.000)
Cash Purchase Indicator	-0.0316[a]	-0.0205[a]	-0.1516[a]
	(0.002)	(0.002)	(0.007)
Leased Indicator	0.0052[a]	0.0036[a]	0.0366[a]
	(0.001)	(0.001)	(0.004)
Sat or Sun FE	0.0004	-0.0003	0.0128[a]
	(0.000)	(0.000)	(0.003)
Last 5 days of month FE	-0.0030[a]	-0.0014[a]	-0.0217[a]
	(0.000)	(0.000)	(0.002)
Last 5 days of Yr FE	-0.0059[a]	-0.0019[c]	-0.0404[a]
	(0.001)	(0.001)	(0.009)
Observations	995287	804099	746863
r2	0.9436	0.9511	0.2868

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. All regressions include model-year, year-month, and retailer fixed effects. Standard errors in parenthesis, are clustered by model-year.

Table A.7: Regressions for Customer Price, Vehicle Cost, and Dealer Margin—Within Trims

	(1) Ln(Cust_Price)	(2) Ln(Veh_Cost)	(3) Ln(Dlr_Marg)
HEV Rebate ($ 1000)	0.0121[a]	0.0079[a]	0.0544[b]
	(0.003)	(0.002)	(0.023)
365-Avg DTT	0.0006[a]	0.0004[a]	0.0041[a]
	(0.000)	(0.000)	(0.001)
Cash Purchase Indicator	-0.0034	0.0009	-0.0345[a]
	(0.003)	(0.002)	(0.012)
Leased Indicator	0.0073[b]	0.0083[a]	0.0404[b]
	(0.003)	(0.003)	(0.016)
Sat or Sun FE	-0.0002	0.0003	0.0091
	(0.002)	(0.002)	(0.016)
Last 5 days of month FE	-0.0001	0.0011	-0.0239[c]
	(0.001)	(0.002)	(0.013)
Last 5 days of Yr FE	-0.0258[a]	-0.0158[b]	-0.2740[a]
	(0.007)	(0.007)	(0.086)
Observations	9661	8916	8732
r2	0.9277	0.9393	0.4418

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. All regressions include model-trim-year, year-month, and retailer fixed effects. Standard errors in parenthesis, are clustered by model-year.

Table A.8: Regressions for Customer Price, Vehicle Cost, and Dealer Margin—Vehicle Specific Days to Turn

	(1) Ln(Cust_Price)	(2) Ln(Veh_Cost)	(3) Ln(Dlr_Marg)
HEV Rebate ($ 1000)	0.0150[a]	0.0117[a]	0.0522[b]
	(0.004)	(0.004)	(0.024)
365-days_to_turn	0.0001[a]	0.0000	0.0013[a]
	(0.000)	(0.000)	(0.000)
Cash Purchase Indicator	-0.0037	0.0007	-0.0331[b]
	(0.003)	(0.002)	(0.013)
Leased Indicator	0.0082[b]	0.0089[a]	0.0455[a]
	(0.003)	(0.003)	(0.016)
Sat or Sun FE	-0.0005	0.0003	0.0112
	(0.002)	(0.002)	(0.016)
Last 5 days of month FE	0.0004	0.0014	-0.0261[b]
	(0.001)	(0.002)	(0.013)
Last 5 days of Yr FE	-0.0255[a]	-0.0165[b]	-0.2697[a]
	(0.007)	(0.007)	(0.086)
Observations	9661	8916	8732
r2	0.9193	0.9315	0.4379

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. All regressions include model-year, year-month, and retailer fixed effects. Standard errors in parenthesis, are clustered by model-year.

Table A.9: Regressions for Vehicle Specific Days to Turn

	(1) Days_to_Turn)	(2) Days_to_Turn
Advertized Rebate ($ 1000)	4.4608	6.6100
	(4.352)	(5.181)
Sat or Sun FE	1.5952	1.8460
	(1.263)	(1.259)
Last 5 days of month FE	-1.0589	-1.2658
	(1.283)	(1.374)
Last 5 days of Yr FE	24.9483[a]	23.9339[a]
	(6.525)	(6.001)
Observations	9825	9825
r2	0.2390	0.2890

[c] $p < 0.1$, [b] $p < 0.05$, [a] $p < 0.01$. Both specifications regress vehicle specific days to turn on the regressors listed, province, and year fixed effects. Standard errors (in parenthesis) are clustered by model-year. The first specification also includes model-year fixed effects. The second specification also includes model-trim-year and retailer fixed effects.