

# Adverse Selection and Moral Hazard in the Leasing Market: Are Buy-Backs the Solution?<sup>1</sup>

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## **Abstract**

We study the problem faced by a car-leasing firm in the presence of both adverse selection and moral hazard. While the literature has primarily focused on the role of leasing in avoiding adverse selection and the role of an above market buyback price in this environment, we show how this result reverses when moral hazard concerns are severe. The key driver of this result is that a low buy back price can incentivize non-contractible investment. We test the model using a difference-in-differences technique to compare accident outcomes of individuals driving leased company vehicles in Israel before and after a tax change and differentiate between drivers by their probability of utilizing the buyback clause. Our analysis shows that once exiting the leasing cycle becomes a relevant option due to a 110 percent increase in the tax rate on company cars it decreases the at-fault accident rate by half an accident per year (s.e. 0.25) for relevant drivers.

# 1 Introduction

In 2015 (CAN THIS BE UPDATED?), roughly 1 out of every 3 new cars in the US was leased, with even higher rates in Europe and Israel.<sup>1</sup> As the lessee's actions might impact the value of the car at the termination of the lease, these cars are subject to a significant agency problem. In the US, the strict maintenance requirements inherent to leasing contracts solve this problem, and, in fact, off-lease second hand cars are considered superior to privately owned ones.(CITE) However, in Israel (AND PERHAPS IN OTHER MARKETS) standard leasing contracts are more lenient and do not mandate the lessee to maintain his car (SUPPORT THIS).<sup>2</sup> Nevertheless, Israeli leasing contracts do contain a clause which should incentivize the lessee to invest in his car, namely, an option to buy-back the car at a discount (SUPPORT THIS) at the end of the lease period. This strong incentive to consider buying back the car blurs the distinction between lessee and owner, and by so doing incentivizes the lessee to invest in his car's upkeep.

The value of incorporating buyback clauses in leasing contracts has been well established by a large literature that has on shown how doing so can alleviate a different information problem that is prevalent in leasing contracts, namely, adverse selection.<sup>3</sup> In particular, as the lessee has better information about the car's quality, a leasing firm can increase its profit from selling off-lease cars by offering the lessee to buyback his car at a premium over the market price; an option that is picked up by lessees who happen to own a high quality car. This theoretical prediction matches the US data documented by

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<sup>1</sup>See the Edmunds Lease Market Report (January 2017), the Israeli Tax Authority Car Report (2015), and BBC news report on UK car purchasing trends (Pollack 2015).

<sup>2</sup>Even in the US market, Dunham (2003), Baker & Hubbard (2004) and Schneider (2010) have shown that lessees invest less in both vehicle upkeep and general driving care than owners.

<sup>3</sup>See work by Desai and Perohit (1998), Hendel and Lizzeri (2002), Johnson and Waldman (2003), Waldman (2003) and Johnson and Waldman (2010).

(SUPPORT THIS).

The Israeli case where buyback prices are set below market price does not fit into the standard leasing story documented in the literature; a buyback discount not only decreases the leasing firm's profits from selling cars to lessee's, but may also create a lemons problem by removing high-quality cars from the off-lease market. However, a buyback discount is reasonable if moral hazard, and not adverse selection, is the leasing firm's key concern. Intuitively, a buyback discount increases the probability that the lessee's exercises the buyback option, and by so doing, increases his investment and mitigates moral hazard concerns.<sup>4</sup>

To show that an increased likelihood of ownership promotes investment in car maintenance we propose a simple model of leasing with two key features. First, the lessee's actions during the lease period endogenously determine the car's quality. Second, at the end of lease period the lessee receives a preference shock that impacts his value from buying his leased car (e.g., a strong preferences to remain in the leasing cycle, a need for a second car in the family, etc...). Clearly, the lessee's investment in car quality is determined by the distribution of this shock, and the size of the buyback discount. Unsurprisingly, investment turns out to be increasing in the ex-ante probability the lessee will consider buying back the car and the size of the buyback discount.<sup>5</sup>

Empirically, we examine the hypothesis that a change in the ex-ante prob-

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<sup>4</sup>Admittedly, a buyback price that seems to be below market price may, in fact, only reflect the leasing firms' savings in transaction costs from not having to proactively sell a used car. However, as this discount is worth on average XXX\$ to the lessor, and it is unlikely the lessee receives the majority of these savings, this explanation does not seem plausible.(EVIDENCE OF COST FROM SELLING CAR)

<sup>5</sup>Johnson, Schneider, and Waldman (2014) find evidence that cars that are purchased at contract termination by the lesser are better maintained than lease cars that are not bought back.

ability of purchase of a leased vehicle increases vehicle care. Our database consists of the car fleet of an Israeli hi-tech company (2005-2012) where not only were lessees unaffected by the price depreciation of their car, but fuel and maintenance costs were covered by their company.<sup>6</sup> We take advantage of a natural experiment where government legislation in 2007 resulted in an increase in leasing costs from a taxation level averaging 1,330 NIS per month in 2007 to 2,790 NIS per month in 2011.<sup>7</sup> This increase in costs created an exogenous incentive for individuals to consider leaving the leasing cycle.

Our paper uses a difference in differences technique to measure how this change in probability of purchase affected driving behavior. The company allowed workers to internally transfer contracts which provides an opportunity to compare driving behavior between first and second-hand lessees. Our analysis is based on the assumption that first-hand lessees are more likely than second-hand lessees to "buy-back" their car since they have better information on vehicle upkeep having been the only drivers to use the car.<sup>8</sup>

The panel structure of our data allows us to run analysis that controls for individual driver fixed effects along with commute distance and car fixed effects. Across all cars, we estimate that once the purchasing clause becomes a viable option it decreases the at-fault accident rate by 0.2 (s.e. 0.1) at-fault accidents per year which is not statistically significant from zero (the average at-fault accident rate is 0.3). When we constrain our sample to lessees driving car makes with an above average buyback rate, our estimate increases in size

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<sup>6</sup>Driving behavior is a prime example of non-contractible investment as leasing firms in Israel self-insure their vehicles and hesitate to include contractual repercussions for accidents (or benefits for safe driving). This is likely due to a high level of cross firm competition as well as a concern that it could lead to a decrease in accident reporting.

<sup>7</sup>See Table (1) for the year by year change in taxation that occurred across car groups and was announced in late 2007.

<sup>8</sup>Indeed we show in Figure (??) that after the change in taxation of leased vehicles, second-hand lessees increased their "buy back" rate to roughly 3 percent, while the "buy back" rate increased to above 8 percent for first-hand lessees. We only have data on 1 year (2005) where cars were returned prior to the change in taxation. In this year the buy-back rate was zero for second-hand lessees and 1 percent for first-hand lessees.

to 0.5 (s.e. 0.25).<sup>9</sup> This finding supports the results of our theoretical model and suggests that an optimally set buyback price may play an important role in promoting investment in situations where monitoring is costly.

Having established empirically that the probability the lessee considers purchase the car impacts driving behavior, we show that allowing the lessee to buyback his car at a discount can be optimal due to complementarities in the lessee's investment choice. In particular, as the lessee's incentive to invest is determined by the product of the probability of purchasing and the net gain from doing so, an option to buyback the car at a discount amplifies the lessee's incentive to invest in the car due to his partial sense of ownership.

Formally, we show that when the average probability of buyback (and, to a lesser extent, the second moment thereof) in the population is low, setting the buyback price below the market price (as is the case in Israel) is the optimal strategy. Intuitively, in this case the lessee's sense of ownership over the car is weak and the adverse selection problem faced by the leasing firm is mild. Thus, the leasing firm can, and does, offer the lessee a strong incentive to invest (in the form of a discount) at a relatively low cost. This result also provides a possible explanation for the different buyback pricing strategy used in Israel versus the US. In particular, if Israelis are more likely to remain indefinitely in the leasing cycle than Americans (DATA), our model predicts a discounted buyback price in Israel in contrast to the buyback premium offered in the US.

This paper proceeds as follows. In the next section we provide a review of the literature analyzing the leased car market. Section 3 presents a simple theoretical model of leasing with both moral hazard and adverse selection. In Section 4 we introduce the data on contracts and behavior in the Israeli

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<sup>9</sup>If lessees are only willing to consider purchasing certain car makes, presumably those that are considered more reliable with higher resale values, then focusing on this group will increase the precision of our results.

leasing industry that is available to us for this study and its relevance for the theoretical model in Section 3. Section 5 presents estimates for the effect of the buyback clause in leasing contracts on driving behavior. In Section 3 we conclude the theoretical analysis by solving for the optimal lease contract, and deriving conditions under which the buyback price is set below the market price. Section 6 concludes.

## 2 A Model

We study the problem faced by a supplier of leased cars when the lessee's actions endogenously determine the car's quality at the end of the lease.

Formally, the quality of leased car at the end of the leasing period may be either high or low. We normalize these two values to 1 and 0, respectively.<sup>10</sup> The car's quality is determined (stochastically) by the lessee's actions during the lease period. Specifically, we assume that if the lessee exerts an effort of  $e \in [0, 1]$  the car's quality is high with probability  $\sqrt{e}$ . This cost represents the lessee disutility from driving carefully, reducing mileage, etc. Importantly, we assume that this effort choice is unobservable, and hence, non-contractible. However, the firm can influence the lessee's investment by a buyback clause that enables the lessee to buy back the car at a price of  $p^l$  at the end of the leasing period. If the lessee does not exercise this option, the firm must sell the car in a competitive used-car market.

To capture idiosyncratic preferences for ownership versus leasing we assume that at the *end* of the lease period, each lessee learns whether his benefit from leasing has decreased to the point where exiting the leasing cycle may be

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<sup>10</sup>Note, that under this normalization a type zero car has positive value for a driver. Moreover, under this normalization a negative buyback price is reasonable, as the normalization price is negative when the lessee makes a profit from buying-back a car of the lowest possible quality.

profitable.<sup>11</sup> That is, the shock determines if the lessee will *consider* buying back his car, or acquire a new leased car irrespectively of the buyback price and the car’s quality.<sup>12</sup> To match our empirical data, we assume that the population is separated into two groups that differ in the ex-ante probability that they will consider buying back their car. The fraction of the population belonging to group  $i$  and the probability that type  $i$  individuals consider buying back their car are denoted, respectively, by  $\theta_i$  and  $\alpha_i$ . We assume that the firm’s cost of providing a car is sufficiently low to make some buyback prices profitable (exact conditions are given below) and that the firm must offer the same contract to both groups. Finally, we assume that the lessee cannot ”buy-back” his car and resell it privately on the used car market.<sup>13</sup>

## 2.1 Lessee’s Investment

Consider the lessee’s investment choice for a given buyback price. First, consider the more interesting case of  $p^l \in (0, 1)$  where the lessee exercises the buyback option only if he considers buying back his car and the car is of high quality. In this case, a type  $i$  lessee’s investment choice maximizes

$$\max_e \alpha_i \sqrt{e}(1 - p^l) - e.$$

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<sup>11</sup>This assumption is in line with our data in which the vast majority (more than 95%) of lessors continue to lease. Moreover, this shock can be seen as a reduced form for a model in which the value of buyback is the sum of the car’s quality and a shock measuring the cost of ownership; where the cost of ownership is either zero or a very high.

<sup>12</sup>To simplify our analysis we make strong simplifying assumption that are not necessary for establishing our main results. In particular, under the appropriate assumptions we can show our qualitative results remain true if: 1) There is a competitive market for providing leased cars, 2) There is a richer distribution of car quality and a more general connection between investment and car quality, 3) A richer distribution of preference shocks.

<sup>13</sup>Our qualitative predictions remain unchanged as long as the lessee must pay transaction cost in order to ”bay-back” and then resell his car on the open market. In particular, the transaction costs bound form above the buy-back discount that can be provided.



The solution to this problem is given by

$$e_i(p^l) = \frac{(\alpha_i(1-p^l))^2}{4}. \quad (1)$$

Next, consider the cases where<sup>14</sup>  $p^l \notin (0, 1)$ . By setting  $p^l \leq 0$  any lessee who considers buying back his car will do so irrespectively of its quality. In which case, the investment choice maximizes

$$\max_{e_i} \alpha_i(\sqrt{e_i} - p^l) - e_i$$

and the optimal investment is given by

$$\tilde{e}_i = \frac{\alpha_i^2}{4}. \quad (2)$$

Setting  $p^l \geq 1$  implies it is never optimal to exercise the buy back option, end thus induces no investment. Which, in turn, implies the the leasing firm makes no profit from selling off-lease cars. Thus, such buyback prices are never optimal and are ignored henceforth.

To summarize, the optimal level of investment is given by

$$e_i(p^l) = \begin{cases} \frac{(\alpha_i(1-p^l))^2}{4} & \text{if } 0 < p^l < 1 \\ \frac{\alpha_i^2}{4} & \text{if } p^l \leq 0 \end{cases}. \quad (3)$$

The main testable implications of this model stems from equation (3) that determines the optimal investment level. Namely, that the level of effort is increasing in the ex-ante probability of considering the buyback, and decreasing in the buyback price.

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<sup>14</sup>Recall, that given our normalization of values, if it is optimal for the lessee with a car of the lowest quality to exercise the buyback option then the normalized buyback price is negative. Thus, this case must be considered.

In the following section we test if this prediction holds in our data. After doing so, in Section 3 we solve for the optimal buyback price, and use this to provide a possible explanation for why buyback prices in Israel are often below the market price; in contrast to the the buyback premium documented in the USA. **ADD DATA, CITATIONS**

### 3 Optimal Contracts

Having established that the probability of considering purchase does, indeed, increase the lessee's investment, we now solve for the optimal buyback price.

Following the literature on the leased car market (e.g. Hendel and Lizzeri (2002) and Johnson and Waldman (2003,2010)) we assume that the value of the car is privately observed by its lessee and that the market for off-lease cars is distinct from that of other used cars. Thus, it follows that the market price of the car, which we denote by  $p^m$ , is equal to the expected value of leased cars that are not bought back.

As before, consider first the case where  $p^l \in (0, 1)$ . From Equation (1) and Bayes Law, it is straightforward to calculate the market price of used cars

$$p^m(p^l) = \frac{\theta_1 \sqrt{e_1(p^l)}(1 - \alpha_1) + \theta_2 \sqrt{e_2(p^l)}(1 - \alpha_2)}{1 - \theta_1 \sqrt{e_1(p^l)}\alpha_1 - \theta_2 \sqrt{e_2(p^l)}\alpha_2} \quad (4)$$

The firm's revenue from selling off-lease cars is thus

$$(\theta_1 \sqrt{e_1(p^l)}\alpha_1 + (1 - \theta_1) \sqrt{e_2(p^l)}\alpha_2)p^l + (1 - ((\theta_1 \sqrt{e_1(p^l)}\alpha_1 + (1 - \theta_1) \sqrt{e_2(p^l)}\alpha_2)))p^m(p^l) \quad (5)$$

Plugging Equations (1) and (4) into Equation (5) yields that the firm's objective is

$$\max_{p^l > 0} \frac{1 - p^l}{2} (\mathbb{E}(\alpha^2)p^l + \mathbb{E}(\alpha) - \mathbb{E}(\alpha^2)), \quad (6)$$

where expectations are taken with regard to the distribution of a variable in

the population. The solution to this problem is

$$p^l = 1 - \frac{\mathbb{E}(\alpha)}{2\mathbb{E}(\alpha^2)}$$

which is consistent with the case we are currently analyzing if  $\mathbb{E}(\alpha) < 2\mathbb{E}(\alpha^2)$ . This choice leads to a market price of

$$p^m = \mathbb{E}(\alpha) \frac{\mathbb{E}(\alpha) - \mathbb{E}(\alpha^2)}{4\mathbb{E}(\alpha^2) - \mathbb{E}(\alpha^2)\mathbb{E}(\alpha)}$$

Note, that this implies that the firm's profit is  $\frac{(\mathbb{E}(\alpha))^2}{8\mathbb{E}(\alpha^2)}$ , thus if production costs are low enough the firm can profit from operating in this market.

To complete the analysis we must also consider the less interesting cases where  $p^l \leq 0$ . In this case any lessee who considers buying back his car will do so irrespectively of its quality.<sup>15</sup> The firm's problem is then

$$\max_{p^l \leq 0} \mathbb{E}(\alpha)p^l + (1 - E(\alpha))\mathbb{E}(\tilde{q}), \quad (7)$$

which is solved by setting  $p^l = 0$ , irrespectively of the optimal investment decision.

From equation (2) we can calculate the expected quality of cars, which, in turn, implies that in this case the buyback price is always below the market price of  $\frac{\mathbb{E}(\alpha)}{2}$  and that the firm's profit is  $\frac{(1-\mathbb{E}(\alpha))\mathbb{E}(\alpha)}{2}$ .

The preceding analysis yields two important result. First, it shows that in this environment the moral hazard problem can be mitigated, but not

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<sup>15</sup>We assume that a lessor exercises the buyback option when he is indifferent to doing so. Otherwise, due to the positive externality of investment an optimal buyback price may not exist.

solved. The socially efficient investment maximizes

$$\max_e \sqrt{e} - e,$$

and, is thus, equal to  $\frac{1}{4}$ , which is greater than the level of investment that is induced under any set of parameters.

Second, it shows that when the ex-ante inclination to buy back cars is sufficiency low, then the buyback price is set below the market price. Formally,

**Proposition 1.** *The optimal buyback price is below the market price of used cars if and only if either:*

1.  $\mathbb{E}(\alpha) \leq \frac{3}{4}$  and  $\mathbb{E}(\alpha^2) > \frac{\mathbb{E}(\alpha)}{4(1-\mathbb{E}(\alpha))}$
2.  $\mathbb{E}(\alpha) \leq \frac{4}{7}$  and  $\mathbb{E}(\alpha^2) < \frac{4\mathbb{E}(\alpha) + (\mathbb{E}(\alpha))^2}{8}$

*Proof.* When it is optimal to set  $p^l = 0$  the result is immediate. It is optimal to set a positive price when

$$\mathbb{E}(\alpha) < 2\mathbb{E}(\alpha^2) \text{ and } \frac{(\mathbb{E}(\alpha))^2}{8\mathbb{E}(\alpha^2)} > \frac{(1 - \mathbb{E}(\alpha))\mathbb{E}(\alpha)}{2}$$

The support of  $\alpha$  is  $[0, 1]$  therefore  $0 < (\mathbb{E}(\alpha))^2 < \mathbb{E}(\alpha^2) < \mathbb{E}(\alpha) < 1$ . This identity enables us to rewrite the previous condition as

1.  $\mathbb{E}(\alpha) \in [\frac{1}{2}, \frac{3}{4}]$  and  $4(1 - \mathbb{E}(\alpha))\mathbb{E}(\alpha^2) < \mathbb{E}(\alpha)$
2.  $\mathbb{E}(\alpha) \in [\frac{3}{4}, 1]$

When the optimal buyback price is positive it is less than the market price if

$$\mathbb{E}(\alpha) \in [0, \frac{4}{7}] \text{ and } \mathbb{E}(\alpha^2) < \frac{4\mathbb{E}(\alpha) + (\mathbb{E}(\alpha))^2}{8}$$

The proposition follows from rearranging the above conditions and eliminating redundancies.  $\square$

The intuitive explanation for this proposition is the result of the trade-off between two forces. In his investment choice the lessee ignores the effect his decision has on the firm's profit in the second hand market which leads to under-investment. To internalize this effect, the firm must increase the lessee's expected utility when buyback is a relevant option which it can do by setting a low buyback price. However, setting a low buyback price exposes the firm to an adverse selection problem which decrease its profits. The key to the resolution of this trade-off is the probability of the buyback option being relevant (the expectation of  $\alpha$ ). When this probability is low the correlation between the lessee's buyback decision and the car's quality is low, and, thus, the adverse selection problem is mild. Furthermore, when utilizing the buyback is unlikely, the firm may have to set the buyback price below market price in order to provide sufficient incentives for investment. Therefore, when the distribution of  $\alpha$  is concentrated at low values, setting the buyback price below the market price is optimal.

The simple intuition behind this result suggests that it remains valid in richer models. In particular, in our model the lessee's buyback strategy is not altered by a small change in the buyback price (apart for the special case where  $p^l \cong 0$ ). In richer models where car quality and/or preferences for leasing are continuous, small changes in  $p^l$  will alter the buyback strategy. However, if this change has a small effect on the buyback strategy, the same mechanism can still justify setting the buyback price below market price. In other words, if the preference for continued leasing remains strong (keeping the adverse selection problem low) then a below market buyback price will still be optimal.

The qualitative nature of this result is also consistent with empirical data regarding the use of buyback options. In particular, in Israel less than 5% of

drives use this option while in the US 20 – 25% of drivers use this option.<sup>16</sup> These findings suggest that in the US more drivers consider quitting the leasing cycle than in Israel. Which, in combination with Proposition 1 can rationalize why in the US buyback prices are above the market price where while in Israel they are below it.

## 4 Applying Our Model to Leasing Data

In this section we test the results of the model in a real-life setting. We observe data on driving behavior of lessees with contracts that grant them the option to purchase their car at a 15 percent discount when their lease terminates. We follow the accident records of these drivers both before and after a large legislative increase in leasing costs. While, prior to legislation, lessee's were likely to remain in the leasing cycle indefinitely, the sharp increase in leasing costs created an incentive to exit leasing. Our model suggests that the increase in leasing costs (an incentive to exit leasing) combined with the 15 percent discount on the car's value (an incentive to purchase their leased vehicle) should result in increased investment in the leased car. This investment could manifest with more careful driving, parking in safer areas, and/or limiting the mileage of the vehicle.

We analyze the data using a difference-in-differences strategy where one group of drivers (first-hand lessees) were likely to consider purchasing their leased vehicle at contract termination during the post period. The control group (second-hand lessees) remained unlikely to consider purchasing the leased vehicle in all periods, as they continued to suffer from a "lemons" concern where they lacked information on driver upkeep during the period

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<sup>16</sup>Johnson and Waldman (2003) received the US buyback estimate from Mr. Art Spinella of CNW Marketing Research. We thank the leasing consultant Mr. Avi Horwitz, former manager of Israel's first leasing firm (New Kopel) for providing the estimate of the Israeli buy-back rate.

when another driver had access to the vehicle.<sup>17</sup> Thus, we focus on whether or not the purchase discount on leased vehicles resulted in a relative decrease in car accidents for first-hand lessees after the change in legislation.

The widespread usage of vehicle fleets began in Israel in 1995 after tax valuation changes in the fair value of company vehicles. Thus, it became significantly cheaper for individuals to use company cars instead of private cars. The demand for company cars continued to increase over the years until 2007, when sixty percent of new cars in Israel were purchased by vehicle fleets.<sup>18</sup> In August 2007, the tax authority announced a gradual increase in the fair value of company vehicles beginning in January 2008 and ending in January 2011. Thus, over a period of four years the fair value of company cars doubled from a monthly cost averaging 1,330 NIS to a monthly cost averaging 2,790 NIS (see Table 1). During this same period the number of fleet cars decreased from 13.4 percent to 12.2 percent of total cars in Israel, although fleet cars still represent roughly 50 percent of new cars (age 0-3) on the roads.

This increase in leasing costs should create an incentive for individuals to consider purchasing their leased vehicle at the discounted price whereas prior to 2007 a vast majority of individuals would choose to remain in the leasing cycle. Indeed, a survey conducted by Albert et. al. (2014) found that these drivers were sensitive to the fair value tax charged for the use of company vehicles. Specifically, 9 percent of their sample planned to exit the leasing cycle by 2011 and an additional 20 percent stated that they would no longer lease if costs increased by an additional 1,000 NIS.

We received data from a hi-tech company in Israel regarding their car fleet between 2005 and 2012. This company offered its employees a standard leasing contract for 32 months. The car was intended for both work and

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<sup>17</sup>This assumption is consistent with purchase rates for these two groups, as shown in Figure (??).

<sup>18</sup>A Summary of Taxation in The Automobile Industry for 2011 (The Israeli Tax Authority, 2012).

private use and could be used by members of the employee's family as well as other employees of the same company. The car fringe benefit included fuel, insurance, and maintenance. Drivers were expected to pay a \$100 penalty for being involved in a car accident. At the termination of the lease period, the contract granted the employee the opportunity to "buy-back" the vehicle they leased at a 15% discount off the blue book value.

An important consideration for our paper is the extent to which first-hand lessees are similar to second-hand lessees. Assuming they are, what causes an individual in the company to lease a second-hand vehicle at the same price as a first-hand vehicle? The key determinant is likely to be the extent to which the driver plans to stay within the leasing framework for the full contract length (32 months). Choosing a second-hand lease shortens the length of time until contract termination (as the 32 months began with the first lessee) and thus, decreases the probability of facing a financial penalty for early contract termination. Avoiding the full 32 month contract will be more attractive when the monthly cost of leasing is expected to increase or drivers are unsure of how long they plan to stay in the company. Since these vehicles are all under 3 years old and any maintenance needs are covered by the leasing firm, a main determinant of holding a first or second-hand leased vehicle may be timing (whether or not an employee at the company is looking to transfer the lease at the same date that another employee needs a new vehicle).

Table (2) compares the characteristics of drivers who are first-hand versus second-hand lessees. We focus on first-hand lessees as our treatment group who will be affected by the purchase discount when the incentive becomes strong enough (post 2007 legislation). It is important that the observed characteristics are relatively similar between the treatment and control groups in order to reduce concerns regarding unobserved heterogeneity. First-hand lessees are more likely to be male (78 percent versus 72 percent) and are on average a year and a half older than second-hand lessees (34 versus 32.5).



First-hand and second-hand lessees face very similar commutes which suggests that predicted car usage is not impacting the selection into the treatment or control group. The most popular cars to lease in this company are the Ford Focus and Mazda 3 which is representative of car fleets in Israel.

The summary statistics in Table (2) suggest very similar driving patterns among first and second hand lessees. First-hand lessees average roughly 30,000 kms per year (s.d. 15,000) while second-hand lessees report 35,300 kms (s.d. 4,100). Both groups report an accident rate of 0.5 (s.d. 0.7) and an at-fault accident rate of 0.3 (s.d. 0.5). We believe accident reporting is consistent with accident occurrence as the price of reporting is set at \$100 and the cars are monitored by the vehicle fleet manager.<sup>19</sup>

## 5 Empirical Analysis

Starting in January 2008 all individuals holding leased vehicles in Israel began to face a gradual increase in leasing costs such that by January 2011 the cost of a leased vehicle was double its previous rate. This legislative tax change created an incentive for first-hand lessees to consider purchasing their discounted vehicle whereas prior to 2007 most individuals would choose to remain in the leasing cycle. Our theoretical model suggests that a higher consideration of purchase will result in more careful driving post legislation. Using a differencing approach, we measure the effect of this exogenous change in the relevance of the buyback option on the driving behavior of first-hand lessees.

We model accident outcomes over the leasing contract ( $y_{it}$ ) for individual  $i$  who began a leasing contract in year  $t$  as a function of personal and car characteristics  $x_{it}$ , being a first-hand lessee  $z_i$ , the start date of the leasing

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<sup>19</sup>These cars are not owned by the driver and thus, the only out of pocket cost of an accident is the \$100 penalty.

contract  $post_{it}$ , and an unobserved individual factor  $v_i$ ,

$$y_{it} = x_{it}\beta_0 + \beta_1 z_i + \beta_2 post_{it} + \beta_3 (z_i \times post_{it}) + v_i + \varepsilon_{it} \quad (8)$$

where  $y_{it}$  is the number of at-fault accidents reported per year. We set  $z_i = 1$  for a first-hand lessee and  $z_i = 0$  for a second-hand lessee. The variable  $post_{it}$  takes the value of 0 for contracts beginning before 2007 and 1 for later years. The vector  $x_{it}$  controls for a range of driver and car characteristics such as driver age and experience as well as commute distance and car type that are likely to impact car accident outcomes. The zero mean residual term  $\varepsilon_{it} = y_{it} - (x_{it}\beta_0 + \beta_1 z_i + \beta_2 post_{it} + \beta_3 (z_i \times post_{it}) + v_i)$  reflects the randomness associated with the occurrence of an accident involving other automobiles and unexpected road hazards. Importantly,  $v_i$  is known by the individual while  $\varepsilon_{it}$  is not.

The coefficient on the interaction term  $\beta_3 = E(y_{post} - y_{pre} | z = 1, x) - E(y_{post} - y_{pre} | z = 0, x)$  estimates the impact of the buyback clause. In essence, we compare the change in accident outcomes between the pre-legislation period (when, by assumption, the buyback clause is not relevant) and future periods for first and second-hand lessees. This allows us to separate a causal effect of the buyback clause from two possible sources of bias. The first, a correlation between the unobserved accident risk ( $v_i$ ) and the choice of becoming a first or second-hand lessee ( $z_i$ ) would bias our results absent a pre-change comparison. The inclusion of second-hand lessees provides a control for bias created when accidents risks ( $v_i$ ) are changing over time (due to changes in vehicle types, road maintenance, etc.). If the relevance of the buyback clause resulted in increased driving care we would expect  $\beta_3$  to be negative.

The effect of the 2007 fair value tax increase on first-hand lessees translates into a buyback effect only under the assumption that any changes related to unobserved accident risks ( $v_i$ ) in the population of first-hand lessees occurred in the population of second-hand lessees as well. The unobserved

individual factor in equation (8) can still bias our estimate of  $\beta_3$ , if post legislative change second-hand leasing became more popular and more dangerous drivers (higher  $v_i$ ) who previously would have chosen a first-hand lease, chose a second-hand lease. In this case we could measure a statistically significant negative effect of the buyback which is due entirely to a change in unobserved sample characteristics and not a change in behavior. Thus, in order to rule out a scenario where there was a change in the sample of drivers who select into 1st or 2nd hand leasing, we condition our analysis on individual driver fixed effects (hence holding  $v_i$  constant).

Lastly, it is important to keep in mind that the buyback rate of leased cars still remained relatively low (8 percent) even in the post period of our sample. Thus, even after legislation many first-hand drivers may have continued with a very low  $\alpha$  (probability of considering purchasing their vehicle at contract termination). These first-hand drivers who are unlikely to consider exiting the leasing cycle will introduce considerable noise into the estimated buyback effect. One way to reduce this noise would be to focus on cars that we would expect people to be more likely to consider owning. This could be driven by reliability, maintenance costs, popularity in the second-hand market, etc. We therefore also run our analysis after dividing the sample based on the make of the leased car and whether it has an above average buyback rate in the data (0.8 percent). We would expect the change in legislation to have a stronger impact on driving behavior in the above average buyback group.

Specification (i) in Table 3 provides an estimate of the effect of the buyback on all car accidents ( $\beta_3$ ) controlling for driver fixed effects and car make. We measure a very noisy effect of the relevance of the purchase clause where accidents decrease by 0.08 per year (s.e. 0.16) for first-hand lessees relative to second-hand lessees at an average accident rate of 0.5 (s.d. 0.6). This outcome doubles in size in specification (ii) when examining the impact of this legislative change on at-fault car accidents which are likely to provide a more accurate measure of driver effort but is still not significantly different

from zero.

Interestingly, although our analysis controls for driver fixed-effects we find a general increase in accidents post 2006 ( $\beta_2 > 0$ ). This finding emphasizes the importance of conducting a difference-in-differences analysis because absent the control group of second-hand lessees this would have biased our estimate of the buyback effect ( $\beta_3$ ). One explanation for the increase in accident rates over time could be that employees at these hi-tech companies felt increased pressure due to the global financial crisis and were driving at later hours.<sup>20</sup> Unfortunately, we do not have sufficient data to explore this issue further.

In specification (iii) we run our analysis on roughly half of our sample that we believe to be most susceptible to the buyback clause. Thus, we focus our analysis on people driving cars with relatively high "buy-back" rates. In this specification the same individual driving a first-hand leased car after the change in legislation decreases his/her at-fault accident rate by 0.5 (s.e. 0.25) relative to a driver in the second-hand group. We see no differential effect on driving behavior for those driving cars with low buyback rates (see specification (iv)).

Our interpretation that the relative decrease in accident rates for first-hand lessees was a result of the change in company car taxation is dependent on the pre-period parallel trend assumption. Figure (??) illustrates that both first and second-hand lessees driving cars with relatively high buyback rates start off with a similar increasing trend in at-fault accident rates of 0.1 per year. However, for leases beginning in 2007, the year the change in company car taxation was announced, first-hand lessees deviated from this trend. It is this widening gap in accident rates that is being captured in our regression analysis.

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<sup>20</sup>This is the opposite trend recorded by the Israel Central Bureau of Statistics that shows a general decrease in accident rates over this period ("Accidents with Injuries 1996-2010," Israel Central Bureau of Statistics, *Statistical* 122).

## 6 Conclusion

This paper introduces a moral hazard component into the leasing problem with adverse selection analyzed in models from previous work. We show how this second type of information asymmetry impacts the optimal buyback price relative to market price. Our results imply that moral hazard can be mitigated by setting a low buyback clause. This finding is in contrast to the recommendation of the existing literature that argues that buyback prices should be high in order to curtail adverse selection. When both problems are present, we establish that whether the buyback clause should be set above or below the market price depends on the relative severity of each problem.

In an empirical application we examine how drivers who lease vehicles from their company change their driving behavior once a buyback clause offering a discount over market price becomes relevant. Specifically when focusing on the most affected group of vehicles with relatively high purchase rates, we find a significant decrease of roughly half an at-fault accident per year (s.e. 0.25) for first hand lessees after a change in taxation made exiting the leasing cycle more likely.

The use of leased company cars has become increasingly popular over the years throughout Europe and Israel which naturally leads to a fear that investment in vehicles is too low. Our paper suggests that a discounted buyback price can help reduce the accident rate and increase general upkeep of leased cars, and by so doing increase the efficiency of the car market.

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Table 1: This table provides the monthly tax valuations for company cars as published by the Israeli tax authority. All cars in Israel are divided into tax groups by the blue book new car value of the vehicle. Thus prior to the legislative change, a person driving a price group 1 vehicle was expected to pay income tax on an additional 1,180 NIS of income for the benefit of driving a company car in this category.

Table 2: Characteristics by Contract Type  
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Table 3: The Effect of the Buyback Clause on Car Accidents  
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