The Potential of Carsharing in the Greater Tel Aviv Area

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# Summary

**Why?**

Carsharing is desirable from an environmental point of view, mainly because users of carsharing services tend to reduce their miles travelled in cars. Theoretically, this can be explained by the high marginal costs for an additional kilometer as compared to car ownership. Numerous studies confirmed this effect.

**What?**

This study aimed to find the percentage of private cars in the greater Tel Aviv area for which carsharing at the current Car2Go pricing is cheaper than vehicle ownership. The methodology of a Monte-Carlo simulation was used in order to create a large sample of different vehicle journeys and cost structures. Yearly ownership and carsharing costs for 200,000 vehicles were simulated. The vehicles' journeys were based on the American National Household Transport Survey (NHTS), since no Israeli data was available. All costs were based on Israeli data and assumptions.

**Comparison of International Carsharing Costs**

Car ownership costs in Israel are markedly higher than in the US and most European countries. If carsharing prices would be equal to the rates in the US, a high sharing ratio could be anticipated in Israel. Thus, a sample survey of carsharing prices in major European and American cities was undertaken and compared against the pricing of Car2Go in Tel Aviv.

**Results**

Under current Car2Go pricing and with vehicle journeys adapted to suit the average Israeli mileage, carsharing was the cheaper option for 22.5% of all vehicles. The same calculations were run several times with changes to the assumptions. The results proved relatively robust at a level of about 20% for changes in mileage, gas prices and exclusion of primary household cars. However, the sharing ratio declined to 18% when luxury cars above NIS 160,000 were not considered for carsharing. When a minimal saving of NIS 4,000 was demanded before switching to carsharing, the sharing ratio sank to 14.86%, highlighting the relatively small difference between costs. The outcomes proved even more sensitive to changes in the hourly fees of carsharing. When these were assumed to rise by 50%, the sharing ratio sank to 11.43%. Combined with a minimal saving of NIS 4,000, a still remarkable 7.43% were calculated. Even with the most cautious assumptions and a low ratio of 5 replaced private vehicles for every shared car, about 49,000 vehicles would be taken off the streets.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Selected Scenarios | 2 | 6 | 7b | 8 | 9 | 10 | 11 |
| Title | Km-adjusted base case | Purchase price for shared cars capped at NIS 160000 | all vehicles except 1st | Minimum saving 4000 NIS | Gas prices = NIS 5 | 50% price increase in hourly rates Car2Go | Scenario 10 and minimum saving NIS 4000 |
| Mean Ownership costs | 32114 | 34230 | 32029 | 32173 | 29781 | 32141 | 32118 |
| Mean Sharing Costs | 42653 | 45553 | 43429 | 42667 | 42631 | 54701 | 54703 |
| Sharing - Ratio | 22.29% | 18.87% | 20.11% | 14.86% | 19.67% | 11.43% | 7.43% |
| Reduced vehicles (assumed ratio 1:5) | 148,339 | 125,582 | 133,818 | 98,906 | 130,903 | 76,093 | 49,420 |

**Remarks**

Even though only households defined as urban or suburban were included, not all neighborhoods are dense and connected enough to make carsharing viable. The assumption of daily vehicle usage would probably also lead to excessive peak demand. On the other hand, this study also does not consider a user's reduction of driven miles. In general, carsharing is not a viable solution for commuters.

**Conclusions**

While the results must be taken with caution, they highlight that carsharing is not only an option for environmentally aware urbanites, but can often be economically justified. The graph below shows that the competitive advantage of carsharing is highly sensitive to the hourly fee charged by the provider. In Car2Go's case, this fee is currently very cheap. However, even after considerable price hikes carsharing remains competitive for an impressive amount of vehicles.

Table of Contents

[Introduction 6](#_Toc263943196)

[Literature Review of Market Potential Analyses 7](#_Toc263943197)

[Economic Impacts of Carsharing 8](#_Toc263943198)

[Why is Carsharing Ecological? 8](#_Toc263943199)

[Israeli aspects 12](#_Toc263943200)

[Comparison of the Cost Structure of Carsharing Providers 13](#_Toc263943201)

[Methodology 15](#_Toc263943202)

[Data sources: 15](#_Toc263943203)

[Results 20](#_Toc263943204)

[Conclusion 27](#_Toc263943205)

[Appendix 1 : Scenario Overview 28](#_Toc263943206)

[Appendix 2: International Carsharing Price Comparison 29](#_Toc263943207)

[Bibliography 30](#_Toc263943208)

# Introduction

Carsharing organizations offer their members convenient on-demand access to strategically located cars around the clock. Similar to cell phone providers, different payment schemes exist to cater for rare and extensive users. In general, there is a certain fixed fee for membership, an hourly rental rate as well as a mileage charge. All other costs such as license and registration, insurance, gasoline, depreciation and maintenance are internalized in the above costs. The concept of carsharing saw impressive growth during the last couple of years worldwide[[1]](#footnote-1). Even though carsharing is still marginal, it is a far cry from its early beginnings 20 years ago. Carsharing organizations can be found in most major and many smaller cities in Europe and America. They receive much praise from proponents of sustainable transport solutions, sometimes even being dubbed the missing link that can overcome service gaps of public transit for a lifestyle without car ownership.[[2]](#footnote-2) The reduction of vehicle miles travelled is key to achieve numerous environmental benefits, starting from more livable streets and walkable communities, reduced parking spot demand and up to the reduction of greenhouse gases from tailpipes. While the literature on the desirability of carsharing is relatively vast, no consensus has been found in regard to market potential estimates. Carsharing can and often does benefit from cooperation with local governments, for instance in receiving designated parking spaces tax rebates[[3]](#footnote-3). Useful estimates of market potential are thus necessary in order to provide decision makers with relevant information. Firstly, the environmental benefits of carsharing are reviewed and theoretically explained. Then, previous market potential studies are summarized and discussed. This paper adopted the methodology suggested by Schuster et al. in order to statistically estimate what percentage of vehicles would financially benefit from carsharing. A Monte Carlo simulation was applied on Israeli data on car ownership costs as well as the current price plans of Car2Go, the Israeli carsharing organization. Different scenarios are analyzed and discussed in the body of the paper.

# Literature Review of Market Potential Analyses

Most early market potential studies of carsharing were either based on demographic data or pure mileage considerations. Demographic approaches identify groups that are specifically prone to consider carsharing, such as young, urban adults with environmental considerations. For example, Steininger et al. (1996) found a minimum market potential of 13.5% of all households in Austria, based on the number of households that met criteria such as aged between 25 and 40, university education, owning a car from a lower price bracket that is driven less than 15000 km a year and a high share of non-car trips. Based on pure financial considerations, the same study estimated a maximal potential of about 69% of households, since they owned at least one car that was driven less than 15000 km.

In their evaluation of Mobility, the world's largest car sharing scheme in Switzerland, Haefeli and Matti (2006) computed a breakeven of about 8000-9000 km/year. Their estimates were low, compared to Muheim (1998) who found that 23% of the Swiss population are potential carsharing clients, based on homes located in communities with more than 2000 inhabitants and journeys to work that would not be lengthened by more than 30 minutes if undertaken by public transit.[[4]](#footnote-4)

Some of the studies used surveys in order to identify the characteristics of the current users, and then projected the findings on the total population that is using carsharing services[[5]](#footnote-5). Most of the surveys found that some of the major motivations for joining a carsharing service were financial and convenience considerations, while environmental and social considerations were minor or even marginal.

A late and rather sophisticated attempt to measure potential is described in Celsor et. al, (2007) who use a GIS-based approach that includes various geographical elements such as density and socio-economic elements such as motorization rates and household size. As a result, they point to neighborhoods with a minimum potential and a high potential for carsharing.[[6]](#footnote-6)

The early methods of calculating a minimum mileage are highly limited, since they do not take into account the most common carsharing pricing model, where the customer pays by the hour and the mile. Schuster et al. (2005) presented a methodology that adds two new dimensions to this simple equation: total trip time and different purchasing costs of cars. They calculated that yearly costs for 4.15% of all vehicles in Baltimore would be cheaper if the current journeys would be undertaken with shared cars rather than privately owned ones. Their methodology served as the base for this paper and will be described in more detail below.

# Economic Impacts of Carsharing

The cost structure of car ownership and carsharing is inherently different. Over a given period, a car owner pays high fixed costs such as depreciation, financing, insurance and registration. Repairs and changing parts may also be considered fixed costs. The marginal cost per kilometer thus consists only of gasoline expenses, and is relatively low. In fact, for a representative Israeli car gas constituted only about 30% of costs.[[7]](#footnote-7)

The marginal price of a kilometer with a shared car internalizes the full yearly costs of the vehicle. This difference has considerable effects on the chosen mode of transportation and lies at the heart of its environmental desirability.

# Why is Carsharing Ecological?

Carsharing might not seem environmental at first sight. After all, what does it matter if a given car driving and polluting on the road is owned or shared by its driver? In order to understand the environmental aspect of carsharing, one must take into account the different price distribution described above.

Assume an individual that chooses the mode of transportation before every trip according to the minimal cost, as outlined in the following equation.



Where TC = Total cost

 MC = Marginal cost

If she is a car owner, she already spent a large sum on fixed costs, which are now correctly considered sunk costs. Other modes of transportation, such as public transport, are less competitive in terms of the marginal costs for the trip. In most cases, the car will be cheaper. If the car option is a shared car, the higher marginal cost will lead to more trips taken by alternative transportation.

Fixed costs thus motivate to committo a certain mode of transportation[[8]](#footnote-8). This is true for public transport season tickets, but certainly for car ownership. Paying the high fixed costs for a car leads to a high incentive to commit to car use also for shorter journeys where convenient alternatives exist. Beyond the economically rational commitment to car use, people are also prone to stick to routines in their travel behavior.[[9]](#footnote-9) Thogersen found that impacts of past routines are especially strong for car owners, who prefer to stick to their routines rather than finding information about alternatives.

A shift to shared cars and thus higher marginal costs is expected to have additional consequences. For instance, it is reasonable to believe that in case of interchangeable trip destinations such as entertainment locations, a carsharer will chose alternative, easier to reach destinations in the first place and thus reduce trip costs and transport needs. Similarly, carsharers may opt for deliveries more often in order to replace trips to shopping centers with private cars.

Carsharing also allows for multi-modal trips. Many carsharing organizations actively promote this by positioning cars at major transit hubs, such as train stations. This allows the splitting of a trip to a farther location, using the train to get to the greater area and a shared car for fine distribution.

Additional environmentalist benefits include:

* Shared fleets usually include newer and smaller cars.
* Shared fleets are professionally maintained, thus reducing polluting and excessive gas consumption
* Shared cars are usually relatively small
* Shared cars do not carry unnecessary luggage

The theoretical models hinting at reduction of vehicle miles travelled (VMT) after a switch from owned to shared cars are backed by empiric research.

Sale of vehicles or foregone purchases

The TCRP Report 108[[10]](#footnote-10) lists tens of research papers that found between 7% and 44% of new carsharing users who sold a car (primary or secondary) as a result of the membership in a carsharing service. In addition, between 5% and 63% of users chose carsharing as an alternative to the purchase of an additional vehicle for the household. Carsharing thus has an impact on the number of cars on the roads and on demand for parking space. For example, the 35,000 users of Philadelphia's PhillyCarShare are reported to have foregone the purchase of 13,000 vehicles.[[11]](#footnote-11)

The impact of carsharing in terms of private car replacement is usually computed as follows:[[12]](#footnote-12)

**(% who give up a car \* members per vehicle) -1 = vehicles reduced**

The member per vehicle ratio was found by Millard-Ball et.al. to be about 27. With such cautious numbers it is safe to assume that every shared car replaces at least 5 privately owned vehicles. In some cases, this number is believed to rise as high as about 15.[[13]](#footnote-13)

Haefeli and Matti (2006) found that the yearly mileage of a vehicle in the fleet of Switzerland's Mobility lies about 50% above average, which may further reduce the need for parking space assuming that shared cars could be parked on regular on-street parking.

Vehicle Miles Traveled

Numerous research papers and surveys found reductions in VMT (vehicle miles traveled) per customer[[14]](#footnote-14). It is relatively complicated to measure the reduced miles and different methodologies were used and correctly criticized. The surveys range in reductions from 28% up to 72%. The highest drop was reported in Munich, where mileage sank from 13000 km to 3000 km (-77%).[[15]](#footnote-15)

Most of the reduction is accounted for by former car owners. User segments that did not own a car before joining mostly report increased VMT. In Switzerland, the percentage of users who increased their VMT was 77%, vs. only 23% who reduced their VMT. However, the increase in VMT for people who did not previously own a car was marginal and by far offset by the reduction in VMT of people who sold a vehicle or refrained from the purchase. After one year of operation, users of Philadelphia's PhillyCarShare reported similar outcomes. The average VMT increase for drivers who previously did not own a car stood at about 19 miles per month, whereas previous car owners reduced their monthly mileage by up to 522 miles.[[16]](#footnote-16)

A returning phenomenon is that carsharing organizations see reductions of use over time. While part of this may certainly be accounted for by initial excitement, the commitment factor outlined above can certainly be seen at work. In a study on CarShare Portland, 75% of users reported that they become more aware of travel costs and 62% reported that this awareness influenced their behavior at least somewhat. Specifically, this led to more trip planning and bundling in order to minimize costs[[17]](#footnote-17). Katzev also notes the importance of a well-functioning public transport system in order to fully materialize the effects of VMT reduction. The insufficient options available in America and also in Israel may not allow copying the impressive results reported in many European studies.

Intermodal shifts were reported also for Philadelphia. Users increased walking by 40%, public transit by 34%, biking by 18% and taxis by 13%[[18]](#footnote-18).

Energy and Emissions

Based on a survey of 520 households with membership in Switzerland's Mobility that were compared against a hypothetical control-household, Haefeli and Matti (2006) calculated a yearly energy saving of about 78 TJ[[19]](#footnote-19). Per active user, this means a saving of about 2000 MJ per year. In terms of CO2 emissions, they calculated a saving of 290 kg per active user and year.

Ryden and Morin (2005) estimated a 40%-50% reduction in CO2 emissions as a result of switching to carsharing in Europe.

# Israeli aspects

The state of the Israeli transport alternatives and the regulatory environment lead to a number of unique features that must be taken into account when estimating the potential of carsharing in Israel.

On the economic side, heavy taxation both on new car purchases as well as on gas led to high prices for consumers. As a result, the number of vehicles per 1000 people is low compared to western standards and stands at 306, as compared to at least 400 (Denmark) and up to 800 (USA). These factors led to a comparatively intensive use of vehicles in Israel. The average vehicle[[20]](#footnote-20) drives about 20000 km a year - the same number as in the USA, but considerably higher than in the UK (16000 km), Switzerland (14000 km) or Japan (10000 km).[[21]](#footnote-21)

These numbers hint at a rather economic use of car and an awareness of the costs of cars.

Public transit is poorly developed when compared to European standard.[[22]](#footnote-22) In addition to this problem, Israel is the only country in the world where public transport completely shuts down for 24 hours every weekend. This significantly increases the service gaps for passengers without access to cars. Carsharing can conveniently close this gap at competitive costs, thus lowering incentives to purchase a car for people who have suitable alternatives during the week.

Many Israelis might also be familiar with the concept of carsharing, since it was and still is applied in its basics in most Kibbutzim.

# Comparison of the Cost Structure of Carsharing Providers

Car ownership costs in Israel are markedly higher than in the US and most European countries. If carsharing prices would be equal to the rates in the US, a high sharing ration could be anticipated in Israel. Thus, a sample survey of carsharing prices in major European and American cities was undertaken and compared against the pricing of Car2Go in Tel Aviv[[23]](#footnote-23).

The high costs of car ownership in Israel are not reflected in the current pricing model of Car2Go. Most notably, the hourly rental fees are below average as compared to the sample. Out of the sample, only the hourly fees in Germany and in Switzerland were cheaper.

[[24]](#footnote-24)

The other major component of carsharing costs is the mileage fee.

The kilometer charge in Tel Aviv is amongst the higher ones in the sample, dwarfed only by Paris and Switzerland. In Manhattan and in Baltimore, 180 miles are included in every rental. It must be noted, that the rate for the Value price plan in Tel Aviv drops to NIS 0.99 / km after 50 kilometers per rental period.

In order to make sense of the differences in hourly and kilometer fares, the monthly fixed costs must be considered.

# Methodology

A Monte- Carlo simulation[[25]](#footnote-25) was used in order to compute the costs of ownership and carsharing, as suggested in Schuster et al. This simulation is often used when facing a high level of uncertainty in regard to the input variables. A distribution is estimated for every variable, and correlations are defined where necessary. Every iteration generates a random sample according to the probabilities of the input distribution. The simulation is then run numerous times. Each result represents a possible outcome. The large amount of outcomes allows inferring reasonable conclusions.

Two values were computed for each iteration: the costs of car ownership and the costs of carsharing. This allowed for direct comparison of the yearly costs of ownership and carsharing for the exact same journeys.

Equation (1) was used to compute the ownership costs:



Equation (2) was used to compute the sharing costs:



For each iteration, the output "0" was produced if ownership costs were lower and "1" if sharing costs were lower. The mean of all iterations thus is the percentage of cars for which carsharing is financially cheaper. The simply model easily allows to add the costs of lost convenience into equation (2), thus lowering the resulting percentage.

# Data sources:

Trip Journals:

No Israeli travel logs that contain both mileage and trip time could be found. Instead, data from the American National Household Transport Survey 2009 (NHTS) was used. The transportation modes included for the data pool were cars, vans, SUVs and pick-up trucks. Up to five vehicles per household were accepted and additional household vehicles were filtered out. The data set was further narrowed to include only cars marked as originating in an urban area, an urban cluster or an area surrounded by urban areas. In order to avoid double counts of time values, only persons that were marked as the drivers in a specific trip were counted. The travel time, dwell time at the destination and vehicle mileage were summed up for every vehicle and day. The data was broken down into a pool of weekday trips and weekend trips. Eventually, the weekday pool contained 5236 travel logs, with 3006 out of them representing a household's primary vehicle. The average travel time for each vehicle was one hour and 12 minutes per day. The average dwell time at the destination was 6 hours and 34 minutes.

For weekends (Saturday and Sunday), 1684 trips were logged, 986 out of them representing primary vehicles. They averaged 67 minutes of daily travel time and 5 hours of dwelling time at the destination.

For every iteration, one of each was randomly chosen. Weekdays were multiplied by 260 and weekends by 104 in order to compute yearly costs. This assumes that each vehicle has a fixed itinerary both during the week (trips to work) and a fixed journey on weekends.

Carsharing Prices

The current pricing of Car2Go, Israel's available carsharing provider was used. Almost all cars offered belong to the cheapest class C, which consists of small cars such as Fiat 500, Peugeot 107, Nissan Micra etc. The simulation was designed to take account of the three different pricing tracks and to choose the cheapest option. Due to the assumption of daily car use, almost all results were based on the Value+ pricing plan for intensive users.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| All prices in NIS, 1.2.2010 | **Kilometer rate****<50 km** | **>50km** | **Hourly rate****(Weekday)** | **Hourly rate****(Weekend)** | **Monthly Fee** |
| **Go** | 1.8 | 1.1 | 15 | 18 | 0 |
| **Value** | 1.5 | 0.99 | 11 | 15 | 99 |
| **Value+** | 0.95 | 0.95 | 9 | 14 | 229 |

**Ownership data**

Depreciation

Depreciation was computed using the following formula equivalent to the one used in Schuster et al.



Where:

P = Purchase price

r = depreciation rate

N = vehicle age

As suggested by Schuster et al, the depreciation rate was assumed to vary between 15-20% and to correlate with yearly mileage. It was computed as follows:



No data about vehicle purchase prices and their distribution in Israel could be found. The price categories of the Green Taxation commission[[26]](#footnote-26) were used, defining a minimum car price at NIS 87,000. The base case used a lognormal distribution with a mean of NIS 105,000 and a standard deviation of 25% as suggested by Schuster et al. The lognormal distribution was chosen following the precautious assumption that most cars would cluster at lower price levels with only a minority priced in the higher end. The mean was assumed to be relatively low and probably lower than in reality in order to achieve a conservative estimate.

In order to generate the vehicle age, Central Bureau of Statistics (CBS) data was used[[27]](#footnote-27). Only data from the Gush Dan towns in central Israel was used, where the average car age was 6.6 compared to 8.2 in the whole country. The probability of a certain age was equal to the share of that age group in total vehicles. Given the generalization of the data for older vehicles, the following values were attributed: 1,2,3,4,5,7,10.

Financing:

In order to allow for a comparison of all types of car ownership, opportunity costs were used rather than actual car finance payments. The opportunity price of capital was defined as the Bank of Israel interest rate, valued at 1.25%[[28]](#footnote-28). A depreciation table was used to discount the purchase value after previous depreciation, and the current value of a car was multiplied by the interest rate.

While Schuster et al. stopped counting financing costs for cars older than six years the model used here did not do so. Given the very low rate used and the fact that financial opportunity costs still hold valid also for cheap "lemons", it was considered correct to do so.

Using the interest rate as a proxy for risk free returns is a very conservative estimate. Specifically in cases where the purchase of a car is financed partially by a bank loan, the true costs of finance are considerably higher.

Vehicle Insurance

The Heshev private car cost estimate[[29]](#footnote-29) was used as the mean of minimal insurance. Heshev used the sum of NIS 1404 yearly insurance cost. A lognormal distribution with deviation of 20% was used, as compared to a lognormal distribution with a deviation of 25% in Schuster et al. The lognormal distribution was chosen under the assumption that most drivers pay relatively low premiums and only a minority is considered risky and pays higher premiums.

Additional insurance was also based on the estimate of Heshev, standing at NIS 3075. Again, a lognormal distribution was assumed with a deviation of 30%.

Schuster et al. used a mean total insurance of USD 828 (approximately NIS 3138), about 30% lower than the Israeli mean of NIS 4479.

Registration

Registration was assumed to follow a lognormal distribution with a mean of NIS 1404 and a standard deviation of 10%. This number was suggested by Heshev for the average Israeli car.

The parallel value in Schuster et al. was USD 40.5.

Repairs and maintenance

A normal distribution with a mean of NIS 4000 and a standard deviation of 25% was used. The result was multiplied by in order to apply with a negative correlation with age and a positive one with mileage, as suggested by Schuster et al.

$$\frac{1+Car age}{100}\* 0.000003\*yearly miles\*repair costs= repair and maintenance costs$$

These numbers are markedly lower than the approximately NIS 5500 for repairs, maintenance and tires that was used in the Heshev calculation. However, given the relative lack of information a conservative estimate was considered reasonable.

Schuster et. al used a normal distribution with a mean of USD 1200 and a standard deviation of USD 500.

Gas costs

Mileage costs were calculated based on the following formula:

$$Mileage costs=\frac{yearly mileage}{efficiency}\*price of gasoline$$

The efficiency was based on a survey of fuel efficiencies amongst car fleet managers of high-tech companies in Israel.[[30]](#footnote-30) All the reported efficiency levels were expressed in km/l and were assumed to have an equal probability. The mean efficiency was 10.19 km/liter.

Gasoline costs were fixed at NIS 6.38. This was the cheapest price for one liter of Benzin 95.[[31]](#footnote-31)

Comparison of Costs (in NIS, per 1.3.2010, USD = 3.79 NIS)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Purchase Price | Financing | Insurance | Registration | Repairs | Gas / liter | Gas costs |
| Tel Aviv | 105000 | 1.25% of depreciated purchase price | 4479 | 1404 | 4000 | 6.38 | Function of Mileage and Fuel efficiency |
| Balti-more | 81864 | 842 | 3138 | 151 | 4548 | 2.78 | 6420 |

|  |  |  |  |
| --- | --- | --- | --- |
|  | Km | Hour | Yearly fee |
| Tel AvivValue + | 0.95 | 9 | 2748 |
| Baltimore(Schuster et. al) | 0.83 | 34Includes 10 miles an hour | 95 |

# Results

The calculations were made in MS Excel, using the free Monte-Carlo add-on YASAI[[32]](#footnote-32). Each scenario contained 200,000 iterations.

Base Case (Scenario 1)

The base case (Scenario 1) resulted in 42,962 vehicles that returned carsharing. This translates into 21.5% of all iterations! In order to evaluate the results, the average capital (Depreciation and financing) and gas costs were measured as were the average driven kilometers per vehicle. Capital costs (depreciation and financing costs) summed at NIS 11,018, while gas expenses averaged at NIS 12,775. The high gas costs were caused by the high average mileage, which was 19,722 km per year and vehicle. The mean purchase price was NIS 110,933.

Scenario 2 (Mileage-adjusted base case):

In order to adjust the travel log sample more towards the Israeli reality, miles were multiplied by 1.35 instead of 1.6 in order to reach a yearly distance of closer to 16700 km per vehicle, which is the average mileage as reported by the Central Bureau of Statistics for 2008.[[33]](#footnote-33) With an average of 16,585 km per year, the carsharing percentage climbed even higher to 22.29%, while gas costs declined to NIS 10736 and capital costs to NIS 10,967.

The mileage-adjusted base case produced the following distribution of ownership and sharing costs.

Results of more than 20% were unexpectedly high. In order to test the methodology and the trip journals, the same Excel sheet was computed with the data and pricing model from Schuster et al., but with the same travel logs. This resulted in a carsharing rate of 5.26%. This is slightly higher than the 4.15% received by Schuster et al. The small difference is assumed to be caused by different driving habits in the Baltimore area as compared to the urban rides in the general NHTS statistics.

Additional scenarios were calculated in order to test the robustness of the results.

Scenario 3+4

Some of the travel logs list vehicles with very low daily mileage, probably as a result of chosing a non-representative day. Scenarios 3+4 were programmed to use a minimum daily mileage of 20 km for every value that was below. For the adjusted scenario, where one mile was translated into 1.35 kilometers, this resulted in 17,889 km per year and a car sharer rate of 21.82% (22.29%). For the non-adjusted scenario, the result was 20.91% (21.48%). The differences in half a percent are relatively small and the base case can be regarded as robust and not very sensitive to changes in mileage.

Scenario 5

One of the largest components of the ownership costs is depreciation, which is a direct derivative of the purchase price. The distribution of the purchase price was not based on statistical figures, except for its bottom limitation. Thus, alternatives had to be calculated in order to find how relevant the base case assumptions were.

Scenario 5 calculated the model assuming purchasing prices followed a triangular distribution with a minimum of NIS 87,000, a peak of NIS 107,000 and a maximum of NIS 250,000. The resulting mean purchase price was NIS 147,822, as a result of which the sharing ratio climbed to 31%.

Scenario 6

Cars do not only serve as means of transportation, but are often believed to provide the owner with a certain social status. Car owners may be divided into two subgroups: those who purchase a car in order to have a comfortable means of transportation, and those who pay a premium for added social prestige or comfort[[34]](#footnote-34). The second group in general tends to spend more on their cars, and also to be less price-sensitive. People who spend a fortune on a prestigious car are unlikely to switch into carsharing, even if it is financially beneficial. Scenario 6 thus attempted to model those two groups of car owners. Vehicles with a purchasing price of NIS 160000 (about the price of a Mazda 5 or a Renault Scenic[[35]](#footnote-35)) and above were directly marked as choosing ownership in disregard of potentially cheaper sharing alternatives. As expected, the sharing ratio fell by about 3 percentage points to 18.87%.

Scenario 7

Carsharing is often cited as a promising alternative to second or even third cars in households.[[36]](#footnote-36) This assumption was tested by limiting the pool of travel journeys to 2nd and 3rd cars in every household. Contrary to the expectations, the sharing ratio declined from 21.48% to 19.59%. Scenario 7b calculated the simulation using a carpool of all cars except vehicles tagged as primary, with similar results. The sharing ratio dropped from 22.42% to 20.1%[[37]](#footnote-37).This provides support for the applicability of carsharing even for primary vehicles. It must be noted however that vehicles were not necessarily numbered according to intensity of use in the NHTS data. Furthermore, this scenario is particularly prone to distortion by the assumption that the trip journey reflects a daily habit and that every car is in use for 360 days a year. Secondary and tertiary cars are more likely to remain unused on some days.

Scenario 8

In addition to prestige, a privately owned car also has some advantages of convenience. For example, the short process of reservation required for shared cars is not necessary. Also, it is possible to store personal items inside the car. Putting a price tag on this convenience is difficult. Most importantly, the dramatic behavioral change usually meets a lot of skepticism. Only a considerable saving potential can provide an effective incentive. For scenario 8, it was assumed that a minimum saving from carsharing of NIS 4000 must prevail in order to switch from ownership to carsharing. As expected, the sharing ratio declined to 14.86%. This is a large drop of about 33%, which reflects the distribution of the difference between carsharing and ownership costs.

Scenario 9

This scenario tested the models elasticity to changes in the price of fuel. The prices of Car2Go were stable since the opening of the business, whilst fuel prices change constantly. The base case and all previous scenarios assumed the fuel price of NIS 6.38/liter (-21%). Lower fuel prices could benefit car owners, while the scenario assumes that carsharing prices will remain untouched. Scenario 9 thus calculated the base case under the assumption that gas prices would be as low as NIS 5. The scenario resulted in a sharing ratio of 19.67%, which constitutes a drop of 12% compared to the base case.[[38]](#footnote-38) Mean gas costs stood at NIS 8406, which is NIS 1064 lower than the Heshev estimate. [[39]](#footnote-39)

Scenario 10+11

In the foreseeable future, Car2Go might raise the low hourly rates to levels more similar to their international peers or even higher. Scenario 10 assumed that all hourly rates increase by 50%. This raised the mean yearly sharing costs by about NIS 12,000 and lowered the sharing ratio to 11.43%.

Scenario 11 added also a minimum saving of NIS 4000 similar as in scenario 8. The sharing ratio declined rapidly to 7.43%.

Discussion of the results

Even for the most cautious scenario that uses current Car2Go pricing, the sharing ratio did not fall below 14%. These numbers are extremely high and would have far-reaching implications. The different scenarios that assumed current conditions and no value on convenience proved relatively robust at a level of about 20%.

Schuster et al. calculated that more than 70% of the variance is explained by travel time, 16% by mileage and about 10% by car age[[40]](#footnote-40). All of these inputs were based on statistics rather than assumptions, even though the first two represented American data rather than Israeli statistics. The high relevance of travel time is probably the key to understand the high results. Due to the assumption that vehicles were used on a daily base, the Value+ price plan turned out the cheapest for all cars. The hourly rate of Car2Go in this price plan is one of the cheapest worldwide, and stands at 26% of the reference case used by Schuster et al. In combination with the significantly higher ownership costs in Israel, the high sharing ratios can be explained. In fact, a shift towards higher hourly rates and lower kilometer fees can be expected in the Car2Go pricing eventually, as was partly incorporated in scenarios 10 and 11.[[41]](#footnote-41)

The theoretical number of vehicles on the roads and parking spaces of Gush Dan that could be reduced when using a low replacement ratio of 1:5 ranged from 49,000 to 149,000[[42]](#footnote-42).

While the numbers are large and might also be reduced by future price hikes of Car2Go, it must be noted that a number of variables and assumptions were cautious. For instance, parking costs (at the home base) were not included in the ownership costs. Many cars are probably also used less than 364 days a year, which would further benefit sharing costs compared to ownership costs.

Weaknesses of the Methodology

The advantage of the methodology chosen for this study is that it clearly marks the financial benefits of carsharing for considerable parts of drivers. However, it also comes with a number of considerable weaknesses. Its macro view ignores neighborhood considerations. Even in areas considered urban, population density may sink to levels where shared cars would be too scarce and parked in too large distances in order to be equally convenient and thus a viable option.

In addition, the resulting large scale carsharing scheme would be unprecedented and possibly not viable to run. Since the study assumes daily car use of shared cars, vehicle demand at peak hours would probably require a low member/car ratio, which would again drive up prices. In addition, the methodology does not take into account the most desired outcomes of carsharing, namely the reduction of VMT.

# Conclusion

This study hints at the immense saving potential that lies in carsharing. It highlighted the large potential for carsharing in Israel resulting from the comparatively high fixed costs of car ownership in Israel. The study's macro-approach will probably meet many more restrictions when compared to more micro-level studies, where whole neighborhoods can be found to be unviable for commercial carsharing. Additional factors like convenience and peak demand may also pose significant challenges for a large scale carsharing network, especially when it is not backed up by excellent public transportation. But the large financial incentives for a considerable group of drivers at the current pricing levels may serve as a good starting point. As a result of the economic approach of this study, it could be shown that carsharing does not rely on environmentally aware populations, but may actually be a rationally justified decision. The results of this study show that carsharing in Israel has a large cost advantage, which can justify switches from car ownership and then trigger reduction of VMT, intermodal habit shifts and a reduction of demand for parking space. Policy makers can provide important support in the initial phases of carsharing services.[[43]](#footnote-43)

# Appendix 1 : Scenario Overview

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 7b | 8 | 9 | 10 | 11 |  |
| Title | Base case | Km-adjusted base case | Minimum 20 km / day | Minimum 20 km a day, Miles=1.6 km | Triangular distribution of purchase price | Purchase price for shared cars capped at NIS 160000 | 2nd and 3rd cars only | all vehicles except 1st | Minimum saving 4000 NIS | Gas prices = NIS 5 | 50% price increase in hourly rates Car2Go | 50% price increase in hourly rates Car2Go, minimum saving NIS 4000 | Replication of Schuster et al. |
| Miles conversion rate | 1.6 | 1.35 | 1.35 | 1.6 | 1.6 | 1.6 | 1.6 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1 |
| Mean Ownership costs | 34277 | 32115 | 33100 | 34969 | 37813 | 34230 | 34035 | 32029 | 32173 | 29781 | 32141 | 32118 | 6309 |
| Mean Sharing Costs | 45660 | 42653 | 43853 | 46549 | 45494 | 45553 | 46147 | 43429 | 42667 | 42631 | 54701 | 54703 | 24320 |
| Sharing - Ratio | 21.49% | 22.29% | 21.83% | 20.92% | 31.04% | 18.87% | 19.60% | 20.11% | 14.86% | 19.67% | 11.43% | 7.43% | 5.26% |
| Mean Yearly km | 19743 | 16585 | 17889 | 20671 | 19614 | 19680 | 19408 | 16473 | 16621 | 16585 | 16596 | 16572 | 12417miles |
| Reduced vehicles (assumed ratio 1:5) | 143,008 | 148,339 | 145,264 | 139,188 | 206,573 | 125,582 | 130,407 | 133,818 | 98,906 | 130,903 | 76,093 | 49,420 |  |

# Appendix 2: International Carsharing Price Comparison

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | Location | Currency | Rate | Monthly Fixed Cost | Fixed Cost | Hour | day | km | km > 100 | URL: )accessed 15.3.2010) |
| Hertz Connect - Berlin | Berlin | EUR | 5.12 | 32.00 | 75.00 | 4.00 | 32.00 | 0.17 | 0.17 | <http://www.connectbyhertz.com> |
| eGo carshare | Denver | USD | 3.79 | 37.90 | 120.00 | 2.50 | 49.00 | 0.19 |  | <http://carshare.org/rates> |
| PhillyCarshare | Philadelphia | USD | 3.79 | 39.48 | 125.00 | 3.45 | 39.00 | 0.16 |  | http://www.phillycarshare.org/ |
| Hertz Connect - Paris | Paris | EUR | 5.12 | 51.20 | 120.00 | 4.00 | 32.00 | 0.35 | 0.35 | http://www.connectbyhertz.com/ |
| City Car Club | London | GBP | 5.71 | 83.27 | 175.00 | 3.96 | 39.60 | 0.10 | 0.10 | http://www.citycarclub.co.uk/ |
| Mobility | Switzerland | CHF | 3.50 | 84.58 | 290.00 | 2.70 |  | 0.48 | 0.24 | <http://www.mobility.ch> |
| Car2Go | Tel Aviv – Value | ILS | 1.00 | 99.00 | 1188.00 |  |  |  |  | http://www.car2go.co.il/ |
| Cambio | Germany | EUR | 5.12 | 128.00 | 300.00 | 1.50 | 18.00 | 0.19 | 0.16 | http://www.cambio-carsharing.de/ |
| Car2Go | Tel Aviv – Value + | ILS | 1.00 | 229.00 | 2748.00 | 9.00 | 90.00 | 0.95 |  | http://www.car2go.co.il/ |
| Hertz Connect - Manhattan | Manhattan | USD | 3.79 | 473.75 | 1500.00 | 8.50 | 59.50 | 180 miles incl. |  | http://www.connectbyhertz.com/ |
| Hertz Connect - Baltimore | Baltimore | USD | 3.79 | 473.75 | 1500.00 | 6.80 | 52.70 | 180 miles incl. |  | http://www.connectbyhertz.com/ |

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17. Katzev [↑](#footnote-ref-17)
18. Lane [↑](#footnote-ref-18)
19. The equivalent of about 2.5 million liters of gas. Haefeli and Matti [↑](#footnote-ref-19)
20. includes all types: private cars, commercial cars, buses, taxis and motorbikes. [↑](#footnote-ref-20)
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23. For sources, see Appendix 2. [↑](#footnote-ref-23)
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38. For both scenarios, a mileage conversion rate of 1.35 km per mile was used in order to achieve the average Israel mileage. [↑](#footnote-ref-38)
39. Note that Heshev calculated with 15000 yearly km only rather than 16522 km as in the scenario and 16700 as was the average mileage for private Israeli vehicles in 2008 (Central Bureau of Statistics, Statistilite 81). [↑](#footnote-ref-39)
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41. Private conversation with Jonathan Gadish, CEO of Car2Go [↑](#footnote-ref-41)
42. See Appendix 1. [↑](#footnote-ref-42)
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