The Rail Bonus in the Israeli Periphery- the Emek Rail Line Case Study

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1. Introduction

With the development of peripheral areas comes the need to provide means of public transport to these areas, however the question arises as to what modes of public transportation best meets the requirements and needs of the residents of these areas. Peripheral areas present different difficulties when planning transit systems, compared to their metropolitan counterparts. These areas sprawl across larger areas, leading to larger travel distances between origins and destination. Commuting to work may also present difficulties as passengers must first travel large distances to an appropriate transit hub, and only then passengers can use public transportation to their final destination.

In October 2016 the Emek Rail Line opened to the public, connecting the peripheral cities of Beit She'an, Afula and the surrounding communities to the Haifa Metropolitan, and consequently the Tel Aviv Metropolis. This line was constructed with only one rail line, with a designed frequency of once an hour and planned travel time of 47 minutes from Beit She'an to Haifa Lev HaMifratz station.

The opening of a new rail line in a peripheral setting allowed an examination of the effect an additional mode of transit has on the area, how residents change their travel preferences and habit, while similarly examining whether the use of the rail is influenced by an inherent preference for the rail known as the "Rail Bonus".

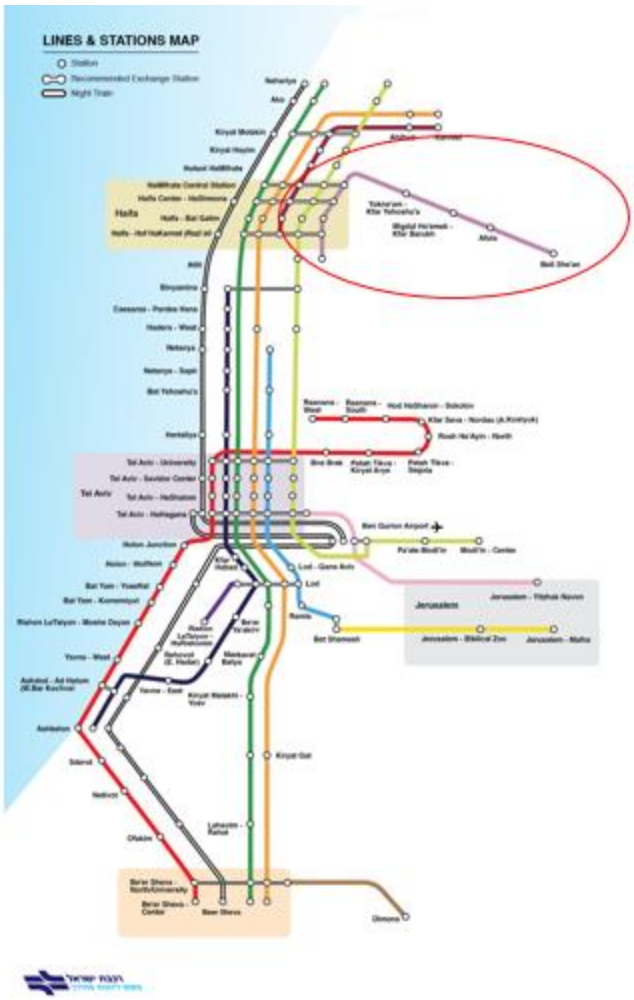

Figure1- Israel Rail Line Diagram, Israel Railways

2. Literature Review

When attempting to use public transportation in the periphery, the quality of service is usually lacking compared to cities and metropolitan areas. As the diversity of uses in suburban areas is smaller and mixed uses are infrequent, the demand for transport is heavily peaked and ridership is comparatively low. Public transportation services in rural areas are further characterized by poor quality of service reflected in low frequencies, limited hours, and indirect routes. Additionally, the daily departures of rail and bus services do not always coincide with work hours. These issues lead the dependency of rural residents on the car to be a necessity and not out of choice (Petersen, 2016; Sharav et al., 2019; Šipuš et al., 2017).

Therefore, in order to improve the relationship between the periphery and public transportation and lessen the private vehicle dependency, policy makers must first understand the attractiveness of the various public transportation systems to residents of these areas in order to increase ridership and improve the quality of service provided.

Many studies have previously commented on the preference travelers have for a rail-based transit system compared to the bus (Ahern et al., 2008; Axhausen et al., 2001a; Ben-Akiva et al.,

2002; Bunschoten et al., 2013; Scherer, 2010, 2012; Tennyson, 1989), which is reflected in higher ridership (Arnold et al., 1997; Bunschoten et al., 2013; Tennyson, 1989).

Some studies argued that this preference for a rail-based public transportation system (be it heavy rail, light rail or tram) is an inherent preference, naming this built-in preference the "rail bonus" or "psychological rail factor" (Axhausen et al., 2001b; Bunschoten et al., 2013; Megel, 2001; Scherer, 2010; Scherer et al., 2011, 2012). This bonus is defined as the preference to use the train rather than the bus when levels of service and quantitative hard factors are identical. The rail bonus may also be defied as the preference to use the train due to image and perception of the train and other factors which are not explained by traditional train service attributes (Henke, 2007).

While the preference for rail may be apparent in an urban setting, in the periphery this preference may not be expressed as clearly since rural communities usually offer low ridership levels. From an economical point of view this, planning and constructing a rail line is substantially more expensive than planning a bus line, as buses use existing infrastructure while rails require a separate infrastructure system. Additionally, the added costs of running rural rail services in comparison to a bus services may lead to lower value for money and may be harder to justify in these areas. Therefore, the existence of an inherent preference to use the train is crucial when planning transit systems in the periphery which are economically sound (Hasiak et al., 2016; Jackson et al., 2012)

Determining the existence of the hypothetical rail bonus is generally found by examining the alternative specific constant of utility functions, determined using discrete choice models (Barlach, 2011; Bunschoten et al., 2013; Hensher, 2016). The constant obtained by the utility function represents the explanatory power of variables which are not expressed in the model; therefore, a large positive constant represents a larger preference for that transportation mode. Accordingly, when comparing the bus to the rail using discrete choice model, the rail bonus should be expressed in a larger positive constant compared to the bus when all service factors presented are identical.

3. Methods

Two rounds of surveys were distributed among potential passengers of the Emek Rail Line, the first a stated preference survey conducted before the opening of the rail line and the second a mixed revealed and stated preference survey distributed after the opening of the rail line.

The first survey, a stated preference survey, was conducted in September and October of 2016 using Facebook and WhatsApp groups to distribute the questionnaire among residents of Beit She'an, Afula and the surrounding communities who may use the rail line.

In the survey, passengers were presented with six random hypothetical scenarios comparing the travel time, price and frequency of the train, which has yet to begin to run, and the transit mode currently being used- the bus or private vehicle. In each scenario, passengers were requested to choose which mode of transport they would prefer to use to make a trip between Haifa and either Beit She'an or Afula, whichever city is closest to their place of residents. Next, current travel habit and demographic factors such as marital status, education level and income were collected from each individual.

A mixed revealed-stated survey was conducted in May 2019 with the 2.5 years separating both surveys allowed the formation of new travel habits and trip preferences. Similar to the initial survey, the second survey was conducted using Qualtrics and distributed among residents of Beit She'an, Afula and other potential users of the Emek Rail Line. The first section of the survey reviewed current travel habits and preferences, questioning passenger regarding their use, or misuse, of the train. Next, in the stated preference section of the survey each surveyee was presented

with six hypothetical scenarios comparing the travel time, cost and frequencies of the various transit modes available in the area- private vehicle, bus and train. Finally, demographic factors such as age, gender and occupation were collected from each individual.

Using "Biogeme" both surveys were estimated using a multinomial logit model (MNL). Since the bus and car were separately compared to the train, a combined model for all modes was created for the initial stated preference survey in order to compare the train to both the bus and the car. For the second survey, a mixed SP-RP model was created using a scale correction for the stated preference survey since variance of error terms may differ between the RP and SP models.

The rail bonus expresses the ingrained preference of passengers to use the train rather than other forms of public transportation. In order to examine the existence of this supposed bonus in the Israeli periphery, the probability of choosing a mode of transport was calculated based on a typical trip conducted by a representative individual in the periphery.

The representative individual was surmised using the data accumulated from the second survey, which represents actual trips between Haifa and the peripheral areas examined. A summary of the individuals characteristics is shown in Table 1.

Table 1- Values used for representative individual

Trip purpose	Work
Leave time	Between 07:00 and 08:00 AM
Car Availability	Yes
Drive alone (if travelling by car)	Yes
License	Yes
Distance travelled (KM)	60
Origin	Beit She'an or surrounding area
Gender	Female
Age	Between 26 and 35
Marital status	Married
Number of Cars in the Household	1.3
Education Level	Academic
Occupation	Employee
Income group (1-Lowest, 5- Highest)	2

Next, an average trip was conceived to assess passenger mode choice using the utility functions estimated. The values of a hypothetical average trip are shown in Table 2.

Table 2- Values used for average trip

	Travel Time (Min)	Cost (NIS)	Frequency (Times per Hour)
Car	70	26	N/A
Public transportation modes	65	22	3

Using the representative individual and average trip, the mode probability was calculated for each mode. As the rail bonus examines preference when service factors for public transportation modes are identical, service factors used for both the train and the bus were identical. For the MNL model the choice probability for each mode is a function of the portion of the utility of all other modes examined in the model. For the mixed SP/RP model, a scale factor for the stated preference section of the model is included in the utility function of each alternative.

4. Results

Since the opening of the rail line, over 3 million passengers travelled on the Emek rail line between Haifa and Beit She'an with the ridership consistently increasing over the years. Understandable

dips, however, present themselves in September- October of each year due to the Jewish holidays, as shown in figure 1.

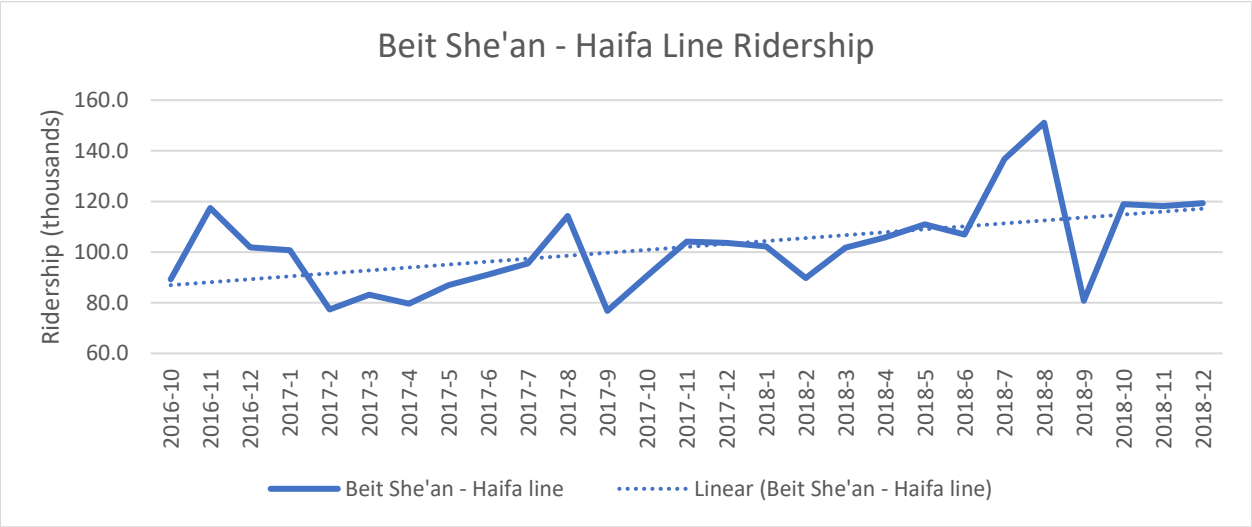

*Figure **Error! No text of specified style in document.**2- Beit She'an- Haifa ridership (CBS, 2020)*

Comparing the Emek Rail line to the Karmi'el-Haifa Rail Line, an additional rural line which opened in September 2017, both have similar ridership numbers in 2018 (1.342 million annual passengers on the Emek rail line compared to 1.346 million for the Karmi'el line), indicating that the Emek line provides similar ridership quotas compared to other rural lines and emphasizing the relative success of the line.

Exploring whether the rail bonus has any influence on the line, the probability of mode choice for each model and alternative were calculated based on the average trip and representative individual, as shown below in Table 3:

Table 3- Mode choice probability

	First Survey	Second Survey Mixed SPRP Model	
	SP Model	RP Model	SP Model
Probability of choosing Private Vehicle	54%	69%	16%
Probability of choosing Train	36%	26%	81%
Probability of choosing Bus	10%	5%	3%

These results indicate a large consistence preference for the train rather than the bus across all models. Before the opening of the Emek Rail Line, a passenger had a 36% chance of using the train compared to just 10% to use the bus, while the reveled preference model disclosed a slight decline in train choice, 26%, and a steep decline in bus preference to 5%, half the choice probability in the initial model. This decline may be explained by the frequent delays and cancellations the train passengers experiences on the Emek Line, with low frequencies of just once an hour, and twice an hour in the morning rush hour, these delays may have a significant affect on a passengers willingness to take the train compared to the private vehicle.

The possible improvements proposed in the stated preference section of the mixed model may explain the substantial increase in train choice probability and the difference presented between both models. The proposed improvements to travel time, trip price and especially

frequency had a meaningful influence on peripheral residents, raising the probability and willingness to use the train while at the same time continuing the decline in bus choice probability.

To further examine the existence of the rail bonus in a peripheral setting, an additional model was created. This model included only the alternative service factors, based on the additional definition of the rail bonus, which stipulates that the rail bonus is only expressed when the utility function only includes the alternative service factors, as the inclusion of perception and individual characteristics may change the nature of the mode specific constants (Barlach, 2011; Bunschoten et al., 2013; Hensher et al., 2015). Additionally, in this model the service factor variables of both the train and the bus are forced to be identical as the rail bonus hypothesis a preference for the train when service factors are identical across the difference public transportation modes.

Based on data from the second survey, a multinomial logit model was created using only the service factors of the alternative- travel time, price, and frequency were examined. The design of this model, however, also required the coefficients of both public transportation modes to be identical. Table 4 summarizes the findings of this model, with the t-test results displayed below the value of each variable, in parentheses.

Table 4 - Model with only the variables of the alternative

	Car	Train	Bus
Constant	Base Case	**0.679** (1.67)	**-0.968** (-1.97)
Travel Time	-0.0373 (-3.46)	-0.0505 (-5.89)	
Price	-0.0672 (-2.49)	-0.0994 (-6.75)	
Frequency		0.114 (2.54)	

As hypothesized, the constant of train calculated in the second model is positive, with a large value compared to the negative constant estimated for the bus. This result further indicates the influence of an additional factor, the rail bonus, which affects the preference to use the train rather than the bus. Past studies surmised that his factor may represent emotional factors and image passengers attribute to the train, indicating a psychological component when choosing between a train and a bus for transit (Megel, 2001; Scherer, 2011, 2012).

5. Conclusions

Ridership on the Emek Rail Line has consistently risen since the opening, with a 21% rise in ridership between 2017 and 2018 indicating the beginning of a successful rural line. This information is supported by the representative passengers' mode preference, which uncovered an overall preference to use the train rather than the bus to make an average type of trip.

Further supported by the results of the second model, where the constant of the train was found to be positive compared to the bus constant, indicating that when service factors and coefficients of public transportation is identical there is still a preference for the train, indicating an ingrained passenger preference to use the train rather than the bus in the periphery.

This preference cannot solely be explained by service factors, but rather additional latent factors which influence a passenger when choosing between the train and the bus in a peripheral setting. Further research is needed in order to estimate the components of the rail bonus as well as its exact influence and size, as understating the exact elements which constitute this bonus may allow bus-based systems to emulate these advantages.

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