

Research Proposal v2

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March 16, 2023

1 Statement of question

How accessibility to transportation affects the prices of houses is a subject that has been widely investigated in real estate and economics research. In this study, I propose to pursue this topic again, and this time using the evidence of the latest transportation construction plan in Taiwan, namely, the proposal for a new station of Taiwan High-Speed Rail (THSR). The THSR connects the northern part of Taiwan, Taipei, all the way down to the southern part, Kaohsiung, spanning a total distance of 350 km. In 2019, the government announced the Railway will be extended from Taipei to the eastern county, Yilan. In this research study, I want to measure how house prices change because of the construction plan.

A public construction plan has different stages of publicizing. Following Yiu and S. Wong (2005), I plan to exploit the differences in the stages. According to official records, as early as 2017, the evaluation of the construction had started, but no formal proposal was raised. It was not until 2019 did the plan become known publicly when the then Minister of Transportation announced the proposal for a new THSR station in Yilan. Then in February 2021, 4 sites in Yilan were chosen as the candidates for the THSR station, after which I call the first stage. The second stage came after December 2021, when the Government announced the final decision on the location among the four.

My hypothesis is that the price of the houses would reflect people's expectations of the accessibility to the THSR station in the future. After the announcement of the proposal, although there was some speculation, the information about the station's location was not clear. The overall house prices in Yilan would rise. In the first stage, I expect to see a more obvious increase around the 4 proposed locations. As for in the second stage, the areas around the winning location would have the most obvious growth among the four sites in house prices.

More detailedly, I plan to apply the hedonic model to measure the premium of expected accessibility to the THSR station. I would like to use a difference-in-differences design in the hedonic model framework, and conduct with 2 parts: pre-announcement stage v. stage 1, and stage 1 v. stage 2. The hedonic model for the price of a house includes the interaction term of the stage in which the transaction is made and expected accessibility. And I would like to try three different kinds of expected accessibility: (a)

dummy variables of the house located within a certain distance, say, 1 km, to the candidate locations, (b) continuous distance from the nearest locations, and (c) discrete bins of the distance (gradients) from the locations.

For the data sources, I will use the data set published by the Taiwan Dept of Land Administration, which contains details of all real estate transactions each season, including the exact house address, price, usage, area, date of transaction, etc. Starting in 2012, the law requires each transaction of real estate to be recorded, creating a rich source of house price data.

2 Literature review

The classical theory of travel cost and house prices can be traced back to von Thünen's model of agricultural land use, who posits that the rent of a property is inversely related to its distance to the market. Stemmed from von Thünen's agriculture-focused model, Alonso (1964), Mills (1967) and Muth (1969) further developed the monocentric urban land use model, called the "bid rent theory", focusing on how house prices change as the distance from the central business district (CBD) increases, where the bid rent refers to the land user's willingness to pay for the accessibility to the CBD.

This research would serve as a piece of evidence for the theory above by showing the decrease in travel costs to the CBD (in this case, Taipei) will lead to an increase in housing prices. There have been several related studies done examining the effect of improvement in transportation. For example, Debrezion, Pels, and Rietveld (2011) use the hedonic model on the Dutch housing price data from 1985-2001 to conclude houses that are close to the station are 25% more expensive than houses that are at a 15 km or longer distance; Levkovich, Rouwendal, and Marwijk (2016) explores the effect of highway development on housing price, also in the Netherlands, with repeat sales and DID method, and finds a positive effect of proximity to the highway on housing price; Mohammad et al. (2013) conducts meta-analysis on 23 empirical studies, mostly in the US, and finds that the distance to railway stations has a positive relationship with the house prices and that the change in the purchase price is actually similar across the studies.

As opposed to the extensive evidence found in Europe and the US, the studies focused on East Asia provide relatively weaker evidence, some due to a lack of good quality data (e.g. Andersson, Shyr, and Fu 2010; Hu 2010), and some due to imprecise measurement (e.g. Geng, H. Bao, and Liang 2015). However, the investigation of the question in East Asia remains important as we are currently observing a large number of ongoing and planned constructions of transportation infrastructure in East Asian countries, and the effect on real estate prices may be different from the western countries because of differences such as house owning culture.

Another strand of literature related to this research is the effect of expected accessibility to transportation. The existing literature studying the dynamics of price uses the timing of the completion or the opening of the transportation as the shock of the transportation (e.g. Levkovich, Rouwendal, and Marwijk 2016). However, this would likely be an underestimate of the change since the price of the housing would be likely to increase right after the announcement of the project and well before the opening of the service due to

the expected increase in accessibility. There are a few articles focusing on the expected increase in accessibility, such as Yiu and S. Wong (2005) and H. X. Bao, Larsson, and V. Wong (2021) investigating the effect of expected tunnels on housing prices, and Cengiz, İnce, and Çelik (2022) find that the average increase in house prices before construction is greater than the increase after the construction had started.

3 Contribution

Most of the studies measuring the effect of transportation are conducted using cross-sectional data. However, only using the cross-sectional data would suffer from endogeneity problems, such as omitted variable bias. It is possible that transport infrastructure is chosen to be built in a neighborhood with certain traits that are not included in the hedonic model. This study, however, proposes a semi-DID design. Not only does the design preserve the benefits of the hedonic model, but it also incorporates the spirit of a control group. Using the “losing” locations for the THSR station as control, we can ensure that the treated and controlled locations share important characteristics in common, for example, proximity to the township center and train stations.

Additionally, this paper would use the data set made available due to the enforcement in 2012 of a law in Taiwan requiring the registration of the actual selling price in real estate transactions. The law requires people to disclose the complete address of the property and the actual selling price. The data set is thus comprehensive and accurate. Indeed, it contains detailed features of a property such as the number of rooms in the house, so the specification can be richer when constructing the hedonic model. This would solve the problem mentioned above of poor-quality data, and give a more precise measure of the effect. By estimating the effect of expected accessibility instead of actual change in accessibility, this research would increase our understanding of the dynamic of housing prices in terms of changes in expectations. In fact, the proposed method in this research will explore the price change in 4 different stages of announcements, so that the change can be observed even more closely.

Furthermore, the study would add to our knowledge of the housing market in East Asian countries. The housing cultures are certainly different across regions. For example, in China and Taiwan, there is more owner-occupied housing than in the US. This piece of knowledge is important as we see transportation construction growing in East Asia.

Finally, the result of the study will benefit policy-making in Taiwan. Firstly, there are plans to extend the south part of THSR, and the experience this time in Yilan can serve as a lesson. Secondly, it is beneficial for future urban planning. The planned TSHR extension will make the connection between Taipei and Yilan tighter, so understanding the change in house prices in Yilan will help better urban policy for topics such as commuting.

4 Data

The dataset used in this analysis is Actual Price Registration Dataset (APRD). The dataset covers almost all sales transactions of the Taiwanese real estate market for a period of

5 years from 2018 to 2022. These transactions are recorded by the Department of Land Administration, Taiwan Ministry of the Interior. In 2011, the Actual Price Registration Act was passed in the congress. Thus, starting in August 2012, the transaction parties are required to register the actual price of sales transaction of real estates within 30 days after the transaction. This greatly improved the precision of the price information and the coverage of the transactions.

Table 1: Sample size compared to total observations

Year	In Sample	Not In Sample	Total
2018	1,446	4,828	6,274
2019	1,694	5,231	6,925
2020	2,104	5,883	7,987
2021	2,327	6,470	8,797
2022	1,422	4,605	6,027
Total	8,993	27,017	36,010

Table 1 summarizes the sample size for each year, and compares the sample in use with the full observations in the dataset. After filtering out the transactions that happened before 2018, the full transaction data for Yilan county contains a total of 36 010 real estate transactions, with each year ranging from around 6 000 to 9 000 observations.

For the purpose of this research, I restrict the data to only residential houses. Furthermore, to limit the size of computation, I only include the single-family houses, which means that condominium buildings are excluded in the analysis. The remaining sample is cut to a total of 8 993 observations, with an average of around 1 400-2 400 observations each year. Notice that the numbers of transaction in 2022, both in sample and out, are not on the increasing trend. This is likely because transactions that happened in 2022, especially the ones in December, have not yet been registered by the end of the year (recall the 30-day registration rule). Since I only use date to see if the house was sold pre- or post- announcement, the incompleteness of the 2022 data should not cause a problem.

Table 2: Description of variables in the dataset

Variable	Definition
Location & Neighborhood	
Villages/Towns	Villages/towns where the house is located.
Address	The exact address of the house.
Zoning	City zoning, e.g. residential, commercial, agricultural, etc.
Contract	
Transaction date	Date of the transaction.
Total Price	Total price of the house. (\$NTD)
Structure	

Variable	Definition
Number of stories	Number of stories of the house.
Main building material	The main material of which the building is made.
Built date	Date when the construction of the house was completed.
Total area of the floor	Total indoor area of the building (m^2).
Number of bedrooms	Number of bedrooms.
Number of living rooms	Number of living rooms.
Number of bathrooms	Number of bathrooms.
Containing partition?	Whether some rooms are separated by light walls. (Yes/No)

Table 2 lists the variables provided in the dataset. According to Malpezzi (2002), hedonic models for residential houses usually include the following aspects: structural, neighborhood, locational, and contract characteristics. This dataset incorporates information related to the addresses, the price of the real estates, and the structural characteristics. Whereas the structural characteristics and contract characteristics can be directly applied from the dataset, the address requires further processing to exploit the locational effect. I plan on geocoding the houses to compute the proximity to the train station, which would serve as the main independent variable of which the effect we would like to understand.

5 Research Design

5.1 Model specification

The method that I plan on using is the hedonic model. The development of hedonic model is often traced back to Lancaster (1966), where he proposes to measure the utility of the non-market goods by viewing them as characteristics of a market good. Using this model, we can single out the consumer's utility of a certain non-market good if we control all other characteristics equal. Housing is the most common example because people receive the utility of the house not through the building *per se*, but through the service it provides, for example, the shelter from the rain, its accessibility to the park, the rooms in the house that can stack groceries, etc. (Malpezzi 2002) In this research, I want to measure the expected value of the accessibility to a THSR station, using the housing value as the market good where our interest attaches.

Within the hedonic model framework, I will use a difference-in-differences design to specify the effect. I plan on evaluating the expected accessibility to the THSR station in 2 parts. In the first part, after the announcement of the candidate locations, I compare the differences in the house prices within a certain distance to the the candidate locations and those that are not. In the second part, I use the candidate locations as the control group, and observe the difference in house prices before and after the announcement of the winning location. The difference in the effects between the two stages can be used to explain the people's expected utility with different level of probability.

For the model specification, I follow H. X. Bao, Larsson, and V. Wong (2021) and Debrezion, Pels, and Rietveld (2011) to adopt a semi-logarithm functional form. According

to Malpezzi (2002), this semi-log model has a few important benefits, including that we can simply interpret the coefficients as percentage change in the house prices given a unit change in the corresponding characteristic. This means using the form can help us compare the same effect across different countries.

The general model used in the research is the following:

$$\begin{aligned} \ln(P_{i,t}) = & \alpha + \beta Post_t \times EAT_{i,t} \\ & + \gamma EAT_i + \delta Post_t + \zeta' \mathbf{X}_{i,t} + \eta_i + \epsilon_{i,t}, \end{aligned} \quad (1)$$

where $\ln(P_{i,t})$ is the logarithm of the price of house i transacted in month t ; α is the constant; $\mathbf{X}_{i,t}$ is a vector of structural and locational characteristics of house i (I will come back to this); η_i signifies the village/town fixed effect. Our main coefficient in interest is β , which is the effect of the expected accessibility to the THSR; and ϵ is the error term.

I use different measurement for the expected accessibility in the two stages because they have different features. For the first part, I would like to use 2 different metrics: (a) the Euclidean distance between house i and its nearest candidate, and (b) a dummy variable indicating whether house i is within 2 km (or other number) to the nearest candidate location. In case (a), since the larger distance implies less accessibility, it has to be noted that we expect β to have a negative sign; and in case (b), I expect β to have a positive sign since the accessibility should have a positive impact on the price of the house.

For the second part, I want to use a slightly different approach: I treat the "losing locations" as the control group. Thus, the metrics I use here are different: (a) using the proposed station locations as centers and splitting the areas around them into 5 zones for increasing distance away from the centers, (b) using a dummy variable indicating whether a house is within 2 km to the "winning" location, and (c) the continuous Euclidean distance between house i and the winning location. More specifically, for part (a), the model will become the following:

$$\begin{aligned} \ln(P_{i,t}) = & \alpha + \sum_{k=1}^5 \beta_k Post_t \times Treat_i \times Zone_{k,i} \\ & + \sum_{k=1}^5 \theta_k Zone_{k,i} \\ & + \gamma Treat_i + \delta Post_t + \zeta' \mathbf{X}_{i,t} + \epsilon_{i,t}, \end{aligned} \quad (2)$$

where $Treat_i$ is a dummy variable indicating whether house i is located within proximity to the finalized station location; $Zone_{k,i}$ is a dummy variable which equals 1 if house i is located in zone k to the nearest candidate location. This specification allows us to compare the effects on different zones through $\beta_1, \beta_2, \dots, \beta_5$. The variables $Zone_{k,i}$ can control for the effect of locating in different zones. To avoid confusion, this model omits the interaction term of any duo combination of $Post$, $Treat$, and $Zone$. Moreover, the model drops the village/town fixed effect since most of the houses with respect to the same station location are in the same village/town, and so it is not useful to keep the fixed effect considering we already have a control variable for the treatment group.

For part (b) and (c), I am using a similar model as model (1), but the data are restricted to the houses located within the specified distance to a candidate location. Thus, in case (b), $EAT_{i,t} = 1$ only when house i is located near the "winning" location, and $EAT_{i,t} = 0$ when house i is located near a "losing location". In case (c), $EAT_{i,t}$ is measured using the distance between house i and the winning location.

Finally, I want to mention $X_{i,t}$, the vector of characteristics of house i . In this vector, I would include all the structural variables listed in Table 2, namely number of stories, main building material, built date, total floor area, number of bedrooms, number of living rooms, number of bathrooms, and the dummy variable of containing partition. Additionally, the zoning variable under the location category would also be included. I am also planning on including the distance of the house to other important facilities, e.g., schools, hospitals, and the entrance and exit of the highways.

I will use the google maps API to geocode the location of each house by their address, and calculate the distance with QGIS, an open-source geographical information system.

5.2 Method limitation

The model attempts to capture the effect of increase in price due to the expected accessibility to the THSR station. However, the models in this research have the following limitations:

1. *Capture of only partial expected accessibility effect:* The government announced the new construction plan in Yilan in 2019. People already expected the accessibility in Yilan by the time, and the candidate-in-future (e.g. area around train station) were likely already expected to have higher probability to have the station. Since the models in this research can only capture the effect after the announcement of the candidate locations, a part of expected effect would be ignored. As a result, the estimate of this research would serve as a lower bound of the total expected effect.
2. *Different probability across the candidates:* In Model (1), I assume the probability of winning for each candidate is the same, whereas in real life people had different beliefs in which location were more likely to win. The estimate should reflect the average probability across the four candidates perceived by people in the period.
3. *Change of characteristics of houses on market:* The design of the model compares the difference before and after the announcements, assuming the house transacted in the two periods are similar. However, it can happen that once the announcement came out, the unobserved characteristics on-market houses located in the designated area changed. The direction of this bias is ambiguous, and it can bring concern to the accuracy of the estimates.
4. *Change of house types on market:* This is similar to the previous point. Since I only include transaction of single-family houses in the analysis, I ignore other types of residential houses. It could be the case that people have greater preference for apartments after the announcement because they are generally closer to the station. If this were true, then this research would be an underestimate of the effect.

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