

# *Network Effects in a Two-Sided Platform: The Rise of Home-Sharing Companies*

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**Abstract:** The sharing economy recently has been regarded as a viable alternative to many traditional markets. The unprecedented rate of growth entails some close examination to the extent of network effect, compared to other websites and platforms. However, a rigorous study on the network effect among home-sharing market has not emerged; hence my work provides evidence to support the idea that network effect is one of the major forces that drive the expansion of home-sharing market, as opposed to any traditional form of advertising. The results of regressions indicate that the cross-market network effect works in both ways yet the increase in the number of listings.

## 1. Overview

### 1.1. The Objectives of the Research Paper

Network effects are defined as the effects that one's usage of a good or a service has on the value of that product to other current users and potential users. In another word, there is a strong correlation between the number of users of the product and the essential value of the product. A good example is the telephone. The larger the network is, the more valuable the telephone service is to the next user.

Two-sided markets are economic platforms that provide multiple user groups network benefits by correctly connecting them. Examples can be found in many markets, such as operating systems and communication networks. There are also a large number of famous companies that successfully maximize the benefits of two-sided markets, such as Google, Skype and Facebook. A typical online two-sided market consists of three markets: the seller market, the buyer market and the online platform that connects the two markets. How users from each market are connected depends on the nature of the service <sup>[1]</sup>. Home-sharing companies, such as Airbnb and HomeAway, are an integral part of the whole "sharing economy". On the supply side, individuals can provide short-term rentals of vacant housing they own that would otherwise be sitting idle; on the demand side, individuals can find all kinds of unique apartments and houses at the lowest price. Research shows that expansion of the home-sharing network has a statistically significant negative effect on economy hotel revenues, which shows that home-sharing economy and hotels are vying to win the same group of consumers.

The paper aims at empirically analyzing network effects of the online home-sharing market from 2008 to 2013 through two websites, Airbnb and HomeAway. Given the current study of

network effects in sharing economy, I predict that every one listing on the website will result in significant percentage increase in the number of potential users and vice versa. Using data I collect from Airbnb.com and HomeAway.com over the five years from 2008 to 2013 and other statistics of funding and number of employees, I show that the number of listings on the online platform is positively correlated to the number of users and vice versa <sup>[2]</sup>. My preferred specification allows us to project that, a 1% increase in the number of listings result in 1.711% increase in the number of potential users and a 1% increase in the number of users lead to 0.65% increase in the number of listings.

To provide additional robustness to the results, I include multiple control variables, such as population and unemployment rate. I also incorporate one instrumental variable to each regression. After taking into the effect of the 2008 Financial Crisis, the cross-market network effect is confirmed.

## 1.2. Reasons behind Network Effects

There are two major reasons for network effects: trend observation and behavior alignment (Easley and Kleinberg, 509). Informational effect is the critical drive: since actions of other people tend to convey a certain kind of message about what they know, observing such behavior and copying it can be a rational choice. Through such collection of information, one can observe trends and possibly profit from such information collection.

## 1.3. Theoretical Model

Katz, Shapiro and Varian proposed an approach to evaluate the reservation price of consumers by taking account into the total number of users of the good (Easley and Kleinberg, 515):

$$x = r(x) f(z)$$

$x$  = the reservation price of consumer  $x$

$r(x)$  = the intrinsic interest of consumer  $x$  in the good

$f(z)$  = the benefit to each consumer from having a  $z$  fraction of the population use the good

As  $z$  increases,  $f(z)$  increases with the rate that reflects how much more valuable when more people are using the service. The multiplicative form indicates that the intrinsic value of the good greatly raises the reservation price of a consumer. In this case,  $f(0)=0$  because when no one is using the platform no one is willing to pay for the good.

If all consumers have an accurate prediction of  $z$ , the fraction of population that is utilizing the platform, the correlation between number of consumers and price is shown in the Appendix 3. Initially as the consumer base expands, the price will go up. However, after reaching a tipping point, the increase in the number of users has a negative effect on the price because the platform is no longer able to sustain the consumer base. The congestion might lead to inefficiencies, such as delay in services, thus further decreasing the value of the service.

Given a  $z$  value that is not a tipping point, the curve can be divided into three intervals based on the psychology of consumers. Between 0 and  $z$ , there will be a "downward pressure" on the consumption of the product because the undeveloped network cannot meet the expectation of consumers. Consumers will regret utilizing the temporarily inefficient platform, thus driving the demand for the service down. Between  $z$  and  $(1-z)$ , the sufficiently large number of users make the platform efficient, thus attracting even more potential users. This force is categorized as the "upward pressure", which will increase the demand for the service. Between  $(1-z)$  and 1, the "downward pressure" starts to exert forces again due to the inefficiencies caused by congestion, thus further decreasing the demand.

I believe that the two home-sharing companies have passed the first phase of "downward pressure" and are currently experiencing "upward pressure" which increases the demand for the service. The most crucial factor that brings more users is the network effect.

#### 1.4. The Rise of Home-Sharing Companies

Airbnb is an online two-sided platform that connects renters who seek short-term rentals and hosts who have the capability of providing the service. As the second largest company in the sharing economy, Airbnb perfectly exemplified the power of network effects. The hosts list their space online with their own nightly, weekly and monthly rates, as shown in the Appendix 5; travellers choose the most suitable apartment or house and then directly book with the host on the website. Airbnb charges guests a 9- 12% service fee every time a reservation is booked, depending on the length of the reservation; and it charges hosts a 3% service fee to cover the cost of processing payments<sup>[3]</sup>. Airbnb is currently experiencing a lot of regulatory friction from governments all over the world due to its innovative business model. For Airbnb, the lengthy struggle to legalize the short-term rental service is just starting. Founded in San Francisco in 2008, the Airbnb now has more than 550000 listings and more than 10000000 nights of cumulative bookings at the end of 2014 (Taylor, "Airbnb Takes on Europe").<sup>[4]</sup>

HomeAway was founded in 2005 by acquiring several sites and consolidating them into a one home-sharing website. Having moved to the new headquarters in Austin in 2009, the company started to employ a new business model. The hosts can choose between a pay-per booking model of 10% commission for each booking and the long-term subscription-fee model averaged to \$442 annually (Austin, "HomeAway IPO"). Besides the commission, guests are not charged any additional fees. Therefore, the de facto free listing policy generated 20% increase in listings from 500000 to 600000 within 5 months of its introduction (Schaal, "New Business Model").

The challenge HomeAway is facing is very different from the one Airbnb is facing due to the differences in the business models. Increasing free listings without disrupting the balance between supply and demand is a surprisingly difficult task. It also needs to guarantee that free listings have sufficient amount of bookings by utilizing different strategies, such as highlighting the listings on the website, without affecting paid listings.

Two major differences between Airbnb and HomeAway are the distinct business models and different niche markets. Airbnb has a fixed service fee that's automatically deducted from hosts' income, while HomeAway provides a choice of "free listing". Airbnb's major market remains the large cities, such as San Francisco and New York, while HomeAway is dedicated to renting entire houses that are usually in vacation destinations, such as Hawaii and Lake Tahoe.

## 2. Literature Review

I intend to explore influences of network effects in the home-sharing market, a relatively new business model that just started to develop; Yuxin Chen and Jinhong Xie (2007) examine the role of the competitive implications of asymmetric customer loyalty in two-sided markets.<sup>[5]</sup> Unlike a traditional market where an advantage in customer loyalty will generate more profits, a medium level of customer loyalty in the primary product market can lead to a decrease. both Airbnb and HomeAway charge different rates of service fees on two markets, which substantiates the idea of price differentiation. Another finding of the paper is that due to the low cost of entry, the first-mover advantage is negligible and the second-mover advantage may endogenously occur, thus attracting even more users to join the network. I explore the home-sharing markets, specifically Airbnb and HomeAway, while they provide a theoretical framework of network effects in the two-sided markets. They take the consumer loyalty into consideration while I only include variables,

such as number of listings, amount of funding and number of employees.

Yifan Dou et al. (2013) explore how firms can strategically maximize network effects through social media features [6]. When the firm targets at an individual consumer type, the researchers find the complementarities between seeding and the building of social media features in the presence of disutility associated with seeding. This paper aims at the correct theoretical approaches of maximizing network effect while I examine the empirical extent of network effects.

Mei Lin et al. (2015) evaluate the influence of network effects on firms' pricing strategies [7]. They find that the platform pricing not only depends on the cost of entry, which directly correlates with network effect, but also depends on the buyers' preferences and the distribution of the sellers' quality. The best strategy is to subsidize the sellers when the market is sufficiently liquid, which is essentially the strategy of Airbnb.

### 3. Datasets and Data Processing

For my study, I collected and combined data from various sources, including Airbnb website, HomeAway website, other research papers and Google Trend.

Two control variables for regression 1, number of employees and amount of funding, are collected from Airbnb website. HomeAway also presented all the relevant information online, since it is a public company. Other general economic indices that are used as control variables for regression 2, such as population and unemployment rate, are obtained from US Census Bureau.

Google Trend is the proxy variable for the number of potential users. Since I could not obtain the statistics of web traffic from 2008 to 2013, I only utilized the interest index over time on the Google Trend.

#### 3.1. Hypotheses

I intend to explore the strength of cross-market network effect between the host market and the user market from 2008 to 2013. I utilize two sets of panel data from Airbnb and HomeAway to achieve the goal, which includes two main questions:

- ✎ Does the increase in the number of listings result in higher Google Trend index?
- ✎ Does the increase in Google Trend index result in more listing on the website?

Two base specifications are presented, where positive coefficient indicates that there is a positive correlation between the dependent variable and independent variable. In addition to each base specification, other variables that will affect the dependent variable are controlled, such as amount of funding, the number of employees, unemployment rate and population. The influence of the 2008 financial crisis is also taken into consideration.

#### 3.2. Regression 1: Google Trend Index as the Dependent Variable

The null hypothesis is that the number of listings will not affect the Google Trend index, which is demonstrated by a statistically insignificant coefficient. My base specification takes the following form:

$$\log(\text{Google Trend Index}_{i,t}) = \beta_0 + \beta_1 (\# \text{ of Listings}_{i,t}) + \varepsilon_{i,t}$$

I construct the dependent variable of the specification by applying the panel data of annual cumulative number of listings and annual average Google Trend interest level, indexed by year  $t$  and website  $i$ . The coefficient of interest is  $\beta_1$ , which is interpreted as the percentage change in the Google Trend index caused by a 1% increase in the number of listings in the seller market. Then I include two control variables, the amount of funding and the number of employees.

I began with the base specification without any control variables and the results are listed in the first column. I found out that a 1% increase in listings result in 1.421% increase in the Google Trend index ( $p < 0.01$ ). As the two control variables are included, the results are shown in the column two to four in the appendix. The  $R^2$  remains at a sufficiently high level. The coefficient for number of listings remains similar but the statistical significance drops to a lower level. While the two control variables are positively correlated with the Google Trend index, unfortunately the results cannot reach the statistical significance of 0.1. Therefore, my preferred specification is the base specification, which shows that 1% increase in listings result in 1.421% increase in Google Trend index. The results make intuitive sense, as the network effect indicates that consumers will be more attracted to the website with the most listings, thus boosting up the search for Airbnb and Homeaway. This effect will push the home-sharing sites to grow more quickly.

### 3.3. Regression 1: The Lag Effect

Since the network effect usually has a lag effect, I also include an additional group of regressions with lag effect, as shown in the appendix. The previous regressions are based on the assumption that the increase in one market has an instantaneous effect on the other market within the same year. However, another reasonable assumption is that it takes some time for the network effect to exert influence on the other market. In another word, the increase in the number of listings in year (t-1) will result in the increase in the Google Trend index in the year t, which also applies for all other control variables. The regression is shown below:

$$\log(\text{Google Trend Index}) = \beta_0 + \beta_1 (\log \# \text{ of Listings}_{i,t-1}) + \varepsilon_{it}$$

The coefficient of the number of listings decreases to 1.063 ( $p < 0.1$ ) and all columns do not have sufficiently high statistical significance for all variables, which shows that the correlation between the current year's Google Trend index and the last year's number of listings and other control variables is relatively weak. One compelling explanation is that the network effect spreads extremely quickly within one year or even within one month. Therefore, the lag effect does not exist in the home-sharing market.

### 3.4. Regression 1: Instrumental Variable

In order to improve the robustness of the regression, I decided to include an instrumental variable---the US Home Price Index. The property price index directly correlates with the number of listings because one can argue that the major incentive for hosts to put their apartments and houses up is the revenue that can be generated. As the property price increases rapidly, the number of listings will increase exponentially as more residents, especially people living in metropolitan areas, such as New York and San Francisco, need some extra money to pay rent. However, the index doesn't have a direct correlation with the number of potential users since customers are usually comparing the hotel price and the price on home-sharing sites, other than the property price. Therefore, this is a legitimate instrumental variable that can improve the accuracy of the regression.

### 3.5. Regression 2: Number of Listings as the Dependent Variable

The null hypothesis is that Google Trend index will not have an influence on the number of listings, which is demonstrated by a statistically insignificant coefficient. My base specification takes the following form:

$$\log(\# \text{ of listings}_{i,t}) = \beta_0 + \beta_1 (\log \text{ Google Trend index}_{i,t}) + \varepsilon_{i,t}$$

I construct the dependent variable and independent variables of the specification utilizing the same panel data. The only difference is the interpretation of the coefficient  $\beta_1$  as the percentage change in the number of listings posted by hosts caused by a 1% increase in Google Trend index. Then I include a different set of control variables, such as US population and unemployment rate.

Home-sharing sites, they have many choices, such as different home-sharing websites, economy hotels and hostels because the market of home-sharing platforms has relatively low entry barrier, compared to other markets. It does not require a larger amount of startup capital and labor force. The only two requirements is the correct expertise, in terms of computer programing, and an idea that can successfully penetrate the sharing market. Therefore, there are relatively large number of websites that offer the service, such as VRBO and FlipKey. If a consumer cannot find the exact housing he or she desires, the consumer can always search another platform. More importantly, the competition from traditional hoteling industry remains ever strong. Therefore, the number of listings defines the value of network to the next user, which accentuates the network effect from seller market to buyer market.

### 3.6. Regression 2: The Lag Effect

Like regression 1, another reasonable assumption is that it takes some time for the network effect to exert influence on the other market. In another word, the increase in the Google Trend index in year (t- 1) will result in the increase in the number of listings in year t, which also apply for all other control variables. The regression is shown below:

$$\log \# \text{ of listings}_{i,t} = \beta_0 + \beta_1 \log (\text{Google Trend index}_{i,t-1}) + \varepsilon_{i,t-1}$$

In terms of the number of listings; without any delay, consumers will vote with their mouse. For the hosts, it takes a much longer time to prepare to put a listing up because the page needs to include complete information about the housing and the host with sufficient amount of pictures. More importantly, the host needs to do extensive research in order to strategize to set the correct price, target at the correct group of consumers and present the unique selling point. For an inexperienced host, the project can take months. Therefore, the number of listings responses to the number of potential customers with lag effects, since the host needs a period to build up a profile.

### 3.7. Regression 2: Instrumental Variable

For regression 2, I chose another instrumental variable---the U.S. average hotel price index. It directly correlates with the number of potential users since hotel service and home-sharing service are substitutes goods with a positive cross elasticity of demand (Georgios et al., "The Impact of Airbnb"). However, no evidence can prove that hotel price has a certain level of influence on the number of listings. Therefore, this is an ideal instrumental variable.

Taking the growth of population into consideration, second column indicates that the percentage increase should be 0.65% ( $p < 0.01$ ), instead of 0.595%. The coefficient of the control variable also is statistically significant. However, the control variable, the employment rate, is not statistically significant. All specifications have a  $R^2$  value that is reasonably high. Therefore, my preferred specification shows that 1% increase in number of listings results in 0.65% increase in the amount of traffic.

### 3.8. The 2008 Financial Crisis

I considered the possibility that 2008 Financial Crisis had an influence on the number of listings and the potential users. The crisis is directly driven by subprime lending, which is directly related to



Airbnb and HomeAway, a business that depends on the spare housing inventory (Georgios et al., "The Impact of Airbnb"). The impact is not very clear from previous two regressions, yet the omitted time-varying factor should be controlled. I excluded all data of year 2008 and 2009 since these two years are the main crisis period with the major economic effect. Overall, all coefficients increase but the statistical significance decreases to a very low level, which makes the result more unconvincing. I conjectured that by excluding the data of the first two years, the panel data only includes four years, which tremendously increases the standard deviation of the results. More importantly, Airbnb was founded in 2008 and HomeAway entered its most critical market, Texas, in 2008, which shows that the two startup companies in the sharing economy might not be influenced by the crisis as other huge corporations. Therefore, the exclusion of the 2008 Financial Crisis might yield a less accurate result.

#### 4. Discussion and Further Work

The major limitation of the paper is the quality of data. The data from Google Trend, as a proxy variable, might not accurately reflect the web traffic of Airbnb and HomeAway since potential consumers might not need to Google the site. If they have a basic understanding of the home-sharing sites, they can directly type the address then start to enjoy the service. The data for listings also lack specificity, such as regions and type of housings. Metropolitan areas and vacation spots might have completely different trends for number of listings, and different states also have different characteristics, which should be regarded as separate markets. The type of housing also should be taken into consideration, because it directly influences the buyer market. A shared bedroom with low price will attract more young people while a vacation house with a pool is more suitable to a family or a group of friends.

Since the sharing economy has been growing for only a few years, the panel data can only include data of 6 years. Obviously the dataset is not sufficiently large to decrease the standard deviation of the coefficients and make an accurate prediction. Therefore, a more comprehensive dataset is needed. My paper is only a small first step to explore the complex network effect behind the rising sharing economy. Given the rapid growth of the sharing economy, further work should be carried out on the economic, regulatory, societal and technological impacts of the sharing economy and how it is different from any traditional markets.

#### 5. Conclusion

The sharing economy recently has been regarded as a viable alternative to many traditional industries, such as taxi and hoteling. The unprecedented rate of growth entails some close examination to the extent of network effect, compared to other websites and platforms. However, a rigorous study on the network effect among home-sharing market has not emerged; hence my work provides evidence to support the idea that network effect is one of the major forces that drive the expansion of home-sharing market, as opposed to any traditional form of advertising. The results of regression 1 and regression 2 indicate that the cross-market network effect works in both ways yet the increase in the number of listings have a larger impact on the web traffic than the impact of the opposite direction.

As my result confirms the existence of network effect in the home-sharing economy, it could be viewed in another light. Airbnb and HomeAway not only provide a cheaper substitute to hotels, but also generate incremental income to hosts and companies. This might not necessarily be a competition between innovative platform and traditional service. The two home-sharing platforms might actually generate more demand for the housing by attracting more travellers with low price and unique experience; they might also increase the supply of housing by motivating more people

to share their homes with travellers all over the world. Such network effect might not only apply to the seller market and the buy market within the home-sharing market; it might expand to other areas, such as local job markets and food markets as travellers spend less on accommodation but more on other services.

However, negative externality should also be taken into consideration, such as noise to the neighborhood. The unregistered hosts and travellers might also pose a safety threat to local residents. Regulations on fire safety also needs to be specified. With the projected growth of the sharing economy, a series of related study needs to be carried in order to maximize the benefit of network effect in home-sharing economy and minimize the negative externalities associated with it.

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