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If a Tax is Levied and No One is Obligated to Remit It, Does It Make a Sound? Tax Remittance Responsibilities and AirBnB

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If a Tax is Levied and No One is Obligated to Remit It, Does It
Make a Sound?

Tax Remittance Responsibilities and AirBnB

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Abstract This tax-incidence analysis examines the shift in remittance obligations of those participating in the short-term rental marketplace, AirBnB. Theory would argue that the levying of a tax on supplier or consumer has no effect on the share of the tax burden they incur. This concept sadly goes out the window as the possibility for evasion presents itself. Through the implementation of a difference-in-differences analysis, it is possible to examine the effect of stabilizing the remittance responsibility by shifting the collection of taxes away from users and onto the platform itself. While no concrete evidence of evasion is found, the policy change results in a greater cost to consumers and contradicts theoretical expectation.

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1 Introduction

The development of “sharing economies,” services and systems that facilitate the exchange of goods and services between private users, have had an extremely disruptive effect on established industries. One of the more prolific cases of such is evident in the emergence of ridesharing. Specifically, rideshare services such as Uber and Lyft allowing users to organize, coordinate, and compensate others in exchange for on-demand transportation has fundamentally changed the taxi and livery market. The historically and notably regulated sector, with most major markets requiring the acquisition of a restricted quantity of taxi medallions, was all at once exposed to a level of price competition and availability that has profoundly altered market participants’ behaviors and income streams. A position that was previously seen as a failsafe income source, with medallions selling for upwards of \$1,000,000, has seen confidence falter with the emergence of ridesharing applications and, as a result, has experienced a steady decline in medallion valuation, some selling for less than 10% of their previous value. This ability to disrupt an established market has led to new enterprises presenting valuations above \$10,000,000,000.

A prime example of this disruption can be seen in AirBnB, a platform utilized by greater than 150,000,000 users that facilitates short-term lodging rentals between consumers and property owners. While short term lodging is not an inherently innovative concept, having been present in some form or another for millennia, AirBnB’s implementation of the idea—allowing everyday property owners to rent out their free space in a non-traditional market environment—has led to an extreme disruption of the vacation rental market, especially among younger market segments.

However, as many of these concepts have grown and developed nationwide presences, the question of regulation and taxation becomes more prominent. In the case of Uber, taxi regulation has historically standardized pricing and quality to avoid competitive price wars and maintain some level of economic profit for drivers so the service continues to exist. If anyone could show up at an airport and offer a visitor a ride to their destination there would be extreme levels of competition and uncertainty surrounding the product. With the emergence of Uber, this concern has held true and, as a result, the application has seen heavy regulation including temporary bans from several major cities (e.g. Austin, Las Vegas, Reno). Though these bans have been lifted, regulation still persists in most Uber markets, specifically regarding hailing procedures at airports and other public venues.

Similarly, in the case of AirBnB, the short-term rental market has historically been taxed. These taxes, known as “Hotel Taxes,” “Short-Term Rental Taxes (STRTs),” “Vacation Rental Taxes (VRTs),” and “Transient Occupancy Taxes (TOTs)” interchangeably, are generally between 10% and 15% of the cost of the stay and levied on any lodging rental that lasts less than 30 days. The general premise of the tax being that it allows localities to generate additional revenue from non-residents on top of property taxes already being generated. As AirBnB and other short-term rental sharing economies have grown there has been a major perspective shift. Initially, AirBnB viewed themselves as a service that connected two private users and as such, it was the onus of property owners renting their rooms to remit any taxes they may owe.

While this idea could be viable in theory, in practice, there were zero checks in place to hold owners accountable leading to an incentive to evade these taxes. As a result, localities began imposing regulations upon AirBnB and other short-term rental services requiring them to collect and remit all relevant taxes at the point of transaction from the consumer. This analysis looks at shifts in the implementation of these taxes and their effect on AirBnB market behavior—specifically examining the share of the tax burden borne by both property owner and renter as a result of the enforcement of these taxes and further analyze the possibility of tax evasion in markets prior to the enforcement of tax remitting systems through the examination of shifts in the sharing of the burden. While no definitive evidence of evasion is found, as it is concluded there is no decrease in the quantity of units supplied or quantity demanded, the fact that a tax-inclusive price increase is observed after remittance obligation shifts is strongly indicative of irregular market behavior.

2 Literature Review

The idea of tax incidence analysis is not a new one. Jenkins (1872) clearly outlines this concept stating, “It is well known that many taxes do not fall ultimately on the person from whom they are in the first instance levied.” More simply put, these analyses attempt to examine and understand the reality that those experiencing reduced welfare due to the imposition of a tax may not be the people who paid it. This idea is most simply illustrated in a partial equilibrium analysis, a process taught in many elementary economics courses.

In Figure 1, a tax is imposed upon a market causing an inward shift of the supply curve with the vertical height of the shift being equivalent to the height of the tax. This shift causes an increase in the total tax-inclusive price while also decreasing the net (tax-exclusive) price. By comparing the rectangles representing the consumer and producer share of the tax burden, the relative elasticities of each of the curves becomes more apparent with the more inelastic curve taking on more of the burden. This level of analysis is extremely insightful but is, in the field of tax incidence, only the beginning.

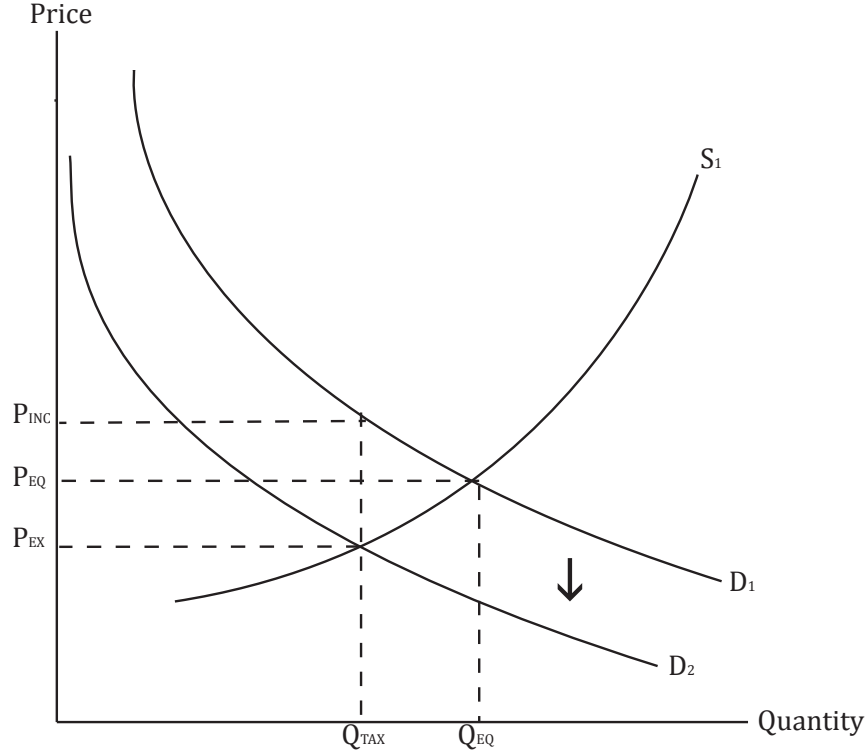


Figure 1: Partial Equilibrium Tax Incidence

From partial equilibrium came a general equilibrium incidence analysis model in Harberger (1962), which attempted to go beyond the aforementioned simple single market analysis to better understand the effect of a tax in one sector on another. This was then presented diagrammatically a decade late in McLure (1974). This expansion of theory allowed for a broader range of questions to be asked, specifically when attempting to look at stratified taxes like a progressive income tax or a geographically specific tax. While these analytical developments clearly provided greater levels of insight into the behaviors of multiple markets, in the context of this analysis, the implementation of a partial equilibrium analysis appears more pertinent given the desire to understand user behavior within the market in question.

In contrast to the depth and breadth of analysis done beneath the tax incidence umbrella, economic research regarding AirBnB and short-term rentals is much sparser and frequently falls in the domain of examining the service's relevance to adjacent industries including hotels and home rental markets. In Schäfer and Braun (2016) the effect that AirBnB had on the housing market in a set of German cities is analyzed to understand the rise in rental costs due to the opportunity cost of renting these listings on AirBnB. Schäfer and Braun methodologically approached the question by manually gathering data on the number of listings available daily over the course of several months. In Germany, if a unit "is used for reasons of repeated daily or weekly letting as a holiday flat or tourist accommodation, especially in cases of commercial letting of rooms or the establishment of overnight facilities" it is considered an illegal misuse of a housing unit.

Schäfer and Braun calculated the numbers of offending units available and regressed this number, relative to the total number of available units, against rental cost changes over the same time period in order to find the effect of these units on cost. While this effect of AirBnB and short-term rental units on general rent costs is extremely interesting, a significant amount of academic interest has been found in examining the economic impact of these units on the industry they are seen to be disrupting, hotels and accommodations.

Analysis on whether AirBnB can be seen as a substitute for other short-term lodging includes Koh and King (2017), which inspects the effect of AirBnB and short-term rental units on hotel rental demand by interviewing and analyzing responses from employees of mid-tier Singaporean hotels. After discussing and reviewing the possibility of shifts in demand, the researchers deemed that while the current status of AirBnB and other short-term rental services did not interfere or diminish demand for traditional hotel units, they did possibly pose a threat to future demand. The authors did not opt to attempt to quantify this conclusion, instead relying on qualitative analysis to defend and justify this idea. Further quantitative analysis could be conducted to verify or disprove this conclusion.

This step was taken in Zervas, et al. (2017) in which they conduct a difference-in-differences analysis on the effect of AirBnB entering certain marketplaces in Texas to analyze its effect on hotel revenue. This approach looked at the effect of AirBnB's presence in a community relative to communities in which AirBnB never entered in order to isolate the effect that the service had on hotel prices. They found that a 10% increase in AirBnB listings could be associated with a .39% monthly decrease in hotel revenues within a city and that this result was statistically significant.

Though these works reveal significant information regarding the relationship between AirBnB and other related goods, they do little in understanding the elasticities of supply, demand, and evasion in the AirBnB marketplace. This idea is, however, examined in Eleanor Wilking's working paper "Hotel Tax Incidence With Heterogeneous Firm Evasion: Evidence From AirBnB Remittance Agreements" (2016). By looking at the changes in pricing before and after AirBnB conducted the tax remittance, Wilking was able to isolate the effect of this tax incidence using a difference-in-differences implementation. Wilking (2016) found that the implementation of the tax remittance system led to a significant increase in the cost to consumers, and as a result meant that these short-term renters were bearing a larger share of the burden of the tax compared to property owners. Though significant, this analysis was conducted on data the author collected following the announcement that AirBnB would begin remitting payments for a given city. This could lead to changes in pricing behavior from the seller between the time of the announcement and the levying of the tax leading to a necessity of further analysis to confirm these findings. With this in mind, I intend to build upon theoretical models developed in Wilking (2016) to further this dialogue.

3 Theoretical Discussion

Willing describes the AirBnB market as monopolistically competitive after coming to the conclusion that property owners listing their homes or apartments on AirBnB present an inherently differentiated product—no two listings are identical as each AirBnB can be distinguished based upon convenience, appeal, appearance, or any number of qualitative characteristics. Consequently, the demand for AirBnBs can be understood as being downward sloping and a function of a given unit’s price (both absolute and relative to others), desirability, and the total supply of units.

In addition to market structure, an awareness of the status of tax remittance before and after the establishment of agreements with AirBnB is vital in understanding host pricing structures and profit maximizing strategies. Prior to the implementation of tax remitting systems, hosts were obligated to remit their vacation rental taxes themselves. That is to say, if one rented out a room in their home and received income from it, they were obligated to pay a share of these gains in taxes to their municipality at the rate of the tax. However, as opposed to hotels and other formal temporary occupancies, an AirBnB unit’s location and ownership information are not published or presented without first booking a stay. While relative location can be seen, it is impossible to pinpoint an exact address from a listing. Because of this, it is quite difficult to enforce the remittance of these taxes and owners are presented with ample opportunity to evade. Those who evade this tax would in all other ways remain identical to those who remit.

So, when maximizing profits, assuming all else equal, a remitting host incurs an extra cost, that of the tax. This can be seen in the equations:

$$\begin{aligned}\pi_{remit} &= P * Q * (1 - T) - C \\ \pi_{evade} &= P * Q - C\end{aligned}$$

Where P represents the seller established price, Q the market demanded quantity, C the generally associated costs, and T the rate of the tax. When solving for a profit maximizing price, *ceteris paribus*, it becomes apparent that the optimal price for a remitting host is greater than that of an evading one as they pass on a portion of the tax to the consumer. This is often represented graphically as an inward shift of the supply curve with the scale of the shift being equal to the size of the tax. This is present in Figure 2, where the original equilibrium represents a tax-exclusive price and the shifted supply curve intersecting the original demand represents a tax-inclusive price. Remitting hosts would best be described in Figure 2 as those resting on supply curve S_2 , while non-remitting hosts would remain on curve S and supply a greater quantity for any given price.

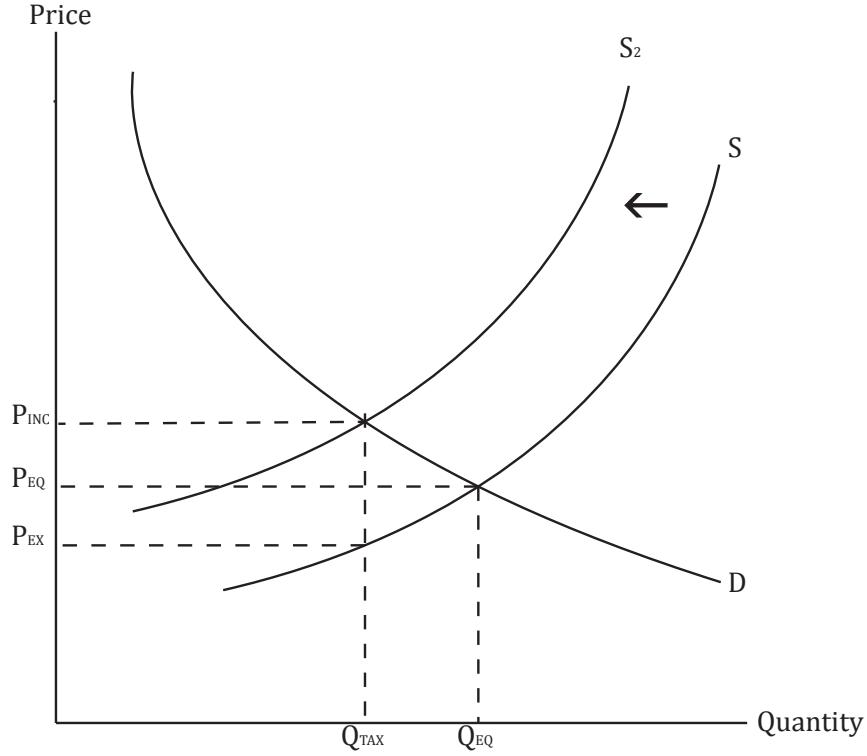


Figure 2: A Tax on The Supplier of a Good

As a result, AirBnB hosts could feel a pressure to evade this tax to keep prices and their own costs down to maximize profits.

So, when applying this Wilking (2016)-based model to a partial equilibrium analysis, it is extremely relevant to understand the relevance of a shift in responsibility of a tax. In an equilibrium tax incidence, whether a tax is imposed upon the consumer or supplier of a good, the tax-inclusive price of a good should, in theory, remain the same. That is, when a supplier is remitting a tax, the price they charge includes the tax and when a consumer is charged with the tax, the price a host charges will exclude that value. As a result of this conclusion, a shift in the implementation of a tax from supplier to consumer may affect the listed price, the price asked by the host, but should leave the total, tax-inclusive, price the same.

More simply, when hosts no longer have the obligation to remit these taxes, they should lower their prices such that consumers still pay, and demand, the same final amount. Were they not to, they would see a decrease in demand and depart from the optimal profit maximizing price. This shift in remittance obligation is visible in Figure 3 as the market simultaneously shifts from supply curve S_1 to S_2 and demand curve D_1 to D_2 . As hosts are no longer required to pay the tax, they do not need to charge the tax-inclusive price, P_{INC} , and instead charge the tax-exclusive price, P_{EX} , with the difference now being collected and remitted by AirBnB at checkout.

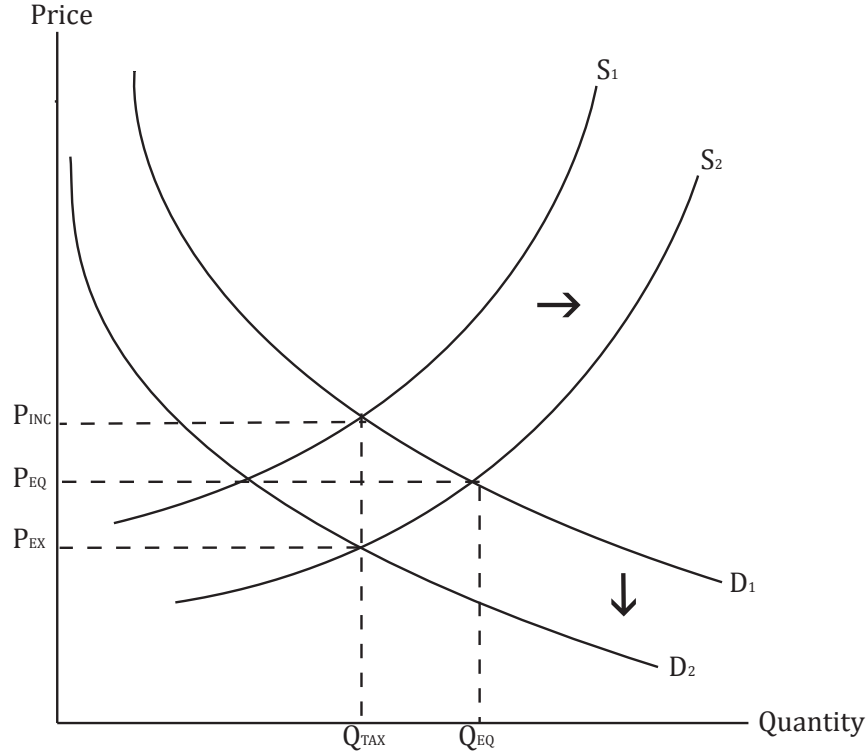


Figure 3: A Shift in Tax Remittance Responsibilities

However, non-remitting hosts operating in the market would experience the shift in remittance responsibility differently. To non-remitting hosts, the implementation of the new remittance procedure would be seen solely as a tax being implemented on the consumer. Instead of being represented as two simultaneous shifts affecting both supply and demand, this would best be represented as is shown in Figure 1. The inward shift in demand would lead to a decrease in listed price and quantity as hosts are subject to the tax they were previously evading.

4 Hypothesis

The body of analysis above, specifically Wilking and Zervas et al., has revealed two extremely relevant points of information to this analysis. First, Zervas et al. demonstrates that AirBnBs can be seen as substitutes for established short-term rentals including hotels and motels. Because of this variety of substitutes and the competition from other AirBnBs, consumers would have more elastic demand for a given AirBnB due to the availability of hotel rooms and other short-term lodging. In contrast, property owners are limited in ways to earn revenue from their property—they may rent the unit short-term via AirBnB or a competitor, rent it long term to a tenant, or sell the property. Second, Wilking has developed a model that implies opportunity for evasion when the obligation of remittance has been levied upon the host of an AirBnB. As a result of

this lack of substitutes for sellers and a present opportunity to avoid additional costs, two major hypotheses are presented: That sellers can be expected to bear a relatively large proportion of the tax burden given the ample supply of alternative lodging (via hotels or other AirBnBs) and, consequently, given the opportunity, sellers will evade additional costs presented by these transient occupancy taxes to remain competitive and undercut those remitting.

5 Empirical Strategy

In attempting to understand how the tax burden of these newly enforced hotel taxes is split between property owner and consumer and examine possible presence of evasion, a partial equilibrium analysis appears to be the most appropriate way of uncovering this effect. By comparing the total value of the tax with post-obligation shifted prices, the relative share of the burden can theoretically be calculated. This can be illustrated in Figure 1; the vertical height between the net price, P_{EX} , and the original equilibrium price, P_{EQ} , is representative of the producer, or in this case property owner's, burden. The consumer's burden would then simply be the remaining share of the tax not covered by the producer. To model this econometrically, a difference-in-differences model was deemed appropriate and can be seen as the interactive effect of a listing being in a market that is receiving a hotel tax and also having had the tax imposed:

$$\log(ListedPrice)_{imt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

Or, including the scale of the tax in the interaction:

$$\log(ListedPrice_{imt}) = \beta_0 + \beta_1 Accommodates_i + \beta_2 ToT_m * TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

Where $\log(ListedPrice_{imt})$ represents the natural log of the listed price of AirBnB i in market m at time period t , $Accommodates_i$ represents the number of guests a unit accommodates, $TaxImposed_m$ represents a dummy variable for if a tax was imposed in market m , $AfterTax_t$ represents a dummy variable for if a tax was imposed at time t , δ_m represents market based fixed effects controlling for variation specific to any given market, δ_t represents time based fixed effects controlling for variation specific to any quarter/year combination, ToT_m represents the scale of the hotel tax in market m , and ϵ_{imt} represents a residual error term. The number of people a unit accommodates was included in the model as it was, logically, found to be highly correlated with price as larger units generally cost more. In this case, β_2 would then be described as the percentage change in price the shifting of the remittance obligation has on listed prices. More simply, one could say it is representative of the price change between when hosts in a market were obligated to remit taxes and when they were alleviated of this obligation. This coefficient would be expected to be negative given that, theoretically, the drop from tax-inclusive price to tax-exclusive price would be equivalent to the scale of the tax.

To examine the possibility of evasion in this market, several methods could be used: the analysis could be approached from an examination of the quantity supplied or the generation of a tax-inclusive price variable. When looking at the supply of AirBnBs, the quantity of units supplied in the market should not change when the obligation of remittance shifts. If hosts were fully remitting, the quantity of units supplied and the number of unique hosts or units joining the platform would, in theory remain, constant across the implementation of the treatment. This idea could be modeled econometrically as:

$$TotalUnits_{mt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

or

$$TotalHosts_{mt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

or

$$NewUnits_{mt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

Where $TotalUnits_{mt}$ is equal to the total number of uniquely listed units in market m at time t , $TotalHosts_{mt}$ contains the total number of hosts in market m at time t , and $NewUnits_{mt}$ is representative of the number of listings added to the platform in market m and time t . Any significant negative shift in the total number of units, $TotalUnits_{mt}$, would suggest that hosts that had previously found it profitable to participate in the market without remitting became unprofitable and left the platform. Similarly, were the number of hosts on the platform to decrease, it could be indicative that the possible gains from the platform became less appealing as a result of the shift. Both of these situations would suggest the transferal in obligation expelled non-remitters from the market. A positive value for either of these estimates would suggest that the tax shift actually made the platform more appealing to sellers. A negligible value would suggest the quantity supplied stayed the same and suggest no evasion in the market as, in theory, a fully remitting market would experience no change in quantity supplied or demand as a result of the shift in obligation as is visible in Figure 3.

Though the Slee dataset is mainly an aggregation of supply in the market, recording the number of units listed not bookings themselves. There is one variable recorded that can be interpreted as a function of demands, number of reviews. AirBnB reports that between 70% and 80% of all guests review their hosts. This review rate should be exogenous to all variables in the model as tax implementations cannot be expected to affect the rate at which guests note their experiences on the platform. As such, the number of new reviews in a given quarter can be interpreted as a proxy for the total quantity of units demanded in the market. To examine the possible movements in quantity demanded, the following model can be implemented:

$$NewReviews_{mt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

Where $NewReviews_{mt}$ represents the number of new reviews in market m at time t . In this model, β_1 could then be interpreted as the effect of the shift in tax remittance responsibility on reviews and, correspondingly, demand. If instead of quantity, this market was to be examined from a price perspective, a tax-inclusive price variable could be generated. This variable would be equivalent to the listed price in pre-tax shift periods and equivalent to the sum of the price and the value of the tax in post-tax shift periods. It is necessary to calculate this newly defined variable to compare like to like. As will be discussed, the Snee contains only a single price variable, that of the price listed by a unit's host on the site, exclusive of any additional fees or taxes. When the tax obligation in a market is shifted from host to guest, the tax is added to the platform outside of this listed price. As a result, the listed price in the period before the obligation shift could be described as tax-inclusive as hosts were obligated to remit the tax themselves. In Figure 2, this is represented as the value P_{INC} . When the obligation to remit the tax moves from host to guest, the shifts presented in Figure 3 should occur if hosts are remitting, with demand moving inwards and supply outward. Hosts, no longer obligated to remit the tax, would then be charging a tax-exclusive price as guests would be paying the tax on top of the listed price. This tax-exclusive price would be represented in Figure 3 as the value P_{EX} . In the after period, guests are paying the value of the tax in addition to the listed price, leading to the tax-inclusive price being calculated as the sum of P_{EX} and the value of the tax. To represent this formulaically:

$$If(ScrapeDate_{im} < TaxImposedDate_m) :$$

$$TaxInclusivePrice_{imt} = ListPrice_{imt}$$

$$If(ScrapeDate_{im} > TaxImposedDate_m) :$$

$$TaxInclusivePrice_{imt} = (1 + TOT_m) * ListPrice_{imt}$$

Where $ScrapeDate_{im}$ is equivalent to the date listing i in market m was scraped, $TaxImposedDate_m$, represents the date of the tax obligation shift in market m , and TOT_m represents the transient occupancy tax rate in market m . Applying this variable to the model would result in the following specification:

$$\log(TaxInclusivePrice)_{imt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

Or, including the scale of the tax in the interaction:

$$\log(TaxInclusivePrice)_{imt} = \beta_0 + \beta_1 Accommodates_i + \beta_2 TOT * TaxImposed_m * AfterTax_t + \delta_m + \delta_t + \epsilon_{imt}$$

Where $\log(TaxInclusivePrice)_{imt}$ represents the log of the tax-inclusive price for a given AirBnB i in market m at time period t and ToT_m represents the transient occupancy tax rate in market m . All other variables in this specification remain the same. In this model, β_2 can be interpreted as the percent change in tax-inclusive price that can be attributed to the shifting of the obligation of remittance. The implementation of this variable allows the comparison of the tax-inclusive price of a unit in the before period (when the listed price included the tax) with that of the after period (when the listed price did not include the tax).

Were all hosts to remit and obey classical expectations, the value of this coefficient would be expected to be negligible and insignificant as, classically, tax-inclusive prices should not change when there is a shift in who it was levied on. Transposing this idea to Figure 3, the price at the intersection of S_1, D_1 should be equivalent to that of S_2, D_2 plus the scale of the tax. A positive value of β_2 would indicate a tax-inclusive price increase, meaning that the removal of the obligation led hosts to implement a relative price increase, while a negative value of β_2 would mean that there was a tax-inclusive price decrease.

Were hosts evading the tax in the before period, the shift in remittance obligation would pressure them to decrease their prices. To a non-remitting host, the shift in obligation would be experienced as a tax being levied on the consumer, as seen in Figure 1. The listed price decrease should be proportional to the hosts elasticity of supply. The more inelastic their supply, the greater share of the tax they will take on. Were supply fully inelastic, listed price would fall the full scale of the tax and the tax-inclusive price would remain constant. In any other case of non-remittance, the tax inclusive price would rise by the share of the burden borne by guests. As a result, the possibility of a shift in β_2 will also reveal much about the relative share of the tax burden.

Prior to running these models, it is necessary to assure that this data fulfills the assumptions of difference-in-differences and is a valid application of the technique. It is required to check that each sample is independent and meets the parallel trends assumption. This assessment would be conducted through the addition of a lead variable to the model that is defined as the number of time period until the implementation of the tax. If this coefficient were found to be significantly different from zero there would be a strong indication of lead signaling, meaning hosts were adjusting their pricing as a result of the coming change.

6 Data

To measure the effect of AirBnB’s collection and remittance of taxes, I intend to use author and data journalist Tom Slee’s AirBnB data scrape in combination with data collected on the initiation of AirBnB’s collection program in that market. Slee’s scrape spans 117 markets over an approximate 4-year timeline, which began in November 2013. Listing numbers are observed as low as 400 listings in more rural areas like Joshua Tree, CA and as high as 70,000 listings in urban centers like Paris, France. When selecting markets to include in the analysis, a series of criteria were defined to ensure data depth and quality—markets had to be within the United States and the scrape of said markets had to have begun prior to January 1st, 2016

to ensure enough data was present in the panel to draw analysis from. After these filters were passed, the sample set was concluded:

Market	First Survey Date	Remittance Shift Date	Tax Rate
Boston	9/24/2014	N/A	
Broward	9/30/2014	5/1/2017	6.0%
Chicago	12/23/2013	1/15/2015	11.9%
Los Angeles	9/1/2014	8/1/2016	14.0%
Miami	8/17/2015	5/1/2017	6.0%
New Orleans	1/16/2015	1/1/2017	4.0%
New York	5/10/2014	N/A	
New Haven	8/21/2015	7/1/2016	15.0%
Oahu	8/17/2015	N/A	
Philadelphia	8/20/2015	7/1/2016	7.0%
Portland	10/28/2014	7/1/2014	11.5%
San Diego	5/25/2014	7/15/2015	10.5%
San Francisco	11/17/2013	10/1/2014	14.0%
Seattle	9/1/2015	10/15/2015	9.6%
Washington D.C.	1/16/2015	2/15/2015	14.5%

'N/A' indicates markets who have not shifted responsibility of remittance from host to guest

Table 1: Markets in Sample

Given the inherent nature of the data, this set can be characterized as a clustered sample of the population of AirBnB units given that the data is selected not completely at random, but on the precondition that it is in one of the aforementioned markets. As a result of this clustering, it becomes immediately apparent that analysis derived from this dataset must have its errors clustered at the market level.

The Snee dataset records 14 variables for each entry: *room_id*, *host_id*, *room_type*, *borough*, *neighborhood*, *reviews*, *overall_satisfaction*, *accommodates*, *bedrooms*, *price*, *minstay*, *latitude*, *longitude*, *last_modified*. Generally, these are defined as follows:

- *Room_id* is the primary key for the dataset and is unique identification number assigned to every listing.
- *Host_id* is a unique identification number assigned to each host. A host can be assigned to multiple listings, but each listing can only be assigned one host.
- *Room_type* designates whether a property is a room, apartment, full home, etc. Borough and neighborhood are used to indicate if a property is part geographic areas AirBnB has defined.

- *Reviews* represents the number of reviews by customers at the given property and can be used as an instrument for popularity or quantity given that AirBnB has declared that approximately 80
- *Overall_satisfaction* contains the average user reviewed star rating for the listing.
- *Accommodates* and *bedrooms* list the number of people who can stay in the listing and the number of bedrooms the listing has respectively.
- *Price* contains the price on the date of the scrape excluding any taxation or fees.
- *Minstay* is the minimum number of nights required for a stay.
- *Latitude* and *longitude* represent the property's geographic location
- *Last_modified* indicates the date and time the scrape loaded that data

Relative to the majority of publically available AirBnB datasets, the Slee scrape is seen as an extremely reliable and accurate one with listing numbers consistently returning within 5%-10% of the total number of officially reported listings in a given market with overestimation often occurring due to blurry boundaries. An example of a blurry boundary would be present when a user searches for a listing in San Francisco but may on occasion find listings from a neighboring town like Daly City or South San Francisco. Given the scope of my analysis, mainly focusing on price changes, the sample appears to be large and thorough enough to be representative of the population of AirBnBs even if a small fraction are excluded from the dataset. An example of one scrape plotted can be seen in Figure 4, which depicts the distribution of AirBnBs in Los Angeles in mid-2017.

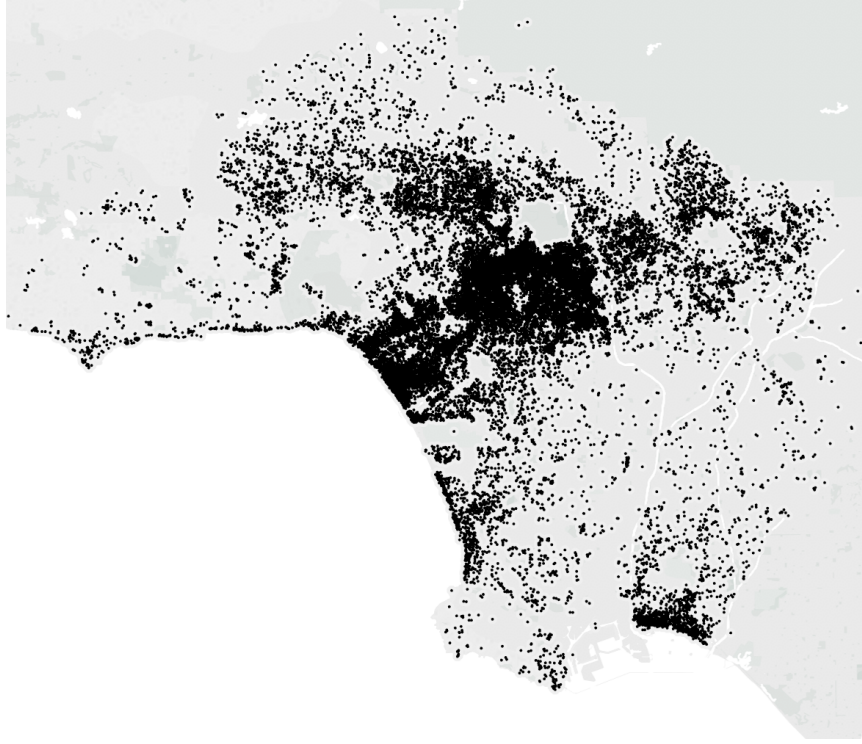


Figure 4: Geographic Distribution of Los Angeles AirBnB Listings, July 8, 2017

The Slee dataset differs greatly from Wilking’s collected data as it contains much more breadth and depth. Wilking scraped data between February 13 and August 30, 2015, focusing on three cities following the announcement of an upcoming obligation shift and three control cities. Slee’s dataset contains listings scraped consistently between December 2013 and July 2017, providing a much longer timespan both before and after obligation shift relative to that of the Wilking dataset. In cities in which Slee scraped over that same time frame as Wilking, his scrape was able to capture approximately twice as many units in markets like San Francisco, providing a clearer, more complete picture of what the listing market contained. By providing data prior to announcement and implementation, the Slee dataset also provides a much greater picture of what the market looked like in the before period. There could be concern that changes in pricing were made by hosts following the announcement of an obligation shift in their market, but prior to the implementation of the tax. These price changes could have been missed by the Wilking dataset as collection began following these announcements.

Upon aggregation, the dataset was cleaned. This data cleansing entailed removing minor errors in the data like listings with non-numeric and null price values, the standardization to quarterly temporal units, and the generation of new variables. Variables generated include the previously described tax-inclusive price, a dummy variable for the interaction between being in a treatment region and post-tax obligation shift, and one that multiplied this interaction, being in a treatment market and having the tax obligation shifted, by the scale of the tax itself. Upon completion of the data cleaning, the total number of 3,052,943 individually

scraped listings to 3,046,923 listings. These erroneous rows account for approximately 0.2% of the total dataset and their removal does not appear to greatly affect the integrity of the data. A table of summary statistics found below illustrates the variety of pricing and tax statistics across markets:

Market	Tax Rate	Remittance Obligation Shift	Median Listed Price	Average Listed Price	Std. dev. of Listed Price	Distinct Listings
Boston	N/A	N/A	\$140.00	\$173.67	\$169.29	10131
Broward	6.00%	May 1, 2017	\$109.00	\$166.54	\$272.28	7677
Chicago	11.90%	January 15, 2015	\$100.00	\$146.89	\$204.00	21455
Los Angeles	14.00%	August 1, 2016	\$110.00	\$192.02	\$423.28	77581
Miami	6.00%	May 1, 2017	\$139.00	\$232.29	\$516.81	27367
New Haven	15.00%	July 1, 2016	\$80.00	\$143.72	\$265.58	1525
New Orleans	4.00%	January 1, 2017	\$130.00	\$196.60	\$265.89	10694
New York	N/A	N/A	\$110.00	\$147.36	\$189.01	111698
Oahu	N/A	N/A	\$135.00	\$241.28	\$493.85	10558
Philadelphia	7.00%	July 1, 2016	\$250.00	\$510.43	\$702.33	13294
Portland	11.50%	July 1, 2014	\$90.00	\$112.43	\$120.82	8326
San Diego	10.50%	July 15, 2015	\$130.00	\$206.20	\$272.22	18322
San Francisco	14.00%	October 1, 2014	\$168.00	\$253.21	\$440.88	24043
Seattle	9.60%	October 15, 2015	\$107.00	\$136.73	\$147.14	11345
washington	14.50%	February 15, 2015	\$120.00	\$212.13	\$349.63	16925

Table 2: Summary Statistics By Market

Market	2013q4	2014q2	2014q3	2014q4	2015q1	2015q2	2015q3	2015q4	2016q1	2016q2	2016q3	2016q4	2017q1	2017q2	2017q3
Boston	-	-	1275	-	1730	-	2048	2855	3419	4036	4395	4167	4715	5210	4695
Broward	-	-	-	-	-	-	2208	3092	3936	4516	5078	5249	-	-	-
Chicago	2095	1979	-	-	3196	-	-	7121	7166	7862	8330	9705	9385	9231	5811
Los Angeles	-	-	12105	11780	-	14102	19273	22649	23418	27379	30193	34530	34475	36771	32146
Miami	-	-	-	-	-	-	6947	10056	11004	9606	9534	11591	9708	11109	8815
New Haven	-	-	-	-	-	-	369	669	752	625	554	547	423	510	428
New Orleans	-	-	-	-	1905	-	2092	3447	4267	4987	5142	5108	6260	6520	3861
New York	-	18921	-	-	-	-	-	42934	42469	47429	46262	48214	45754	47475	41168
Oahu	-	-	-	-	-	-	2481	3398	3661	4503	4915	5665	5983	6720	6163
Philadelphia	-	-	-	-	-	-	5990	7719	7516	7704	7721	7301	7638	8021	7367
Portland	-	-	-	1748	1900	-	1917	3202	3418	3814	4221	4151	4380	4248	3950
San Diego	-	1901	-	2632	-	-	3318	5266	5699	7278	8717	9018	8710	9894	9111
San Francisco	215	-	4771	-	5202	-	5140	8639	10288	10238	9737	10213	10008	9021	8344
Seattle	-	-	-	-	-	-	3223	4231	4593	5310	5960	6341	6487	6922	6399
washington	-	-	-	-	2815	-	2800	4741	5057	5581	6091	8192	10310	9266	8235

-,¹ Indicates no data collected in that quarter/market combination.

Table 3: Units Listed in Each Market by Quarter

7 Results

As discussed, it was necessary to ensure there was no lead effects present prior to inferring from model itself.

Table 4 shows the estimates for the following model:

$$\log(\text{TaxInclusivePrice})_{imt} = \beta_0 + \beta_1 \text{Accommodates}_i + \beta_2 \text{TaxImposed}_m * \text{AfterTax}_t + \beta_3 \text{Leads}_{tm} + \delta_m + \delta_t + \epsilon_{imt}$$

Where Leads_{tm} is a variable that describes the tax imposition occurring in Leads_{mt} quarters, in market m and quarter t . This means that 3 quarters prior to the imposition of a tax in a given market, Leads_{mt} would be equivalent to 3, 2 quarters prior, Leads_{mt} would equal 2, etc. The estimates of these results are found below in Table 4:

	(1)
	log(Tax Inclusive Price)
Accommodates	0.205*** (0.00528)
Interaction	0.0882* (0.0384)
Leads	0.000136 (0.0105)
Constant	4.329*** (0.0611)
N	2908337

Clustered standard errors in parentheses

Calculated with Year/Quarter and Market Fixed Effects

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Checking for Signaling with Leads

That the value of β_3 , the coefficient on Leads_{tm} , is so close to 0 and insignificant—with a p-value of .99—indicates that no effect can be concluded from signaling. Pricing in the AirBnB market does not appear altered due to advanced knowledge or tax remittance shifts in other markets at other time periods. This allows the core assumptions of a difference-in-differences analysis to be confirmed and validates the rest of the analyses as a fair application of the technique. Tables 5 and 6 provide estimates of the listed-price regression described above. Theory would predict a negative coefficient on the interaction variable because, logically, remitting renters should feel pressure to lower their prices an amount equivalent to the scale of

the tax when the obligation shifted. Non-remitters would also feel downward competitive pressure due to remitters shifting their price.

	(1)
	log(Listed Price)
Accommodates	0.205*** (0.00528)
Interaction	-0.0158 (0.0230)
Constant	4.339*** (0.0380)
<i>N</i>	2908337

Clustered standard errors in parentheses

Calculated with Year/Quarter and Market Fixed Effects

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: The Effects of Treatment on Listing Price

	(1)
	log(Listed Price)
Accommodates	0.205*** (0.00528)
TOT*Interaction	-0.000410 (0.00152)
Constant	4.350*** (0.0344)
<i>N</i>	2908337

Clustered standard errors in parentheses

Calculated with Year/Quarter and Market Fixed Effects

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: The Effects of Treatment on Listing Price by Scale of Tax

These results interestingly suggest no significant impact on the listed price of a unit following the shifting of the tax obligation. Assuming at least some hosts were remitting this tax and including it in their listed price, were they behaving according to classical theory, following the shift in obligation there would be a

pressure to maximize profits by lowering their price. If they did not, guests would be paying taxes on top of this listed price; this would lead to a drop in profits and the quantity demanded as units became more expensive. Similarly, given that demand for a given AirBnB unit is a function of its relative price, it could be expected that as remitting hosts lowered their prices, even those who opted not to remit would still feel pressure to lower their listed prices as those in the market who were remitting taxes move from charging a tax-inclusive price to a tax exclusive one. That the coefficient on *Interaction*, representative of the total percentage shift in listed price, and on *TOT*Interaction*, representative of the percentage shift in listed price given a percentage increase in the shifted tax, were both insignificant directly contradict these theoretical assumptions and the findings of Wilking (2016), which found a significant decrease in price between “2.9% to 5.5% after agreements were enacted.”

While this lack of listed price decrease differs from the literary and theoretical body of evidence described above, it does not deride any inherent conclusion, but only suggests further analysis would be necessary. This leads to a quantity-based analysis. A drop in the quantity of units supplied, units listed, or hosts on the platform would all be strong indicators of evasion as a negative coefficient on any of these variables would suggest that once profitable non-remitting sellers became unprofitable after they were forced to take on some share of the tax burden. The estimates of these aforementioned quantity supplied based models can be seen below in Tables 7, 8, and 9:

	(1)
	Listed Units
Interaction	780.3 (1962.9)
Constant	-2580.1 (2239.9)
<i>N</i>	149

Clustered standard errors in parentheses

Calculated with Year/Quarter and Market Fixed Effects

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: The Effects of Treatment on Total Units Listed

	(1)
	AirBnB Hosts
Interaction	-14.57 (1336.8)
Constant	-3045.6 (1693.1)
N	149

Clustered standard errors in parentheses

Calculated with Year/Quarter and Market Fixed Effects

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: The Effects of Treatment on Total Hosts Using AirBnB

	(1)
	New Units
Interaction	1186.0 (1258.8)
Constant	454.3 (1292.0)
N	135

Clustered standard errors in parentheses

Calculated with Year/Quarter and Market Fixed Effects

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: The Effects of Treatment on New Units Listed on AirBnB

That each of these estimated coefficients are insignificant implies no real shift in the number of units or hosts on AirBnB as a result of the change in tax remittance. This seems to be strongly indicative of a lack of mass evasion of the tax. Were hosts evading the tax, when it began to be levied upon the consumer and hosts were obligated to take on some of that burden, some would be exit the market and the rate of new listings would decrease as the opportunity for profit decreased. That there was no decrease at all seems to strongly invalidate this evasion-based hypothesis.

The lack of movement in the quantity supplied could, however, be a function of the platform itself. It costs hosts nothing to maintain a listing on the platform. A host only actually incurs an AirBnB related cost when a guest stays with them and they must clean, maintain, or repair the unit. Given that a host must approve of a guest applying to stay in their units, it can be said that they will not incur any of these

costs unwillingly. As a result, there is no incentive to delist their unit; disinterested hosts may never exit the market, as there is no penalty to remain, and continue to appear in the dataset. Because of this, an examination of the quantity demanded, by looking at the number of new reviews, may be more indicative of actual shifts in the market. Table 10 contains estimates for the effect of this responsibility shift on the number of new reviews.

	(1)
	New Reviews
Interaction	11470.9 (8211.7)
Constant	-769.5 (7861.3)
N	92

Clustered standard errors in parentheses
 Calculated with Year/Quarter and Market Fixed Effects
 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: The Effect of Treatment on New Reviews

That this effect is found to be insignificant implies there was no shift in the quantity demanded as a result of the shift in obligation. Quantity demand remained the same before and after the shift of remittance responsibilities implying there is no evidence of evasion in the market. Had hosts been evading, when the tax obligation shifted the post-tax equilibrium quantity would decrease. Evading hosts who were previously profitable and able to participate in the market would drop out as the now unavoidable tax priced them out. Similarly, guests who were only able to afford units in this fringe area would be unable to find and rent these units. That neither the quantity supplied nor demanded fell strongly suggests, according the aforementioned model, there was no evasion in the market.

The final analyses that could be conducted to gain some understanding of the share of tax burdens and possible evasion would entail examining shifts in tax-inclusive price. Tables 11 and 12 contain estimates for the effect of the shift in tax obligation on tax-inclusive price. More clearly, these tables examine the effect of the tax remittance obligation shift on the total cost, listing price and taxed amount, in one variable. According to the partial-equilibrium model, if all hosts were remitting, the shift in remittance obligation would have no effect on this variable as hosts would decrease the listed price to counteract the “new” taxes remitted by guests. If hosts in the market were evading, when the tax remittance responsibility shifted, they could be expected to decrease their prices by some fraction of the tax in proportion to their relative elasticity. If supply was relatively elastic, only a small portion of the tax would be borne by hosts, and the tax-inclusive price could be seen increasing.

	(1)
	log(Tax-Inclusive Price)
Accommodates	0.205*** (0.00530)
Interaction	0.0880* (0.0359)
Constant	4.329*** (0.0463)
<i>N</i>	2908337

Clustered standard errors in parentheses
Calculated with Year/Quarter and Market Fixed Effects
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: The Effects of Treatment on Tax-Inclusive Prices

	(1)
	log(Tax-Inclusive Price)
Accommodates	0.205*** (0.00528)
TOT*Interaction	0.00897*** (0.00151)
Constant	4.349*** (0.0343)
<i>N</i>	2908337

Clustered standard errors in parentheses
Calculated with Year/Quarter and Market Fixed Effects
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: The Effects of Treatment on Tax-Inclusive Prices by Scale of Tax

That these estimators both show significant increases to tax-inclusive price after implementation show a huge cost being passed on to the consumer. These results suggest an 8.80% increase in total cost after the transition of a tax from host to guest or a .897% increase in cost for every 1% of tax that was levied upon consumers.

These results could suggest two possible scenarios. In the first scenario, a large proportion of hosts were

evading the tax and had extremely elastic supply. When forced into the tax system by the shift in remittance, they decreased their listed prices slightly, and a vast majority of the tax was passed on to the consumer. While this reality would validate the established hypothesis of pervasive evasion, it is contradicted by the lack of movement in the quantity of units both supplied and demanded, which theoretically should have fallen but empirically did not. A second scenario would entail almost the entirety of the host population refusing to adjust their listed price. These remitting hosts, for some reason or another could have opted not to ensure that their tax-inclusive price remained competitive, contradicting the theoretical expectation that they would. Because listed prices didn't move, as was shown in tables 5 and 6, but tax-inclusive prices skyrocketed, it would appear that consumers simply accepted a disproportionate amount of the tax they were now obligated to remit. In reality, a third scenario could present itself that was some combination of the aforementioned scenarios in which some non-remitting hosts opted in and lowered their prices and some remitting hosts did not lower their prices.

There are multiple hypothetical behavioral conclusions as to why hosts may have elected to digress from what was theoretically optimal and not held tax-inclusive prices constant. A lack of information regarding the implementation of the tax obligation shift may have stalled price changes. If the changes were not publicized or were implemented subtly, it could take time for hosts to find out. This hypothesis, however, is rebuked by multiple factors. While there could have been an information delay, this would be resolved over time and prices would ultimately fall as the information became more well known. This spread of information, and resulting decrease, would present itself eventually as the dataset extends thoroughly beyond most treatment dates. That it did not indicates that a lack of information was not relevant in these results.

These results could also be achieved if remitting hosts had an active behavioral association or fixation with the prices being charged and made the decision to maintain their prices regardless of tax policy. An example of this behavior would be a host charging \$100 for their spare room. If, in the host's mind, they received a nice, round \$100 every time a guest stayed in their home, this host may throw pricing strategy to the wind and stay put at \$100/night despite the shift in tax obligation. Both of these strategies could also be working in conjunction with a reality in which no AirBnB hosts were remitting the tax, a plausible truth given the lack of enforcement.

As discussed, if evasion was excessively pervasive, instead of being a shift in obligation the forced remittance at the point of checkout could be interpreted as the levying of a tax and the assumed tax-inclusive price from pre-obligation shifts would not be accurate. It would instead be representative of the pre-tax equilibrium price. This would then suggest that the calculated tax-inclusive price increase was solely representative of the relative elasticity of supply and would suggest an extremely elastic supply and relatively inelastic demand with the majority of the tax borne by guests. In this case, hosts would be behaving exactly according to the classical expectation of an evading host. This would mean the proposed hypothesis, though incorrect in its assumptions regarding elasticity, was correct in surmising that hosts would evade. However, this conclusion is inherently contradicted by the lack of movement in the quantity supplied and demanded.

If this full-evasion theory were the case, the number units demanded, listed, and joining the platform should have decrease.

Interestingly, these results could also be achieved if guests in the market had extremely high and inelastic demand for AirBnBs. Were this the case, a price increase of 5%-10% could have no demonstrable effect on the quantity demanded. This would be true if AirBnBs were so significantly cheaper than alternatives that these price variations did not matter. A final hypothetical explanation for these results that builds off of this idea of inelasticity could be related to the initial assumptions regarding the AirBnB market itself. The regressions and conclusions drawn above are based on the postulation that the AirBnB market is inherently competitive. While units are differentiated based upon their amenities, location, etc. Wilking builds her model on the assumption that they are all competing with each other for a given guest. This is an extremely logical inference to make as the units are listed in a common “marketplace” on the AirBnB platform and guests can easily compare these units when making a decision. In so many ways this platform, at least superficially, seems like a classic example of a monopolistically competitive market.

However, all units being on the same platform does not mean they are evaluated equally by the consumer. While a city may have thousands of listings, the number of units that fulfill a given guest’s requirements could be significantly smaller. Listings that meet a long list of criteria of a guest, like being in the right neighborhood, accommodating the correct number of guests, possessing the right number of bathrooms, etc. are few and far between. As such, guests could find themselves comparing a couple of units as opposed to the thousands originally listed on the platform. Though it was originally hypothesized that the ample supply of units would serve as substitutes, this filtering could suggest that the number of substitutes for a given unit is quite small. As a result, this would suggest relatively inelastic demand for a given AirBnB unit. AirBnBs may not actually be competing with each other for guests, and instead, the reverse is true: guests are competing to book the limited supply of AirBnBs.

This reality, one in which AirBnBs, are more differentiated then initially assumed, could suggest a non-competitive market structure in which hosts do not price their products competitively but instead through some monopolistic behavior or oligopolistic pricing game. If this were true, the shift in remittance responsibility would then has very little effect on the quantity supplied as the burden would be passed on almost entirely to the consumer, much as has been seen in these results. Correspondingly, these increases in tax-inclusive price would be a logical result of the excessive and inelastic demand of the situation.

8 Conclusion

The rapid acceptance and integration of AirBnB into cities across the globe has led to huge amounts of disruption in established hotel and lodging industries. A sector that had clear tax policies and implementations and conventional barriers to entry was flooded with new members as the opportunity to rent one’s home out for no up-front cost presented itself to property owners. These new AirBnB hosts found themselves subject

to tax policy that was constructed around a relevant but completely different product. In many ways the unintuitive nature of hotel taxes in combination with its unenforceability in the context of AirBnB hosts made it ripe for evasion. This led to a hypothesis that hosts were opting to evade this tax because of its unenforceability and the belief that were it to be enforced they would bear a large share of the burden of this tax due to the variety of substitutes and competition in the market.

This analysis intended to examine the reality of this hypothesis. From the regression estimates found above, it can be concluded that the shifting of tax remittance obligations from host to guest had no effect on the absolute quantity and growth of hosts and units listed on the platform and no effect on the quantity demanded by guests. Were evasion present, a decrease in quantity would be expected as non-remitting hosts were forced to take on some portion of the tax burden after the shift. Concurrently, the shift in obligation led to a significant increase in the tax-inclusive price paid by the consumer. This upsurge would be symptomatic of evasion, but only in conjunction with the aforementioned decrease in quantity. As a result, it appears that the lack of movement in quantity supplied and quantity demanded is derived not from evading hosts, but the structure of the market itself. This could be of a behavioral nature, that hosts are anchored to certain prices, or a competitive nature, that the market is less competitive than initially assumed. An interesting next step in this analysis, would be to conduct a spatial analysis of individual units and attempt to determine how unique a given AirBnB listing is to those that surround it. This analysis would allow for better understanding of the actual competitive nature of the platform.

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