Modeling the Impact of the Sharing Economy on Traditional Firms

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Abstract

The rapid growth of the sharing economy in multiple industries suggests that the peer-to-peer participants are claiming an increasing share of the market, and having a real impact on traditional firms. Assessing the magnitude of this impact is critical for both sets of providers. Economic conditions play a critical role in determining the overall demand for services and the extent to which different providers can capture that demand. This paper uses a system dynamics approach to evaluate market share and revenue under a variety of economic conditions when traditional and peer-to-peer providers compete. The paper focuses on the travel and hospitality industry and examines the role of apartments for rent in contrast to traditional hotel rooms. Results suggest that unless the sharing economy is subjected to strict regulation, it will perform favorably under a variety of economic conditions.

Keywords
sharing economy, Airbnb, simulation, system dynamics

Introduction

The sharing economy has grown rapidly over the last decade, facilitated by technology that permits easy participation for providers and consumers. The benefits for participants are largely monetary in nature – a source of income for the providers, albeit neither steady nor reliable, and real savings for the consumer, though the extent may be dubious and concomitant risks ensue. It is estimated that the number of adult users of sharing economy in US reached 44.8 million in 2016, and the number is expected to grow to 86.5 million by 2021 (Statista 2017). Popular services like Airbnb and Uber have demonstrated that the sharing economy is here to stay. The growth in the number of listing and bookings for Airbnb, coupled with similar growth in the number of drivers and booking for Uber, indicates that the sharing economy is claiming an increasing fraction of the market, and will inexorably have an impact on the traditional firms in these industries. The simplicity and convenience of the peer-to-peer exchanges among providers and consumers in the sharing economy make for easy and effortless transactions.

The sharing economy operates in a largely unregulated space alongside the traditional firms in the industry. By not having to comply with myriad regulations, providers in the sharing industry have a financial edge and can undercut traditional firms. Though there has been pushback, with some attempts to regulate sharing economy providers, the sharing economy continues to thrive. The easy entry as a provider means that the supply can be quite volatile, as compared to traditional firms. Furthermore, suppliers can choose to temporarily exit from the system, further exacerbating the volatility. This flexibility allows the sharing economy to scale up or scale back relatively quickly. All of these factors make it difficult to assess the impact of the sharing economy on traditional firms. While the impact is clearly tangible, the effects are harder to isolate. Several researchers have sought to assess the impact in the travel and hospitality industry (Zervas et. al. 2017). While some of the implications are recognizable, extrapolating from this to other scenarios remains a challenge. Others have called for research that can address this question (Cheng 2016). This paper attempts to fill this gap by creating a model that allows exploration of the impact of the sharing economy on traditional industry stakeholders. In this case we address sharing in the hotel industry.
Another motivation for this research is the relative paucity of work at the industry or societal level. The sharing economy has frequently been examined at the level of individual peer-to-peer participants. Researchers have examined motivations to participate, either as provider or consumer (Kim et. al. 2015), assessed barriers and risks to individuals (Hawlitschek et. al. 2016), and sought to identify the beneficiaries of the sharing economy (Quattrone et. al. 2016). Studies that examine the impact of the sharing economy on a particular industry or at the societal level are comparatively few. Nonetheless they are needed to shed light on the practice at a macro level.

The rest of the paper is organized as follows. Prior research and the theoretical background needed for assembling a model on the role of the sharing economy in the hotel industry are presented in the next section. A dynamic model that encompasses peer-to-peer apartment sharing alongside traditional hotel room rentals is then assembled. After calibration and validation, the model is run for a variety of economic conditions. The impact on both sets of providers is assessed. Research and managerial implications of the simulations round out the paper.

**Prior Research**

The sharing economy represents the embodiment of the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online services (Hamari et. al. 2016). Though the extent of peer-to-peer sharing has grown rapidly in recent years, the concept of sharing in the tourism and hospitality industry has been observed in the past in conditions involving extreme short supply of rental units in the face of unprecedented demand (Smothers 1995). While this predates any online platform for sharing, manual coordination and lack of a central clearinghouse made for an inefficient process, and one where suppliers and consumers are at risk for ineffective pricing due to lack of comparative information. The introduction of a common technology platform eliminates many of these market inefficiencies, introducing transparency in terms of product and price information, along with convenience and ease of booking.

Several factors have been identified in motivating consumers to participate in the sharing economy, including sustainability, enjoyment, reputation, and economic benefits (Hamari et. al. 2016). Using an online survey of sharing economy participants, they found that enjoyment and sustainability had an effect on attitude, and that enjoyment and attitude influenced intention to participate. Interestingly, economic gains did not have a significant effect. Drawing from social exchange theory, researchers have postulated that in addition to relative advantage, trust and perceived risks also play a role (Kim et. al. 2015). The decision to book an Airbnb listing has also been studied using technology acceptance (Lin et. al. 2017).

Trust in the sharing economy is an area that has garnered a lot of attention. Most researchers consider trust to be an antecedent of participation in the sharing economy. Determinants of trust include reputation, benevolence, and social pressure (Kim et. al. 2015). A different approach is adopted by (Hawlitschek et. al. 2016), where trust is the sole determinant of intention to transact. Another approach is adopted by (Bergh and Funcke 2016), who explored the role of social trust at the country level to assess the size of the sharing economy. Using macro-level data and regression models, they found that social trust is a significant variable in predicting sharing economy size. An alternative approach is adopted by Andreotti et. al. (2016), who posit that trust is an outcome, and not an antecedent to participation, with repeated satisfactory engagements creating trust.

Other streams of research touch upon legal aspects (Kassan & Ors 2012, Jefferson-Jones 2015). In addition, the sharing economy also has broader societal implications. For example, in the hotel industry, unscrupulous landlords may evict clients and convert apartments to short term rentals since they are more lucrative. This could lead to a shortage of affordable long-term rentals in areas frequented by tourists. Short term rentals could also constitute a nuisance for neighborhood residents. Discrimination in the sharing economy is potentially a problem, with little recourse for effective redress. Several of these have been enumerated as the dark side of the sharing economy (Malhotra & Van Alstyne 2014).

**Airbnb and the Travel and Hospitality Industry**

Airbnb represents the most prominent provider platform in the sharing economy within the travel and hospitality industry. Despite inception in 2008, substantial growth occurred only in 2012, and it has now
come to dominate this space, with more than 640,000 hosts and 4 million listings (Smith 2018). More importantly, it was responsible for a projected 100 million guest arrivals in 2017. With a presence in 191 countries, clearly Airbnb is a force to be reckoned with in the travel and hospitality industry. Airbnb has been viewed as a disruptive innovation in the industry (Guttentag 2013; Guttentag & Smith 2017), with effects at the low-end market first, and visible success permitting migration to other segments.

Despite the large number of hosts and listings, Airbnb listings tend to be concentrated in cities that experience high tourist activity (Lane & Woodworth 2016). Moreover, while listings exist throughout metropolitan areas, rentals tend to be in areas in close proximity to city centers and tourist attractions (Quattrone et. al. 2016). Professional Airbnb hosts, who typically rent more properties than amateur hosts, also outperform them in terms of visits booked (Li et. al. 2015). While sellers can enhance the likelihood of their properties being rented, it is argued that the online reputation systems used can be biased and not provide an accurate picture (Slee 2013). Research has shown that the reputation of listings tends to be higher on Airbnb than other sites (Zervas et. al. 2015).

**The Impact of Airbnb on Hotels**

The influence of Airbnb on the hotel industry remains an important question for researchers and practitioners alike. During its early days, Airbnb was a no-frills operation, and typically targeted the low-end market and budget conscious customer. However, with the explosion in the number of listings, the range of properties offered has moved from rooms in an apartment/house, to include complete apartments, houses, with additional amenities and tourist services, making for a more complete experience. Target customers now include traditional hotel customers, who are either looking for more comfortable stays, more in-depth experiences, and those looking to save some money.

This will certainly have an impact on the hotel industry, though quantifying it is a challenge. Some researchers have attempted to study this, with mixed findings. Choi et. al. (2015), examined the effect of the number of Airbnb listings in Korea on the macro-level revenues of the hotel industry. Using a panel regression approach, they found only a mild effect on the economy and budget category of hotels. A different approach was adopted by Zervas et. al. (2017). They studied the impact of Airbnb in Texas using a model that estimates hotel revenue based on Airbnb listings, city characteristics, hotel properties, and wage and unemployment data. Using a coarsened exact matching procedure, they estimate the impact of Airbnb on the hotel revenue to be about 8-10%, with the greatest impact on lower-priced hotels, and non-business-oriented hotels. Another report concluded that Airbnb had a 4.6% impact on revenue and 8% impact on bookings in New York in 2014-15 (HVS Consulting 2015). Airbnb has been characterized as “bad for hotels but good for tourism” (Oskam and Boswijk 2016).

**Need for an Alternative Approach**

Studying the impact of Airbnb on the hotel industry typically adopts a retrospective analysis of published data. While this can provide insights into past performance, it may not be a good predictor for the future. Extrapolating from the scenarios studied, or to different economic conditions can be challenging. Managers of hotels in a given metropolitan area need a better understanding of the impact that Airbnb listings can have within their context, taking into account economic factors, overall market size, seasonal demand, growth, and related factors. Since they do not have the capability to dramatically scale room inventory up or down, they need to operate with the tools at their disposal. These include price, promotion, temporarily shuttering rooms, or folding rooms from smaller hotels into the corporate umbrella. Before any such tactics can be deployed, they need to understand the impact of Airbnb listings on the industry within their geographical area.

This study takes the position that a shared economy and traditional industry coexist in a complex and dynamic ecosystem that is characterized by several constructs that are constantly interacting. Diverse factors and dynamic relationships typify this situation. These can be studied through simulation. Several options are available, including discrete event simulation, continuous simulation, system dynamics, and agent-based simulation. System dynamics uses a combination of first order linear and non-linear difference equations to relate qualitative and quantitative factors within and across time periods (Sterman 2000) and is based on principles developed by Forrester to study managerial and dynamic decisions using control principles (Forrester 1961).
This paper employs system dynamics to investigate the effect of the sharing economy on the hotel industry within a major metropolitan area. System dynamics was chosen for the simulation as it permits examination of relationships between constructs within a time period, as well as across time periods. It describes a model that examines sharing economy and hotel room inventory, utilization, growth, and revenue under different economic conditions. While the model cannot cover all scenarios, it provides managers with insights into the relative performance under different scenarios. This research adopts a design science methodology (Hevner et. al. 2004) using the system dynamics model as the artifact of interest. The artifact's utility is demonstrated through execution of the model under different scenarios, and the results can guide hotel management about the impact of the sharing economy on their business.

Sharing Economy Performance Model

The model examines the impact of the peer-to-peer rentals in the hotel industry under diverse economic conditions. It is configured to mimic a large metropolitan area with a large inventory of hotel rooms and apartment listings. Since the model is created at the macro-level, it is assumed that all apartments listed for rent are equally attractive, as are all hotel rooms. A seasonal demand pattern is established for the city. This demand is met through rentals of hotel rooms and apartments. High occupancy prompts an increase in the inventory of resources for tourists. Hotels add new rooms through contracting with existing residential facilities, and more providers enter the sharing economy. Low occupancy, on the other hand, leads to a decrease in housing inventory. Revenue, occupancy, rentals, and inventory are tracked over the course of the simulation.

Figure 1. Sharing Economy Performance Model

The model was developed over several rounds of iteration and testing, and is depicted in Figure 1. Variables in rectangles represent stocks that can accumulate or deplete over time. Stocks are affected by flows, which are represented by a double arrow and valve symbol. They address incoming or outgoing rate. Other variables on the diagram represent converters, which have values that are specified for the given time period. Values of converters are determined by differential equations and affected by other converters through connectors. Positive signs on connectors indicate that an increase in one will lead to an increase in another. Negative signs represent the opposite relationship. Reinforcing (all positive signs), or balancing (at least one negative sign) loops are formed when a chain of connectors cycle back to the
originating converter. Reinforcing loops can eventually generate zero or infinite values for the involved converters while balancing loops generate oscillatory trends.

**Model Structure**

The model can be applied to any large city. However, to anchor its performance, it is based on the inventories and prices prevailing in New York City. The model is assembled in mirror image form – one segment dealing with hotel rooms, and the other segment addressing the sharing economy, termed apartments in this case. The description of the model will focus on one side only. Economic factors and demand drive the model. The economic factors can be constant or varying, representing different scenarios. The demand is based on current room rentals in the city, and is moderated by an annual seasonal pattern. Depending upon the economic conditions, the demand will be split into room demand and apartment demand. A growth economy will favor demand for rooms, representing preference for traditional rentals. A stagnant or shrinking economy will cause consumers to be more budget conscious, and look to apartments instead. In addition, the relative difference between the room price and the apartment price also affects the demand for the two providers.

The rest of the description focuses on modeling the hotel rooms at a macro level. Modeling the apartments is very much the same, and will not be presented in detail. The room inventory represents the variable of interest. It can be augmented or shrunk, but not quickly. If the demand for rooms rises, then hotels look to add new rooms, either through acquisition of smaller independent hotels, through extension of current facilities, or construction of new facilities. The decision to add is based on the availability of rooms given the demand and the current inventory. On the other hand, if the demand drops considerably, then the hotel looks to shrink its inventory, either through shuttering rooms, or repurposing them, or leasing to a third party. Revenue is computed using a base room price, local room tax, and the rentals, scaled up to a monthly equivalent, since the simulation time period is a month. The model has several loops involving the room inventory. Some are reinforcing loops, while others are balancing loops. If not managed properly, reinforcing loops can drive the values along the loop to zero or infinity. Carefully constructed models do not exhibit such behavior. Balancing loops help counter the reinforcing loops, and make for more streamlined simulation. The big difference on the apartment side of the model is that the apartment inventory can be scaled up or down very quickly, and the apartment rentals are more price sensitive.

**Model Calibration, Verification, and Validation**

Calibration of several variables was based on published data on conditions in the tourist and hospitality industry in New York City. This included an assessment of the magnitude of the hotel room inventory and the number of Airbnb listings in the city. Tax rates were customized for the region. A seasonal demand pattern was developed based on prior room rentals in the city. Depending upon the economic conditions, the demand was revised accordingly. Some segments of the model are deterministic in nature, and are easily verified. This includes the computation of revenue, utilization, occupancy, and relative fractions of the sharing economy to the total market.

Other segments of the model are a little more challenging to calibrate and verify. These include determining how many new hotel rooms will be added, how many will be shuttered, as well as estimating the number of new listings for Airbnb properties, and removal of these properties in different economic conditions. Pricing is also a challenging issue as demonstrated in (Wang and Nicolau 2017). In order to create a robust and sound model, the model was calibrated in a serial manner. This allowed us to examine the effect of each variable in isolation, and isolate any unusual behavior. While this had the effect of slowing down the model calibration, it provided greater confidence in the resulting model. A second benefit from this approach is that it permitted the investigation of reinforcing loops, to ensure that they did not tail to zero or grow unfettered during the course of the simulation.

The model was validated through a combination of structural testing and behavioral pattern testing. Structural testing was performed using boundary adequacy, structural verification, parameter verification, dimensional consistency, and extreme condition analysis (Forrester and Senge 1980). This involved identifying constructs and relationships from the literature, verifying that appropriate units are employed, and stress-testing the model under extreme values. Behavioral pattern testing checks if the results from
the simulation are consistent with the real world phenomena. Since the model is assembled in an iterative manner, both tests were repeatedly performed to ensure that the model was robust and accurate. Any abnormal patterns and brittleness were noted and used to recalibrate the model.

**Simulation Scenarios and Results**

Vensim® PLE, a fully functional system dynamics software package from Ventana Systems, Inc. was used to create the model and run the simulations. A medium term planning horizon of 60 months was adopted. Longer time frames would likely involve greater uncertainty of environmental conditions and result in potentially inaccurate predictions. The experiments are conducted to validate that the model is performing realistically, as well as to assess the impact of the sharing economy on traditional stakeholders in the industry.

**Scenarios Explored**

The model was tested using a set of three scenarios – a growing economy, a stagnant economy, and a shrinking economy. The scenarios are obtained by manipulating the Economic Factors variable, as described in Table 1. These represent changes in gross domestic product in terms of annual change.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Economic Factor</th>
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<tr>
<td>Shrinking Economy</td>
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</tr>
<tr>
<td>Stagnant Economy</td>
<td>0.0</td>
</tr>
<tr>
<td>Growing Economy</td>
<td>0.04</td>
</tr>
</tbody>
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Table 1. Scenarios for Economic Conditions

The simulations tracked all the variables in the model, across all scenarios. This was done for several reasons. First, it allowed us to examine whether the model is behaving meaningfully. Comparisons were made for both sets of providers within different economic conditions, as well as across economic conditions for each set of providers. Different insights can be gleaned from the varied portrayals.

**Behavior Observed**

We first focused on room inventories, as it illustrated the proportion of the market that was captured by different providers. These results are illustrated in Figure 2.

**Figure 2. Inventory of Hotel Rooms and Apartments**

The graph of hotel room inventory provides several insights. Given a sustained 4% growth in the economy over 5 years, it is not surprising that the hotel room inventory increases significantly. There are
several reasons for this expansion. A growing economy entails increasing demand. More of this demand will be channeled towards hotels, as travelers seek out less spartan accommodations. With increasing demand, there is also a tendency for hotels to acquire additional inventory. It is important to note that the growing inventory does not necessarily translate into higher occupancy. In fact, the occupancy does fall over time from around 70% to 55%, moderated by the monthly demand. For a stagnant economy, the hotel room inventory remains essentially unchanged over the course of the simulation. As the demand remains essentially flat, hotels are able to retain loyal customers, and there is no need to shed rooms. However, there is some migration from hotels to apartments. In the shrinking economy case, a bleaker picture emerges for hotels. With decreasing demand, and more price-conscious customers, there is pronounced flight to the sharing economy. This results in a noticeable drop in revenue, and the inability to cover basic costs requires some closing of rooms.

The picture for the sharing economy is quite different. For the growing economy case, the increased demand leads to greater listings, but the attractiveness to non-budget-oriented customers is lacking, and the market share of the sharing economy remains essentially the same. Nonetheless, there is healthy growth in terms of the inventory, increasing from 30,000 to 85,000 over the 5 year horizon. The stagnant and shrinking economies present an interesting contrast. In these cases, apartments present greater appeal to customers who are now more budget-conscious. As a result, the number of listings grows, prompting more rentals, which feeds into further growth in the number of rentals. In these cases, there is clear shift away from hotel room rentals towards apartment rentals.

The change in inventory for each category of provider, when viewed in isolation, provides an incomplete picture of the composition and success of the industry. When viewed relative to each other, a different picture emerges, as illustrated in Figure 3. The graphs are assembled using the same scale to facilitate comparison across different scenarios.

The relative proportions of the sharing economy and the hotels are much starker. In the growing economy case, hotels dominate the growth. Under stagnant economic conditions, the final inventory levels are somewhat comparable. However, in the shrinking economy case, traditional hotels perform rather poorly, and the market shifts more to a peer-to-peer sharing model.

While the inventory provides overall insight into the tactics of the two providers, an examination of performance-oriented variables yields a more accurate insight into the actual success of the different
providers over the simulation period. Several variables will yield similar perspectives on performance, including rooms rented, revenue generated, room occupancy, among others. We elect to depict rooms rented, since it provides a measure of the relative market share captured by the two types of providers. This is illustrated in Figure 4, depicting rooms rented under different economic conditions. As before, the graphs are assembled using a common scale to facilitate cross-scenario comparison.

The patterns reflect the seasonality of demand experienced in the area. In a growing economy scenario, it appears that hotels outperform the sharing economy. In a pure numbers sense, that is the case. However, it should be borne in mind that the hotel room inventory exceeds the apartment inventory by a factor of 2 to 3. Factoring that into the analysis, it becomes clear that the sharing economy performs well, with higher occupancy rates. The segment at the start of the simulation does not reflect the seasonal demand, due to the fact that it involves very high occupancy. As more providers enter the sharing economy, the inventory grows large enough to reflect the demand, though at a lower level than the hotel segment.

In the case of a stagnant economy, both sets of providers struggle to maintain market share. The demand is considerably less than experienced in the growth scenario, and given the economic conditions, price-conscious customers will look to apartment rentals first. Though the relative shares appear similar, the larger initial hotel room inventory would entail lower occupancies. In the shrinking economy case, demand for rooms drops over the course of the simulation. Once again, the competition between the two sets of providers leads to similar market shares, with apartments coming out ahead marginally. However, as the hotel room inventory shrinks, occupancy remains high for the hotels. On the other hand, the shrinking economy prompts new entrants into the sharing economy, and though the number of apartments rented appears similar, the occupancy rates dip. A similar pattern is seen in the revenues generated by the two sets of providers.

The results provide useful insights into the market for room and apartment rentals in a large metropolitan area under varying economic conditions. It should be borne in mind that it is unlikely that economies will grow or shrink with these levels of consistency over an extended period. Rather, one can expect a mix of these three scenarios. The simulations demonstrate the opportunistic nature of the sharing economy, and the conditions under which it is likely to prosper.

Managerial and Research Implications

The results suggest that the sharing economy outperforms traditional firms in a number of economic conditions. Only in cases of a sustained growing economy do hotels outperform the peer-to-peer providers. However, even in those cases, the sharing economy does quite well. These results indicate that it is likely that price and convenience will appeal to a large segment of the consumers. The regulations and charges imposed on traditional firms make for a playing field that is not quite level. Traditional firms have several avenues to pursue in this regard. They can see if the sharing economy participants are in compliance with local ordinances and zoning laws (Cusumano 2015). Most cities have a vast set of arcane laws on the books that may be applicable in this case. They can also lobby to have regulations put into place that treats the sharing economy on par with traditional forms. This has been tried in several instances, with mixed results. Another option is to lobby to reduce the regulations they operate under. While this appears reasonable in principle, cities are less likely to roll back regulation and possibly reduce their income streams. Additional strategies for competition are presented in (Winterhalter et. al. 2015).

The simulations reflect the underlying decision making on the part of the two sets of participants. Hotel room inventories remain an expensive investment, and are not amenable to quick scaling up. While a hotel chain can sometimes add inventory by folding a local independent hotel into its corporate mantle, the option does not work at the industry level. Reducing room inventory is much more plausible – the rooms can be simply shuttered, or repurposed, or leased out to another enterprise. Apartment inventory on the other hand, reflects a more opportunistic decision strategy. Demand and relative advantage in terms of price and convenience can be easily exploited. In many cases, the cost of unused inventory is minimal, and any revenue is a bonus. Under these circumstances, supply can be scaled up in short order to exploit temporary demand surges, or rental rates cut to generate bookings.

Another finding is that under all economic conditions, the sharing economy can expect to perform well, for the reasons just outlined. The provision of resources to customers in stagnant and shrinking economies at affordable costs ensures that they can claim a sizeable portion of the market. And though
the sharing economy market is not recession proof, it is able to compete in adverse economic conditions, at the expense of the traditional firms.

From a research perspective, the findings provide a variety of insights about the effectiveness of the sharing economy. First, it demonstrates that a large number of individual actors can have a significant impact on a small coterie of established operators. This is despite the fact that they operate independently and pursue different objectives. However, it does require a significant presence to have an impact.

Another research finding is that the decision making of the third party— the consumer— also affects the success of the two providers. Under good economic conditions, the consumers are less likely to skimp, and hotels come out ahead. However, in difficult economic circumstances, the consumer is more likely to look for bargains, thereby rewarding the sharing economy participants.

This research provides a starting point for additional exploration of the sharing economy impact in traditional industries. The consideration of more diverse economic factors would form the next logical step. Additional simulations could look at the impact of prevailing operating conditions— e.g. imposition of taxes on short term rentals, and zoning implications. Yet another stream of research is needed to examine when the sharing economy becomes effective in terms of size. Clearly too few participants will lead to stagnation; likewise, an oversupply will also cause internecine competition. A self-sustaining population is needed for it to be effective.

Conclusions

The impact of the sharing economy on traditional providers is clearly palpable and is well documented. Moreover, it is here to stay, though the magnitude and direction of the impact are harder to predict. This research provides a model that permits investigation into the impact of the sharing economy under a variety of economic conditions. Simulations indicate that the sharing economy can perform well under a wide variety of economic conditions, including situations that put traditional firms at some risk.

References