# Platform versus traditional firm: competition and entry regulation

Vincent Malardé - CREM - Université Rennes 1

February 16, 2017

**Abstract**

In a growing number of markets traditional firms face competitive pressure from peer-to-peer platforms. For exemple it is the case in the accommodation industry, where hotels are challenged by accommodation peer-to-peer platforms; it is the case in the transportation sector where railway transport companies are challenged by ride-sharing platforms. This article provides a framework to model this competition, and conditions under which a regulation that would limit the entry of peer suppliers on the platform could increase social welfare. We find that such a regulation may have a positive effect if peer suppliers fixed entry costs are high and/or indirect network effects are low.

**Keywords:** peer-to-peer platforms; regulation; network externalities

## 1 Introduction

In the recent years, with the fast development of information technologies, new business models have emerged. These new actors, called platforms, allow peer sellers and consumers to transact directly with each other. Platforms operate in various industries, but the most impressive successes are related to transportation and accommodation industries, with companies such as *Uber*, *Lyft* or *Airbnb*, valued several billion dollars.[1]

Even though these platforms had few users only a few years ago, they have exhibited impressive growth trends. For a significant part of the population they became a serious alternative to

[1] In august 2016, Airbnb was valued around $30 billion, and Uber was valued around $68 billion

traditional firms, and incumbents are forced to take these platforms into consideration when making strategic decisions. Traditional firms heavily complain about the competitive pressure exerted by these new actors, often qualifying this competition as "unfair", and lobby for the regulation of peer-to-peer marketplaces. On the other side, platforms claim that they allow consumers that were traditionally excluded from the market to benefit from their service, because of lower prices, and that they allow for a better utilization of excess capacities. In addition, the activity of peer-to-peer marketplaces sometimes creates externalities on other markets, and, at least for the negative ones, this may justify the intervention of the legislator (Edelman and Geradin (2015)). Although it has not been statistically proven, peer-to-peer accommodation marketplaces may reduce the stock of lodging available on long term housing market and affect the price on this market (Malhotra and Van Alstyne (2014)). This negative externality is the reason why a number of important cities legislate to restrict *Airbnb*'s activity, one may cite New York, San Francisco, Berlin, London, Amsterdam.

In this article we model the competition between a traditional integrated firm and a peer-to-peer platform that benefits from indirect network effects. We find that a regulation that would increase fixed entry costs incurred by peer sellers to be active on the platform, if it does not solve information asymmetries nor increase the quality of peers, has a negative effect on social welfare. We also find that there exist conditions under which a regulation that would limit the supply on the platform could be socially optimal.

To the best of our knowledge, there is no article about the regulation of peer-to-peer marketplaces that explicitly integrates indirect network effects.

Since the seminal article by Rochet and Tirole (2003) the economic literature has studied the behaviour of a monopoly platform. The literature has shown the importance of indirect network externalities for the definition of the price structure chosen by the monopolist: the monopolist has to choose a price decomposition so as to attract both agents types on the platform. The literature also studies competition between platforms (Rochet and Tirole (2003), Caillaud and Jullien (2003), Armstrong (2006)). However, only few articles study the competition between a platform and a traditional firm, and address the question of the regulation of peer-to-peer marketplaces.

Einav, Farronato and Levin (2015) study the competition between individual sellers, active on a platform, and a traditional industry. In their model, peer sellers have higher marginal costs and are active only when the demand exceeds the installed capacities of professionals. The authors find that peer production is favored when the demand fluctuates. More importantly, they find that when there is variability in demand it is efficient to have peer sellers operating part of the time. The authors find that when a platform enters the market, peer sellers may benefit from lower advertising costs and gain market shares at the expense of professional dedicated sellers. Some empirical works have shown a signicative impact of peer-to-peer marketplaces on traditional industry. Seamans and Zhu (2013) study the effect of Craigslist's entry on local US newspapers. The authors find a 20.7% decrease in classified-ad rates, and an increase of 3.3% in subscription prices. Kroft and Pope (2014) find that Graigslist's entry led to a significant 7% decrease in the number of classified job posts in print newspapers. Zervas, Proserpio and Byers (2016), study the impact of Airbnb on the hotel industry. They find a causal impact of Airbnb's activity on the decrease in hotel revenue, they find that the impact is non-uniformly distributed, lower-priced hotels are the most affected. They find that, in areas where Airbnb is most popular the revenue of the most vulnerable hotels has decreased by about 8-10 % over the period 2010-2015. Another relevant stream of literature is related to the "collaborative consumption". Based on survey, Cervero and Nee (2007)) study the impact of the non-profit program launched by the city of San Francisco, *City CarShare*. This program allows its members to rent a car on a hourly basis. The authors find a significant effect of membership on the likelihood of vehicle shedding. Based on survey, Martin, Shaheen and Lidicker (2010) show that there is a negative effect of carsharing adoption on North American household vehicle holding.

Edelman and Geradin (2015) discuss the regulation of platforms. They point out the necessity to end "protectionist" regulations, and identify market failures that could justify regulatory intervention in the case of transportation and short-term rentals platforms: externalities, information asymmetries and cognitive biases. To regulate short-term rental activities within a city, Miller (2014) proposes a system where each dwelling unit would get redeemable *transferable sharing right* that would allow the owner to engage in a short-term rental for a given period of time. A market would allow owners that do not want to join the short-term market to resell their rights to other owners who would like to host more than what is permitted by their initial allocation. Quattrone et al. (2016) examine what are the socio-economic conditions of the areas that benefit from *Airbnb*. The authors find that demand and supply have changed over time. They argue that traditional regulations have not been able to adapt to the dynamics of demand and supply, and they defend the idea of "dynamic regulation", i.e. regulation that relies on large data sets to adapt to real-time changes in demand. On the other side, some authors, such as Koopman, Mitchell and Thierer (2015), argue that much of the top-down regulation is not needed in the case of the sharing economy. Because the majority of regulations aims at protecting consumers by alleviating information asymmetries and platforms are able to solve these asymmetries thanks to reputation systems. In order to avoid regulatory asymmetries because of the actual regulation that applies to incumbents, rather than imposing a regulation to platforms, the authors advocate a better alternative to restore fairness is "deregulating down".

The article is organized as follows. Section 2 spells out the assumptions, the model and the competitive equilibrium. Section 3 analyzes the equilibrium with some comparative statics. In section 4 we analyze the impact of a regulation that limits the number of active peer sellers. We conclude in section 5.

# 2 Model

## 2.1 Assumptions

We model a competition between a one-sided firm, named after *traditional firm*, that may be viewed as representative of a whole industry, and a firm that operates as a platform. We model the traditional firm as a monopolist to reflect the market power that the incumbent has because of its historical position. The platform acts as an intermediary between buyers and peer sellers. Buyers pay a price to peer sellers, and the platform gets a fixed fee for each transaction. Buyers and sellers do not have to pay access fees to join the platform.

To imagine a context we could think about the competition between the whole hotel industry, or a large hotel chain, and a peer-to-peer accommodation platform. This model may be used in a more general framework, but if one wants to go on with the example of the competition between the hotel industry and the accommodation platform we need to make simplifying assumptions. To fit with this framework one has to consider that each city constitutes a distinct geographic market, and each hotel quality constitutes a distinct product market. Those markets are independent, and we will focus for the analysis on a market characterized by a particular quality in a particular geographic location. The model may be used to represent other markets but it will be necessary to verify if the assumptions still fit well to the new market.

**Supply side** We make the assumption that the traditional firm has its own infrastructure and incurs a constant marginal cost $c_I$ to provide one unit of service. The subscript $I$ stands for *incumbent*. The traditional firm charges a price $p_I$ for a unit of service.

On the platform side, there are $n$ potential peer sellers (hosts). Each peer seller incurs a fixed cost $f$ to enter the market. This fixed cost $f$ include various costs: the cost to upgrade the quality of an apartment or a room in order to match the quality standards defined by the demand, the investments to comply with safety standards, the time to open an account on the platform and to learn to use the platform. This fixed cost also include the time spent in acquiring information to set the optimal price given intra platform competition, the time spent in administrative procedures (declaration of annual earnings, for instance). These fixed cost are called *bringing-to-market costs* by Horton and Zeckhauser (2016).

One may argue that, in addition to fixed costs, peer sellers also incur marginal costs. For example, being present to deliver the keys to a host, to answer the messages sent by potential hosts on the platform. Although these costs exist, for simplicty these costs are set to zero.

When sellers enter the platform they can charge a price $p$. We assume that peer sellers choose a price $p$ that maximizes their joint revenue. The price $p$ is assumed homogeneous. Peer sellers enter the platform as long as the joint profit is positive.

The platform charges an additional fee, $r$, payed by consumers, for each transaction. The platform does not incur variable costs to match peer users of both sides.

**Demand side** There is a continuum of consumers, uniformly distributed between 0 and 1. They have the choice between buying from the traditional firm or the platform. The preferences of consumers for the "traditional" service or "collaborative consumption" are heterogenous. To model this heterogeneity, we consider that consumers are distributed on a "Hotelling line", where the traditional firm and the platform are located at the two extremities. As shown on the following picture.


This heterogeneity in consumers' preferences reflects the fact that some consumers consider that buying on the platform repesents a risk, because they do not feel comfortable with this "peer-to-peer" consumption mode, where relations are dematerialized. Some consumers will prefer the traditional service, because they place high value on the possibility to make a reservation by phone, interacting with a "real person". Thus, a first source of heterogeneity in preferences comes from the habits in digital technology usage. In addition, the traditional firm may offer lower diversity in choice, although it also means minimal uncertainty in quality. Another source of heterogeneity may be purely philosophical, with some individuals placing high value in "collaborative consumption" for some reasons, or conversly low value in this "new" way to exchange.

So, a consumer have the choice between buying from the traditional firm, at price $p_I$, or buying from peer sellers, through the platform, at the final price $p + r$:

- In the first case a consumer gets a net utility $u_I = v + \delta - p_I - t(1 - x)$.
- In the second case a consumer gets a net utility $u_p = v + \alpha n - (p + r) - tx$.

The part $\alpha n$ in the utility that consumers derive when buying through the platform reflects the fact that the number of peer sellers active on the platform has a positive impact on the valuation of the platform's service. Indeed, the higher the number of peer sellers, the higher the diversity of supply, and the more attractive the platform. In line with the literature on platforms, we call this effect *indirect network effect*. As the parameter $\alpha$ is the same for all consumers, we say that consumers are homogenous in the way they value the presence of sellers on the platform.

**Timing of the game**

- **Stage 1**: The traditional firm chooses the price $p_I$ that maximizes its profit
- **Stage 2**: The platform sets the fee $r$ that maximizes its profit
- **Stage 3**: Peer sellers form expectations $\hat{p}$ on the price $p$ they will be able to charge to consumers at equilibrium. Given these expectations they enter as long as their joint profit is positive.
- **Stage 4**: Consumers choose to buy either from peer sellers or from the traditional firm.

We solve the model for fulfilled expectations. At equilibrium peer sellers choose a price $p^*$

equal to the expected price $\hat{p}$. We have $p^* = \hat{p} = \underset{p}{\text{argmax}}\ pD_p$, with $D_p$ the demand that addresses to the platform.

## 2.2 Equilibrium strategies

**Stage 4** Equating the utilities that a consumer gets

- when buying on the platform: $u_p = v + \alpha n - (\hat{p} + r) - tx$
- when buying from the traditional firm: $u_I = v + \delta - p_I - t(1 - x)$

we find the position $\tilde{x}$ of the consumer indifferent between buying from the platform and buying from the traditional firm:

$$\tilde{x} = \frac{p_I - \hat{p} - r + \alpha n - \delta + t}{2t}$$

**Stage 3** A peer seller active on the platform expects to make a profit $\pi = \hat{p}\frac{D_p}{n} - f$. Where $D_p$ is the demand that adresses to the platform.

Sellers enter the platform as long as $\pi > 0$. Then by solving the equation $\pi = 0$, we get the number of peer sellers entering the platform at equilibrium:

$$n = \frac{\hat{p}(\delta + \hat{p} - p_I + r - t)}{\alpha\hat{p} - 2ft}$$

**Stage 2** From stage 4 and 3 we know that the demand that addresses to the platform is

$$D_p(p_I, \hat{p}, r, \alpha, f, \delta, t) \equiv \tilde{x}(p_I, \hat{p}, r, \alpha, f, \delta, t) = \frac{p_I - \hat{p} - r - \delta + t}{2t - \alpha\frac{\hat{p}}{f}}$$

The platform collects a fixed fee $r$ on each transaction, payed by the buyers. Thus, the platform's profit, $\pi_p$, is:

$$\pi_p = rD_p = r.\frac{f(p_I - \hat{p} - r - \delta + t)}{2ft - \alpha\hat{p}}$$

The platform maximizes this profit with respect to $r$. This gives the first order condition:

$$\frac{\partial\pi_p}{\partial r} = \frac{p_I - \hat{p} - 2r - \delta + t}{2t - \alpha\frac{\hat{p}}{f}} = 0$$

and we obtain the best response of the platform:

$$r(p_I, \hat{p}, \delta, t) = \frac{1}{2}(t - \hat{p} + p_I - \delta)$$

**Stage 1** The profit of the traditional firm is $\pi_I = p_I D_I$, and the price of the traditional firm is:

$$p_I(\hat{p}, \alpha, f, \delta, t) = \frac{1}{2}\left(\delta + \hat{p} + 3t - 2\alpha\frac{\hat{p}}{f}\right)$$

**Equilibrium price and fee** Using the equilibrium price $p_I$ we obtain the competitive fee as a function of the expected peer sellers price, $r(\hat{p})$:

$$r(\hat{p}) = \frac{1}{4}\left(-\delta - \hat{p} + 5t - 2\alpha\frac{\hat{p}}{f}\right)$$

Using $r(\hat{p})$ we obtain $p_I(\hat{p})$:

$$p_I(\hat{p}) = \frac{1}{2}\left(\delta + \hat{p} + 3t - 2\alpha\frac{\hat{p}}{f}\right)$$

The derivative $\frac{\partial r(\hat{p})}{\partial \hat{p}}$ has a negative sign. Indeed, the higher the $\hat{p}$ the higher the platform's final price $(\hat{p}+r)$ will be, and the lower the possibilities for the platform to increase its fee. This negative relation between $r$ and $\hat{p}$ is a source of misalignment of the platform and peer sellers' incentives. Indeed, the platform is better of with peer sellers charging lower price, and peer sellers are better of with a platform charging lower fee to consumers. So, $\hat{p}$ determines the sharing of the profit between the platform and peer sellers. If peer sellers charge a too high price, the platform cannot charge a positive fee. The extreme case is for $\hat{p} = \frac{f(5t-\delta)}{f+2\alpha}$, where the optimal fee $r^*$ is equal to zero. So, the peer sellers' price $p$ depends on their costs, on the degree of competition inside the platform, but it may also depend on the bargaining power of peer sellers "against" the platform. This may be one of the reasons why a peer-to-peer platform would like to make recommandations on prices: to keep control over the price charged by peers.

The derivative $\frac{\partial p_I(\hat{p})}{\partial \hat{p}}$ is equal to $1 - 2\frac{\alpha}{f}$, the sign of this expression depends on the parameters $f$ and $\alpha$. The reason is that an increase in $\hat{p}$ has two opposite effects on the optimal price of the traditional firm: a positive one, an increase in $\hat{p}$ makes the platform less competitive and the traditional firm can increase its price; a negative one, an increase in $\hat{p}$ increases the number of peer sellers and makes the platform more attractive and competitive because of indirect network effects. In the case where the condition $\frac{\alpha}{f} < \frac{1}{2}$ is satisfied we have $\frac{\partial p_I(\hat{p})}{\partial \hat{p}} > 0$, it corresponds to the case where indirect network effects are small and the positive effect dominates the negative one.

**Equilibrium peer sellers price** We assume that peer sellers coordinate to set a price $p^*$ that maximizes their joint revenue:

$$p^* = \hat{p} = \underset{p}{\text{argmax}}\ \ pD_p = \frac{2ft}{\alpha} - \sqrt{2}\sqrt{\frac{f^2 t(\alpha\delta + 2ft - \alpha t)}{\alpha^2(2\alpha + f)}}$$

Using this expression of $p^*$ we get the equilibrium fee and traditional price as functions of the parameters $\alpha, f, \delta, t$:

$$r^* = \frac{1}{4}\left(t - 2t\frac{f}{\alpha} - \delta + \frac{\sqrt{2}}{\alpha}\sqrt{f + 2\alpha}\sqrt{t(2ft - t\alpha + \alpha\delta)}\right)$$
$$p_I^* = \frac{1}{2}\left(2t\frac{f}{\alpha} - t + \delta - \frac{\sqrt{2}(f - 2\alpha)}{\alpha\sqrt{f + 2\alpha}}\sqrt{t(2ft - t\alpha + \alpha\delta)}\right)$$

# 3 Comparative statics

## 3.1 Equilibrium prices and fees

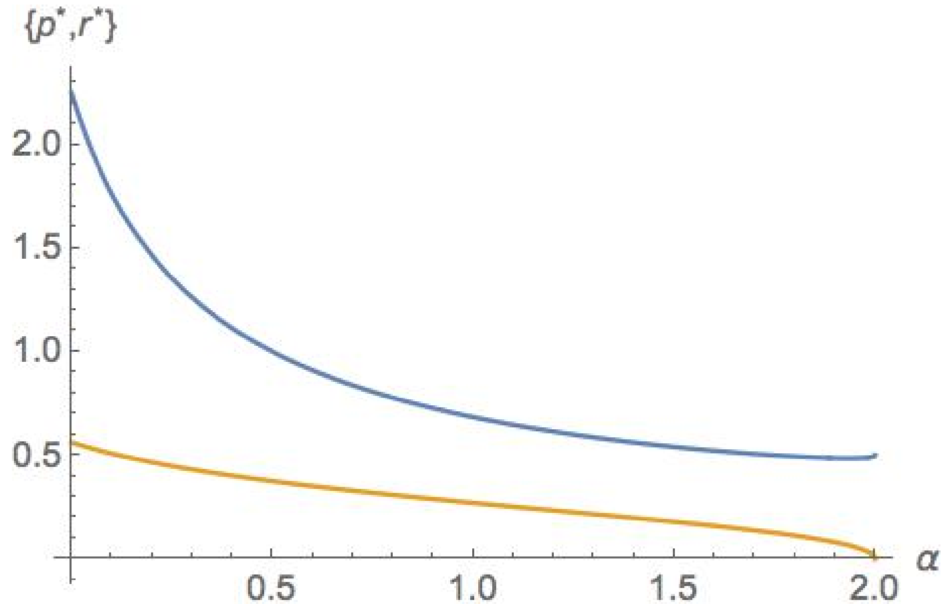
The derivatives $\frac{\partial r^*}{\partial \alpha}$ and $\frac{\partial p_I^*}{\partial \alpha}$ both have negative sign. So, the higher the network effects the lower the equilibrium price of the traditional firm, and the higher the network effects the lower the fee charged by the platform. This result is in line with the literature on two-sided markets: higher network effects implies higher degree of competition and leads to lower equilibrium prices. This negative effect is stronger for the price of the traditional industry $p_I^*$.

The derivatives $\frac{\partial r^*}{\partial f}$ and $\frac{\partial p_I^*}{\partial f}$ both have positive sign. The intuition is close from the previous one: a higher $f$ means a lower number of peer sellers and a softened competition. This positive effect is stronger for $p_I$.

The derivatives $\frac{\partial p^*}{\partial \alpha}$ and $\frac{\partial p^*}{\partial f}$ both have ambiguous sign. There exist conditions on parameters $\alpha, f, \delta, t$ for these derivatives to be positive or negative. In order to understand better the impact of $\alpha$ and $f$ on peer sellers price $p^*$, we use numerical exemples, with $t = 1$ and $\delta = \frac{1}{2}$. [2].

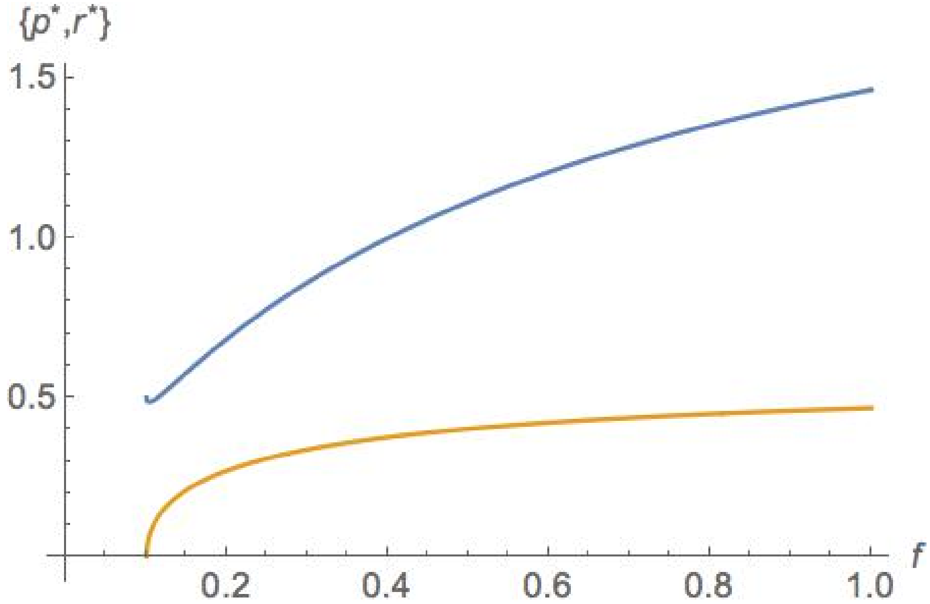
With the values $t = 1$ and $\delta = \frac{1}{2}$, it appears that $\alpha$ almost always has a negative effect on the price $p^*$ (figure 1), and $f$ almost always has a positive effect on the price $p^*$ (figure 2).

**Figure 1: Peer sellers price and $r^*$ as a function of $\alpha$, with $f = 0.5$**




[2]We consider the value $\delta = \frac{1}{2}$, this is close from the average value of the $\delta$ that is endogenously chosen by the traditional firm, when we include an additional step where the traditional firm chooses the quality level that maximizes its profit $\pi_I = p_I D_I - \frac{1}{2}\delta^2$

**Figure 2: Peer sellers price and $r^*$ as a function of $f$, with $\alpha = 0.4$**




Note: $p^*$ is in blue, $r^*$ is in red

Both $r^*$ and $p^*$ are decreasing in $\alpha$, but not at the same rate, it means that the ratio $\frac{r^*}{p^*}$ changes with the value of $\alpha$. Interestingly, this relation is not monotonic as it can be seen on the following figures:

**Figure 3: Ratio $r^*/p^*$ as a function of $\alpha$, with $f = 0.5$**

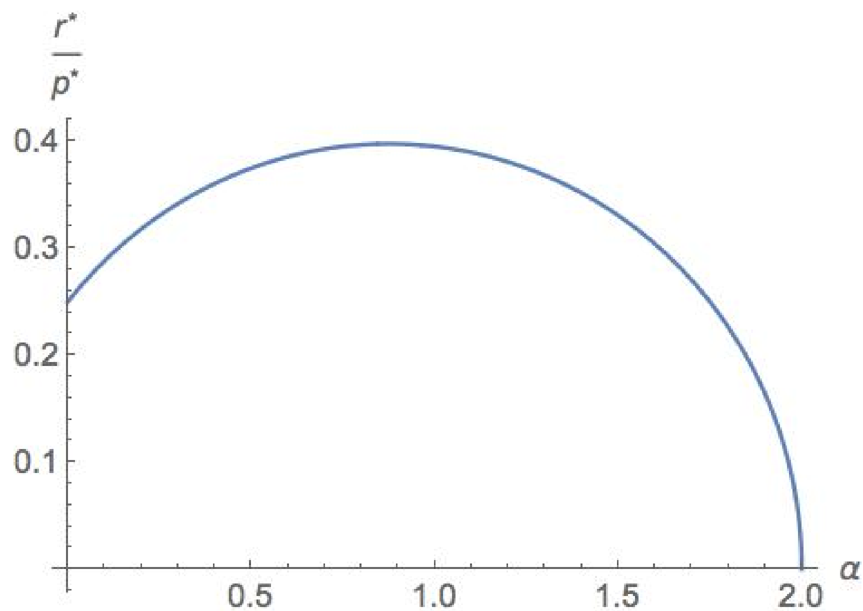
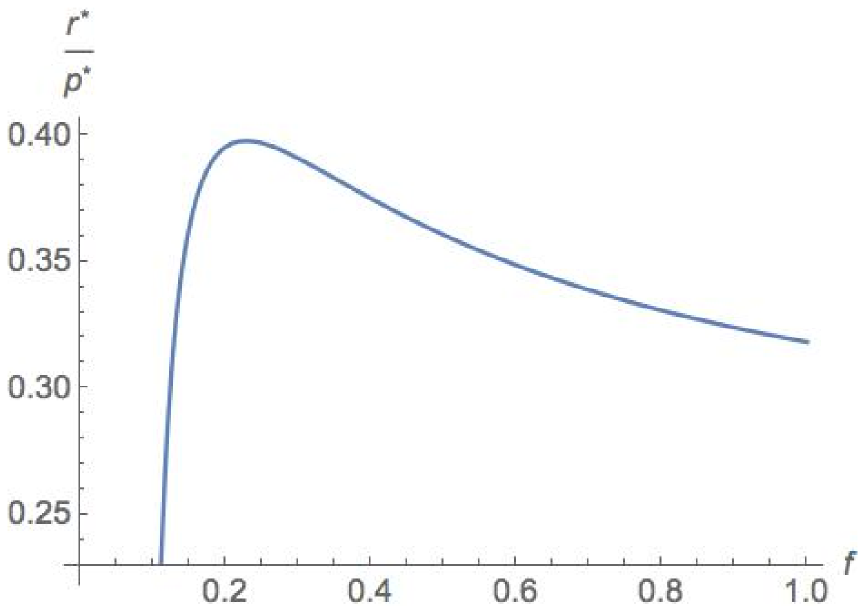


**Figure 4: Ratio $r^*/p^*$ as a function of $f$, with $\alpha = 0.4$**




One might object that the ratio $\frac{r^*}{p^*}$ appears higher than the commission that an accomodation peer-to-peer platform may charge for a transaction. For instance *Airbnb* charges a 6 to 12% fee to the guests and a 3% fee to hosts. But, for instance, the platform *TaskRabbit* set its service fee to 35% for first-time transactions. The platform *Uber* takes a 20 percent to 30 percent commission.

The derivative of the ratio $\frac{r^*}{p^*}$ with respect to $\delta$ is always positive. So, the higher the quality of the traditional firm, the higher the ratio $\frac{r^*}{p^*}$.

The derivative of the ratio $\frac{r^*}{p^*}$ with respect to $t$ is always negative. So, the lower the percieved differentiation between the platform and the traditional firm, the higher the ratio $\frac{r^*}{p^*}$. In a market where there is a platform competing against a traditional firm, if the percieved differentiation between the competing services decreases, even if this would result in a higher degree of competition and lower final price $(p^* + r^*)$, the platform may be able to set a higher fee $(r^*)$ relative to the final price $(p^* + r^*)$.

### 3.2 Market shares

Using the equilibrium prices $r^*$, $p^*$, $p_I^*$, we derive the equilibrium demands:

$$D_p^*(\alpha, f, \delta, t) \equiv \tilde{x}^*$$
$$D_I^*(\alpha, f, \delta, t) \equiv 1 - \tilde{x}^*$$

Using the second order conditions and the condition $0 < \tilde{x}^* < 1$ we find that the effect of an increase in indirect network effects is positive for the market share of the platform:

$$\frac{\partial \tilde{x}^*}{\partial \alpha} > 0$$

Using the second order conditions and the condition $0 < \tilde{x}^* < 1$, we find that the effect of an increase in peer sellers' fixed cost is negative for the market share of the platform:

$$\frac{\partial \tilde{x}^*}{\partial f} < 0$$

Using the second order conditions and the condition $0 < \tilde{x}^* < 1$, we find that the effect of an increase in the quality of the traditional firm's service is negative for the market share of the platform:

$$\frac{\partial \tilde{x}^*}{\partial \delta} < 0$$

### 3.3 Equilibrium profits

Using the equilibrium prices $r^*$, $p^*$, $p_I^*$, and equilibrium demands we derive the equilibrium profits:

$$\pi_p^*(\alpha, f, \delta, t)$$
$$\pi_I^*(\alpha, f, \delta, t)$$

Given that $\frac{\partial D_I^*}{\partial \alpha} < 0$ and $\frac{\partial p_I^*}{\partial \alpha} < 0$ the sign of $\frac{\partial \pi_I^*}{\partial \alpha}$ is clearly negative.
Given that $\frac{\partial D_I^*}{\partial f} > 0$ and $\frac{\partial p_I^*}{\partial f} > 0$ the sign of $\frac{\partial \pi_I^*}{\partial f}$ is clearly positive.

However, because $\frac{\partial D_p^*}{\partial \alpha} > 0$, but $\frac{\partial p^*}{\partial \alpha} < 0$, $\frac{\partial r^*}{\partial \alpha} < 0$ the sign of $\frac{\partial \pi_p^*}{\partial \alpha}$ is not clear a priori. Using the second order conditions and the condition $0 < \tilde{x}^* < 1$, we find that the sign of $\frac{\partial \pi_p^*}{\partial \alpha}$ is negative.

Similarly, because $\frac{\partial D_p^*}{\partial f} < 0$, but $\frac{\partial p^*}{\partial f} > 0$ and $\frac{\partial r^*}{\partial f} > 0$ the sign of $\frac{\partial \pi_p^*}{\partial f}$ is not clear a priori. Using the second order conditions and the condition $0 < \tilde{x}^* < 1$, we find that the sign of $\frac{\partial \pi_p^*}{\partial f}$ is positive.

### 3.4 Number of peer sellers

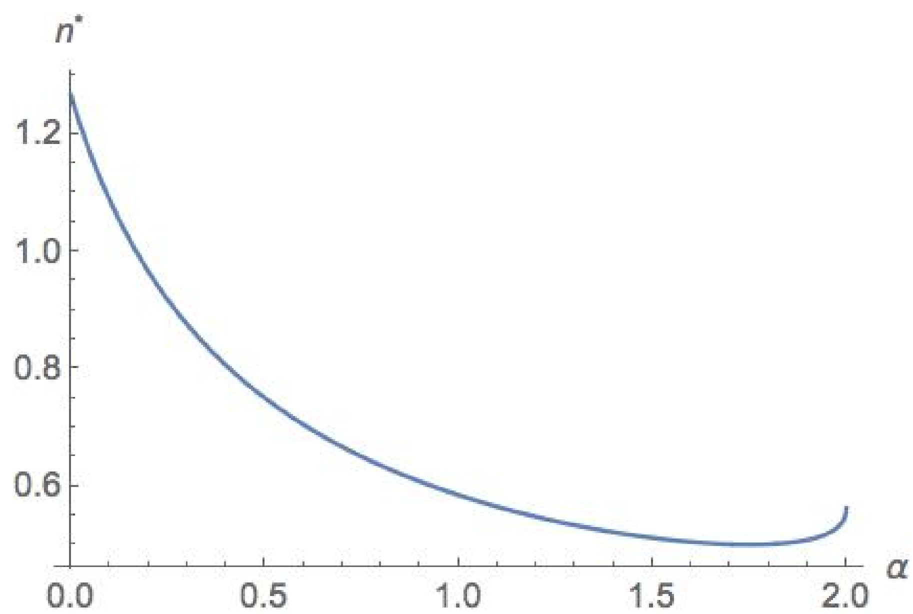
At equilibrium the number of peer sellers that join the platform is given by the following expression:

$$n^*(\alpha, f, \delta, t) = \frac{1}{4\alpha^2 f}\left(\alpha f\left(\delta - 2\sqrt{2}\sqrt{\frac{f^2 t(\alpha\delta + 2ft - \alpha t)}{\alpha^2(2\alpha + f)}} + 3t\right) - 4\sqrt{2}\alpha^2\sqrt{\frac{f^2 t(2ft + \alpha(\delta - t))}{\alpha^2(2\alpha + f)}} + 4f^2 t\right)$$

We find a negative sign for the derivative of $n^*$ with respect to $f$: $\frac{\partial n^*}{\partial f}$<0.

However, we find that the sign of the derivative of $n^*$ with respect to $\alpha$ depends on the values of the parameters $\alpha, f, \delta, t$. To have better insights on the effect of $\alpha$ on $n^*$ we use numerical exemples, with $t = 1$, $\delta = \frac{1}{2}$, and $f = \frac{1}{2}$.

**Figure 5: Equilibrium number of peer sellers as a function of $\alpha$**



We observe that, except for high values of $\alpha$, an increase in $\alpha$ would decrease the number of peer sellers active on the platform.

Interestingly the conditions for $\frac{\partial n^*}{\partial \alpha} > 0$ and $\frac{\partial x^*}{\partial \alpha} > 0$ do not coincides. Because $\frac{\partial x^*}{\partial \alpha}$ is always positive it means that, unless network effects are strong, it is likely to have a situation where an increase in $\alpha$ would increase the market share of the platform while decreasing the number of peer sellers.

# 4 Welfare analysis

## 4.1 Equilibrium consumer surplus and welfare

The total consumer surplus $S$ is equal to the sum of the surplus that consumers get when buying from the platform, denoted by $S_p$, and the surplus that consumers get when buying from the traditional firm, $S_I$.

$$S = S_p + S_I = \int_0^{\tilde{x}} (\alpha n - p - r^* - tx)\,\mathrm{d}x + \int_0^{1-\tilde{x}} (\delta - p_I^* - tx)\,\mathrm{d}x$$

The social welfare is defined as the sum of consumer surplus and firms' profits:

$$W_e = S_e + \pi_I^* + \pi_p^*$$

at equilibrium $\pi_I^*$ and $\pi_p^*$ are functions of $\alpha, f, \delta, t$, so the welfare at equilibrium is a function of these parameters:

$$W_e = W(\alpha, f, \delta, t)$$

In this model an increase in $f$, because it results in a decrease in the number of peer sellers, reduces the gross utility of consumers. Both the traditional firm and the platform increase their prices ($\frac{\partial p_I^*}{\partial f} > 0$ and $\frac{\partial r^*}{\partial f} > 0$). The equilibrium price charged by peer sellers almost always increase in $f$. So, consumer surplus is reduced with an increase in $f$. However, $\frac{\partial \pi_I^*}{\partial f} > 0$ and $\frac{\partial \pi_p^*}{\partial f} > 0$. So, the welfare impact of an increase in $f$ is a priori ambiguous.

When we take into account the conditions to solve the model, we show that there is no situation where the sign of the derivative $\frac{\partial W_e}{\partial f}$ is positive. It means that an increase in $f$ would always negatively impact the social welfare. This result means that, using this framework, a regulation that would result in higher entry costs for peer sellers, for instance by requiring higher minimal quality standards, would always negatively impact the social welfare. Of course, this result may not hold in the case where the regulation would benefit consumers by solving information asymmetries. However, if one believes that reputation systems used by platforms already efficiently minimize information asymmetries (it is the implicit assumption of this model), then, a regulation that would increase $f$ would not be efficient.

**Proposition 1.** *If the regulation does not solve information asymmetries nor increase the quality of peer sellers, an increase in peer sellers fixed entry costs has a negative effect on social welfare.*

### 4.2 Impact of a regulation on the number of peer sellers

In order to see how a social planner could improve the welfare it is necessary to derive the social welfare as a function of the number of peer sellers. We consider a conceptual case where the social planner can directly set the number of peer sellers $n$.

The timing of the game we consider is the following:

- **Stage 0**: The social planner chooses $n$
- **Stage 1**: The traditional firm chooses $p_I$
- **Stage 2**: The platform chooses $r$
- **Stage 3**: Peers choose $p$
- **Stage 4**: Consumers choose to buy either from the platform or the traditional firm.

We solve the game, starting from stage 4, we equalize $u_p = \alpha n - p - r - tx$ and $u_I = \delta - p_I - t(1-x)$, and find the position of the indifferent consumer: $\tilde{x} = \frac{\alpha n - p - r + p_I - \delta + t}{2t}$. Then we derive profits and, from the first order conditions, we get the best responses of the traditional firm and the platform.

At stage 3, peer sellers choose a price $p$ that maximizes their joint revenue $\tilde{x}p$.

$$
\begin{aligned}
p = \underset{p}{\text{argmax}}\ \tilde{x}p &= \underset{p}{\text{argmax}}\ \frac{\alpha n - p - r + p_I - \delta + t}{2t} p \\
&= \frac{1}{2}\left(\alpha n + p_I - r - \delta + t\right)
\end{aligned}
$$

At stage 2, the platform chooses a commission $r$ that maximizes its profit:

$$\begin{aligned} r = \underset{r}{\operatorname{argmax}} \;\; \pi_p &= \underset{r}{\operatorname{argmax}} \;\; r\tilde{x} \\ &= \frac{1}{2}\left(\alpha n + p_I - \delta + t\right) \end{aligned}$$

At stage 1, the traditional firm chooses the price $p_I$ that maximizes its profit:

$$\begin{aligned} p_I = \underset{p_I}{\operatorname{argmax}} \;\; \pi_I &= \underset{p_I}{\operatorname{argmax}} \;\; p_I(1-\tilde{x}) \\ &= \frac{1}{2}\left(\delta - \alpha n + 7t\right) \end{aligned}$$

So, at equilibrium the prices and the fee take the values:

$$\begin{aligned} p_I^* &= \frac{1}{2}\left(\delta - \alpha n + 7t\right) \\ r^* &= \frac{1}{4}(\alpha n - \delta + 9t) \\ p^* &= \frac{1}{8}(\alpha n - \delta + 9t) \end{aligned}$$

and the equilibrium market share of the platform is:

$$\tilde{x}(\alpha, n, \delta, t) = \frac{\alpha n - \delta + 9t}{16t}$$

The social welfare is defined as:

$$\begin{aligned} W &= S + \pi_I + \pi_p + p\tilde{x} - nf \\ &= \int_0^{\tilde{x}} (\alpha n - p - r - tx)\,\mathrm{d}x + \int_0^{1-\tilde{x}} (\delta - p_I - tx)\,\mathrm{d}x + \pi_I + \pi_p - nf + p\tilde{x} \\ &= \frac{1}{256t}\left(-256fnt + 15(\delta - \alpha n)^2 + 2t(57\delta + 71\alpha n) - 65t^2\right) \\ &= w(n, \alpha, f, \delta, t) \end{aligned}$$

We note that the derivative of the social welfare with respect to $n$ has an ambiguous sign:

$$\frac{\partial W}{\partial n} = \frac{1}{128t}\left(\alpha(-15\delta + 15\alpha n + 71t) - 128ft\right)$$

and

$$\frac{\partial^2 W}{\partial^2 n} = \frac{15\alpha^2}{128t} > 0$$

So, the function $w(n)$ is convex, this form is due to indirect network effects. It means that we can find a $\tilde{n}$ that minimizes the social welfare, and every regulation that would increase the gap between the actual number of peer sellers and this minimum would be welfare improving.

Solving the equation $\frac{\partial W}{\partial n} = 0$, this minimum is found for $\tilde{n}$:

$$\tilde{n} \equiv \underset{n}{\text{argmin}}\ W = \frac{15\alpha\delta + 128ft - 71\alpha t}{15\alpha^2}$$

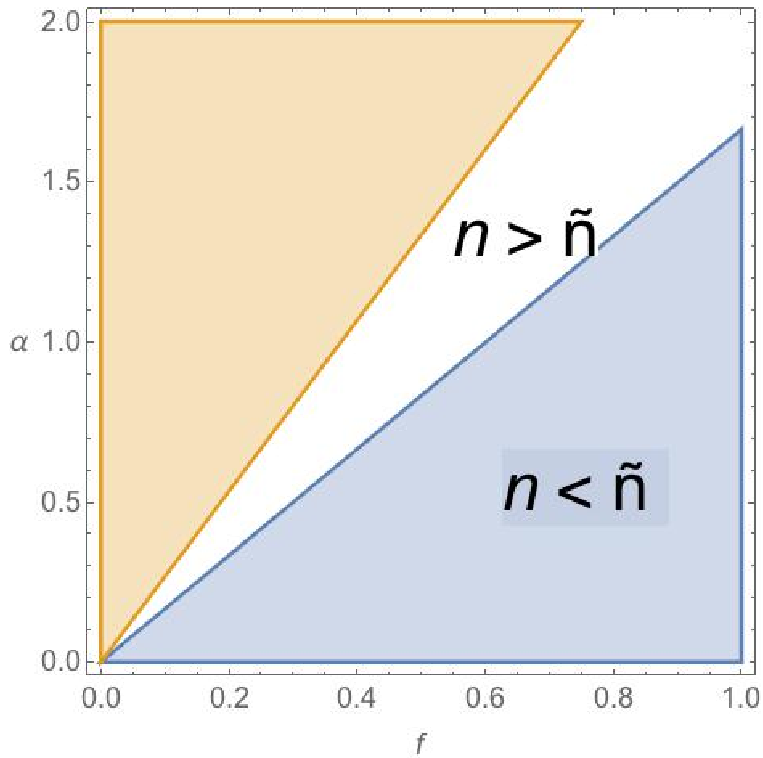
Because $\tilde{n}$ is the number of peer sellers that minimizes the social welfare, if the equilibrium number of peer sellers, $n^*$, is lower than $\tilde{n}$ a decrease in $n$ would be welfare improving.

So, we want to compare $n^*(\alpha, f, \delta, t) =$ and $\tilde{n}(\alpha, f, \delta, t)$.

Because we are interested in the effect of the parameters $\alpha$ and $f$, we consider the case where: $t = 1$ and $\delta = \frac{1}{2}$

So, the difference $n^* - \tilde{n}$ is only a function of $\alpha$ and $f$. The following figure shows the parameter range for which $n^* < \tilde{n}$, for $t = 1$ and $\delta = \frac{1}{2}$.

**Figure 6: Sign of the difference $\tilde{n} - n$ depending on the parameters $f$ and $\alpha$**




As we can see the equilibrium number of peer sellers is lower than the number that minimizes the social welfare, $n^* < \tilde{n}$, for high values of $f$ and low values of $\alpha$. So, a regulation that would limit or reduce the number of peer sellers on the platform may be welfare improving in cases where indirect network effects are low and fixed entry costs are high.

The intuition for this result is the following: when $f$ is high, total entry costs $nf$ are high, so a reduction in $n$ would avoid high social losses, at the same time if $\alpha$ is low, then reducing the diversity of platform options only moderatly affects consumers utility.

**Proposition 2.** *A regulation that would limit the number of peer sellers active on the platform would be welfare increasing in cases where peer sellers' entry costs, $f$, are high and indirect network effects, $\alpha$, are low.*

### 4.3 The case of a non national platform

When the traditional firm is national and the platform is international, a social planner, such as a government, may be tempted not to take into account the platform's profit when deciding about regulating or not. In such a situation the objective function would not include the platform's profit:

$$\begin{aligned} W_{-p} &= S + \pi_I + p\tilde{x} - nf \\ &= \frac{1}{256t}\left(-256fnt + 11(\delta - \alpha n)^2 + 2t(93\delta + 35\alpha n) - 389t^2\right) \end{aligned}$$

The derivative of the social welfare, with respect to $n$, would be:

$$\frac{\partial W_{-p}}{\partial n} = \frac{-256ft + 22\alpha(\alpha n - \delta) + 70\alpha t}{256t}$$

and the second derivative:

$$\frac{\partial^2 W_{-p}}{\partial^2 n} = \frac{11\alpha^2}{128t}$$

The number of peer sellers that minimizes the social welfare, $\tilde{n}_{-p}$, is found to be:

$$\tilde{n}_{-p} \equiv \underset{n}{\text{argmin}}\ \ W_{-p} = \frac{11\alpha\delta + 128ft - 35\alpha t}{11\alpha^2}$$

It is straightforward to show that $\tilde{n}_{-p}$ is higher than the threshold derived in the previous section, $\tilde{n}$. It means that a reduction in the number of peer sellers would be welfare improving in situations easier to reach. The intuition is that the social planner does not take into account the negative effect on platform's profit resulting from the regulation.

As a result, when the platform is not national there may be higher incentives to regulate the number of peer sellers. This result stands even though the benefit of such a measure would be lower than in the case where the platform is national. To see this, we compare the second derivatives of welfare with respect to $n$ the number of peer sellers, $\frac{\partial^2 W}{\partial^2 n}$ and $\frac{\partial^2 W_{-p}}{\partial^2 n}$, and check that the objective function is flatter in the non national platform case ($\frac{\partial^2 W_{-p}}{\partial^2 n} < \frac{\partial^2 W}{\partial^2 n}$). This result is graphically illustrated by figures 7 and 8 in Annex.

**Proposition 3.** *If the platform is not national a government has higher incentives to impose a regula-*

*tion on the number of peer sellers, even though a regulation of the same amplitude would have a lower impact on the social welfare than in the case where the platform is national.*

## 5 Conclusion

We show that a legislation that increases peer sellers fixed entry costs reduces social welfare if it does not help to solve information asymmetries between both sides of the platform, nor increase the quality of peer sellers. As Miller (2014) we believe that the best way to regulate a peer-to-peer platform, when there is a political will for it, is to allocate licenses for participation in a platform on the supply side, and allow for a secondary license market to emerge. The introduction of such a system, if the number of licenses allocated is lower than the actual number of peer sellers at the time it is launched, is equivalent to a reduction in the number of peer sellers. We show that such a regulation may increase welfare in markets with low indirect network effects and/or strong peer sellers fixed entry costs. We show that if the platform that competes against the traditional industry is not national, the legislator has higher incentives to restrict the activity of the platform even though an equivalent regulation does not increase welfare as much as if the platform is national.

This model makes a link between two streams of literature, the literature on two-sided markets initiated by Rochet and Tirole (2003), where indirect netwok effects is a central notion, and the recent literature on platforms regulation where indirect network effects are not explicitly included. With this article we intend to contribute to the discussion around peer-to-peer platforms regulation. We give some insights on this question, in a context where a growing number of cities take measures to regulate peer-to-peer accommodation platforms.

In any cases it is important to mention that a public regulator only has imperfect information about the markets. This is this particularly true for numerical peer-to-peer markets, where the demand and supply conditions change rapidly. This makes the design of the regulation costly and necessarily imperfect.

# 6 Annex

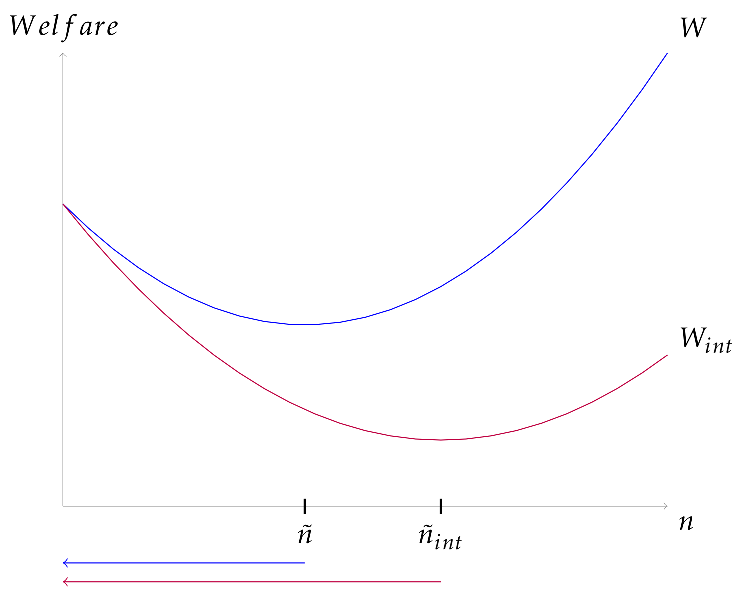



**Figure 7: Welfare functions for national and non national platform cases**

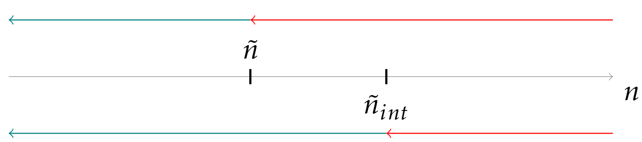



**Figure 8: Comparison of number of peer sellers that minimize welfare**

## References

**Armstrong, Mark.** 2006. "Competition in two-sided markets." *The RAND Journal of Economics*, Volume 37: Pages 668–691.

**Caillaud, Bernard, and Bruno Jullien.** 2003. "Chicken & Egg: Competition Among Intermediation Service Providers." *RAND Journal of Economics*, Vol. 34(No. 2).

**Cervero, Robert, Aaron Golub, and Brendan Nee.** 2007. "City CarShare: longer-term travel demand and car ownership impacts." *Transportation Research Record: Journal of the Transportation Research Board, (1992): 70-80*.

**Edelman, Benjamin G., and Damien Geradin.** 2015. "Efficiencies and Regulatory Shortcuts: How Should We Regulate Companies like Airbnb and Uber? (November 24, 2015)." *Forthcoming, Stanford Technology Law Review*. Available at SSRN: http://ssrn.com/abstract=2658603.

**Einav, Liran, Chiara Farronato, and Jonathan Levin.** 2015. "Peer-to-Peer Markets (August 2015)." *NBER Working Paper No. w21496*. Available at SSRN: http://ssrn.com/abstract=2649785.

**Horton, John J, and Richard J Zeckhauser.** 2016. "Owning, Using and Renting: Some Simple Economics of the" Sharing Economy"." National Bureau of Economic Research.

**Koopman, Christopher, Matthew D. Mitchell, and Adam D. Thierer.** 2015. "The Sharing Economy and Consumer Protection Regulation: The Case for Policy Change (May 15, 2015)." *The Journal of Business, Entrepreneurship & the Law*, Vol. 8.

**Kroft, Kory, and Devin G. Pope.** 2014. "Does Online Search Crowd Out Traditional Search and Improve Matching Efficiency? Evidence from Craigslist." *Journal of Labor Economics*, vol. 32: pages 259 – 303.

**Malhotra, Arvind, and Marshall Van Alstyne.** 2014. "The dark side of the sharing economy... and how to lighten it." *Communications of the ACM*, 57(11): 24–27.

**Martin, Elliot, Susan Shaheen, and Jeffrey Lidicker.** 2010. "Impact of Carsharing on Household Vehicle Holdings." *Transportation Research Record: Journal of the Transportation Research Board*, 2143.

**Miller, Stephen R.** 2014. "Transferable Sharing Rights: A Theoretical Model for Regulating Airbnb and the Short- Term Rental Market (October 24, 2014)." Available at SSRN: http://ssrn.com/abstract=2514178 or http://dx.doi.org/10.2139/ssrn.2514178.

**Quattrone, Giovanni, Davide Proserpio, Daniele Quercia, Licia Capra, and Mirco Musolesi.** 2016. "Who Benefits from the "Sharing" Economy of Airbnb? (February 26, 2016)." *International World Wide Web Conference. WWW 2016, April 11–15, 2016, Montréal, Québec, Canada*. Available at SSRN: http://ssrn.com/abstract=2738731.

**Rochet, Jean-Charles, and Jean Tirole.** 2003. "Platform Competition in Two-Sided Markets." *Journal of the European Economic Association*, 1(4): p. 990–1029.

**Seamans, Robert, and Feng Zhu.** 2013. "Responses to Entry in Multi-Sided Markets: The Impact of Craigslist on Local Newspapers." *NET Institute Working Paper*, , (No. 10-11). Available at SSRN: http://ssrn.com/abstract=1694622.

**Zervas, Georgios, Davide Proserpio, and John Byers.** 2016. "The Rise of the Sharing Economy: Estimating the Impact of Airbnb on the Hotel Industry (June 9, 2016)." *Boston U. School of Management Research Paper No. 2013-16*. Available at SSRN: http://ssrn.com/abstract=2366898 or http://dx.doi.org/10.2139/ssrn.2366898.