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Shared networks and market power in two-sided markets

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Abstract

We develop a two-sided market model with N platforms in which we compare the cases with and without shared networks. We find that, in markets with shared networks, platforms have a higher market power than in the case without shared networks. We analyze the conditions under which this behavior is profitable. Lastly, we compare our results with other works in literature, and we show that previous works are particular cases of our framework.

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1 Introduction

Some digital multi-sided platforms are constantly sharing their networks, for example, Tinder (a dating app) with Facebook or Fitbit with Withings (two fitness-tracker companies). However, despite being a common practice, the effects of sharing networks in the market power are not clear. Shared networks are not well addressed in the industrial organization literature, and it is not clear what the consequences of this behavior are.

For example, if Apple makes a sharing agreement with Google, developers on Apple Store can sell their software on Play Store without paying an extra fee. The market power of both, Apple and Google, may increase. Developers benefit from this agreement, but users also benefit because they can access to more software. Therefore, platforms may fix higher prices, gain more market power, and earn larger profits.

We develop a duopoly with two price-competing platforms to address the impact of such decisions. We consider a set H of platforms, which agrees to share an exogenous proportion of their networks. We compute the Lerner indexes with and without shared networks. Comparing the two cases, we find that shared networks increase the market power of those companies involved in the sharing agreement, we also point out the conditions of profitability. Lastly, we compare our model with previous works in the literature, and we show that they are particular cases of our model.

2 Sharing networks and market power

The relationship between sharing networks and market power is not fully addressed in the multi-sided market literature. To the best of our knowledge, Doganoglu and Wright (2006) and Salim (2009) are the only two works that consider sharing agreements, although they refer to them as "compatibility agreements".

The first one analyses the relationship between compatibility and multihoming, and the second one analyses investment incentives when no one shares their networks and when everyone shares them. On the other hand, the market power is not a major topic in the theoretical part of the two-sided market literature. As a matter of fact, only three theoretical works consider the Lerner Index, Rochet and Tirole (2003), Armstrong (2006) and Weyl (2010).

On the one hand, Doganoglu and Wright (2006) and Salim (2009) prove that shared networks may mitigate price competition in two sided markets. However, the conclusions may not be robust because both works rely on the same framework: linear demands and horizontally differentiated users, but also because traditional works such as Farrell and Saloner (1985) or Katz and Shapiro (1985) find the opposite conclusion.

On the other hand, Rochet and Tirole (2003) is the first work in dealing with the Lerner index in two-sided markets, but the focus of the work is on the credit card market. Armstrong (2006) also obtains the Lerner index, but he does not address it extensively. Also, he assumes strong assumptions that limit his conclusions such as linear demands and utilities. The first work which addresses the market power and the Lerner index extensively is Weyl (2010). He proposes a generalized case in which the Lerner indexes of Rochet and Tirole (2003) and Armstrong (2006) are particular cases. However, those Lerner indexes depend highly on the assumption of quasi-linear utilities.

Lastly, to the best of our knowledge, there is no work which addresses the impact of shared networks in market power in two-sided markets. This work tries to be the first contribution on this topic.

3 The Model

The model comprises three classes of agents: users, developers, and platforms. Users (developers) can interact with developers (users) and platforms. Platforms are intermediaries that enable the interactions between the two groups.
Let's assume the utility of a user i consuming the platform k depends on the prices on the users' side (V_k) and on individual features (θ_i) such that $U_{i,k} = U(V_k, \theta_i)$. Users choose the best platform for them. Thus, users who choose the same platform k will form the demand for that platform k. Formally:

$$D_k(V,\theta) = \sum_{\forall i \in A} i \quad ,\text{where} \quad A \equiv \{(V,\theta_i); \quad U_{i,k} \geq 0, \quad U_{i,k} \geq max(U_{i,-k})\}$$

In a similar way, the profit of a developer j on a platform k depends on the prices on developers' side (T_k), on individual features (δ_j), and on the technical features of the platform (that is related to the number of users on the platform), $C_k(D_k(\cdot))$ such that $\Pi_{j,k} = \Pi(T_k, \delta_j, C_k)$. Developers choose the best platform for them. Thus, developers who choose the same platform k will form the demand for that platform k. Formally:

$$G_k(T,\delta,C) = \sum_{\forall j \in B} j \quad ,\text{where} \quad B \equiv \{(T,\delta_j,C); \quad \Pi_{j,k} \geq 0, \quad \Pi_{j,k} \geq max(\Pi_{j,-k})\}$$

In both cases, we assume demands are continuous and differentiable with respect to prices, and agents consume one platform only, i.e. agents singlehome.
Given the symmetry of the model, for simplicity's sake and without loss of generality, we assume one externality on developers' side only. This assumption does not change the conclusions but simplifies the exposition. Lastly, we consider platforms maximize their profits with respect to prices. Formally:

$$\max_{T_k, V_k} \quad \pi_k = T_k * G_k + V_k * D_k - c_k(G_k, D_k) \tag{1}$$

$c_k(\cdot)$ denotes the twice continuously differentiable cost function. It is important that the first-order conditions represent the optimal allocation for platforms. In this sense, we can assume that the platform's profit function is concave, but some authors consider that this assumption is overly restrictive, Weyl (2010). Therefore, we assume log-concavity.
To rule out the multiplicity of equilibria, we assume the first-order conditions represent the unique global interior equilibrium, and agents are "sufficiently differentiated". In that sense, deviations towards zero prices are not profitable, and platforms cannot monopolize a part of the market by giving the platform for free to one side [1].

3.1 Case without Shared Network

Taking the first order conditions of the equation (1) with respect to prices we get the Lerner indexes. On developers' side, the Lerner index is:

$$\frac{1}{\left|\varepsilon^k_{jj}\right|} = \frac{T_k - MC^d_k}{T_k} \tag{2}$$

[1] We acknowledge that the differentiation condition is rather vague. However, it cannot be described better without making further assumptions about users' utilities.

$MC_k^d = \frac{\partial c_k(\cdot)}{\partial G_k}$ denotes the marginal cost of providing the service to developers, and $\varepsilon_{jj}^k = \frac{\partial G_k}{\partial T_k}\frac{T_k}{G_k}$ denotes the own-price elasticity of demand for the platform k on the developers' side. However, on the users' side, the Lerner index is more complex:

$$\frac{1}{\left|\varepsilon_{ii}^k\right|} - \frac{T_k}{V_k}\frac{\partial G_k}{\partial C_k}\frac{\partial C_k}{\partial D_k} = \frac{V_k - MC_k^u}{V_k} \tag{3}$$

$MC_k^u = \frac{\partial c_k(\cdot)}{\partial D_k} + \frac{\partial c_k(\cdot)}{\partial G_k}\frac{\partial G_k}{\partial D_k}$ denotes the marginal cost of providing the service on users' side. However, note that $\frac{\partial c_k(\cdot)}{\partial D_k}$ is the marginal cost of providing the service to users, and $\frac{\partial c_k(\cdot)}{\partial G_k}\frac{\partial G_k}{\partial D_k}$ is the extra marginal cost generated by developers that are attracted to the platform because of the larger number of users on the platform. Additionally, $\varepsilon_{ii}^k = \frac{\partial D_k}{\partial V_k}\frac{V_k}{D_k}$ represents the own-price elasticity of demand for the platform k on users' side.

If shared networks among platforms are not allowed, the market power is lower than in a market without network effects (a one-sided market). The difference between a case with and without network effects is $\frac{T_k}{V_k}\frac{\partial G_k}{\partial C_k}\frac{\partial C_k}{\partial D_k}$, which is positive. So the Lerner Index is lower. The intuition is the following: Developers value the presence of users, and platforms need to attract developers and users. To do so, platforms reduce prices on users' side, and that decrease mitigates their market power on users' side [2].

3.2 Case with Shared Network

Let's assume that a set H of platforms make a sharing agreement. Those platforms can access a proportion ρ_k of her partners' networks (rights to access). In this framework, $C_k^*(D_k + \rho_k \sum_{\forall l \neq k \in H} D_l(\cdot))$ represents the technical features of platform k. Therefore, if platform l shares her network with platform k, the number of users on platform l influences the developers' decisions on platform k.

On the one hand, the Lerner index on developers' side will have the same expression than in (2). However, this does not imply that the market power is unchanged, as a consequence of the increase of technical features from C_k to C_k^*, prices and market power on developers' side can be higher. On the other hand, the Lerner index on users' side will have a different expression:

$$\frac{1}{\left|\varepsilon_{ii}^k\right|} - \frac{T_k}{V_k}\frac{\partial G_k}{\partial C_k}\frac{\partial C_k}{\partial D_k} + \frac{T_k}{\left|\varepsilon_{ii}^k\right|}\frac{\partial G_k}{\partial C_k}\frac{1}{V_k * D_k}\left(\rho_k \sum_{\forall l \neq k \in H}\frac{\partial C_k}{\partial D_l}\varepsilon_{ii}^{k,l} * D_l\right) = \frac{V_k - MC_k^u}{V_k} \tag{4}$$

$\varepsilon_{ii}^{k,l} = \frac{\partial D_l}{\partial V_k}\frac{V_k}{D_l}$ denotes the cross-price elasticity of demand for the platform l with respect to the price fixed by platform k on users' side.

Proposition 1. *Sharing networks increases the maker power of platforms in the agreement.*

Proof. In comparison with the case without agreements, the Lerner index has an extra element that represents the effect of shared networks in the market power. This element is positive and is countervailing the effect of the two-sidedness in the market power. So this new term is increasing the market power. □

In the case without shared networks, platforms fix a low price on users' side to attract them because developers prefer platforms where there are a lot of users. On the other hand, when platforms share their networks, developers can access users on other platforms through one

[2] Because of the large number of users attracted, the market power may increase on developers' side. Developers will be willing to pay higher prices, and platforms may exploit this feature.

platform. In this case, there is no need to fix low prices on users' side to attract them, and developers are willing to pay higher prices because they can find more users so, the market power of platforms increases.
Additionally, the market power can increase in three ways: a) an increase in the rights to access to the competitors' networks (increases in ρ_k); b) the number of platforms in the agreement ; c) other individual features of platforms [3].

Proposition 2. *Sharing networks among platforms does not necessarily mitigate the subsiding effect of the two-sided market.*

Proof. If we assume $\rho_k = 1$, we can prove that $\frac{T_k}{|\varepsilon_{ii}^k|}\frac{\partial G_k}{\partial C_k}\frac{1}{V_k * D_k}\left(\rho_k \sum_{\forall l \neq k \in H} \frac{\partial C_k}{\partial D_l}\varepsilon_{ii}^{k,l} * D_l\right)$ does not equal $\frac{T_k}{V_k}\frac{\partial G_k}{\partial C_k}\frac{\partial C_k}{\partial D_k}$ unless we make further assumptions. □

The intuition is the following: if developers can get in contact with any user in other platforms, platforms have an incentive to fix higher prices than when developers can only get in contact with a few platforms. However, unless we assume that every platform is in the agreement and developers can reach all users on any platform, there will be an incentive to try to attract some users by lowering prices.
Opening your network to competitors is common in the fitness tracker market. In Fig. 1 is depicted a network that represents the compatibility relationships among the databases of the relevant players in the fitness tracker ecosystem [4]. The most connected player is Under Armour. As theory predicts, the professional access to their API is not free, however, some years ago it was free. Garmin is another example of this behavior. They have a one-time license fee of $5000, although in 2014 was completely free. However, other companies have open APIs because: a) fitness tracker is not the main line of business (as Nokia-Withings), or b) their ecosystems are not so vibrant as those of Garmin or Under Armour. [5]

3.3 Incentives to share networks

Companies are interested in profitable strategies, so it makes sense to analyze the incentives of platforms to share their networks with competitors (third-party access) [6]. Let's consider the equilibrium profits of platforms when there is no sharing at all (π_k^{ns}) and when they can access their competitor's network (π_k^{s}). The difference between these two cases is the following: in the first case, the technical features of platforms are $C_k(D_k)$, in the second case, the technical features are $C_k^*(D_k + \rho_k \sum_{\forall l \neq k \in H} D_l(\cdot))$.
Thus, sharing networks can be profitable if, and only if, profits increase when the access to other platforms increases. Analytically: $\frac{\Delta \pi^*}{\Delta D_l} = \pi_k^s(C_k^*(\Delta D_l)) - \pi_k^{ns}(C_k(\cdot)) > 0$. However, sometimes

[3]There are other factors that influence the market power. However, we omit this part of the analysis because all those effects are positive. Therefore, they only increase the market power.

[4]We only consider those companies which sell a fitness tracker. There are other players that influence the market such as Google Fit, Apple Health or Runkeeper, but they do not sell a fitness tracker with a complementary platform.

[5]Under Armour: `https://developer.underarmour.com/`, Garmin: `https://goo.gl/nLUw35` and `https://goo.gl/QkHfHu`

[6]One of the reviewers raised an interesting concern about the impact on welfare. However, we cannot address this issue without making further assumptions about the utility functions. Nonetheless, it is clear that welfare will only increase if, on average, the increase in utilities on both sides as consequence of the increase in network effects offset the increase in prices. So, welfare will not always increase. It will depend not only on network effects but also on other features that influence users' willingness to pay, such as the level of differentiation.

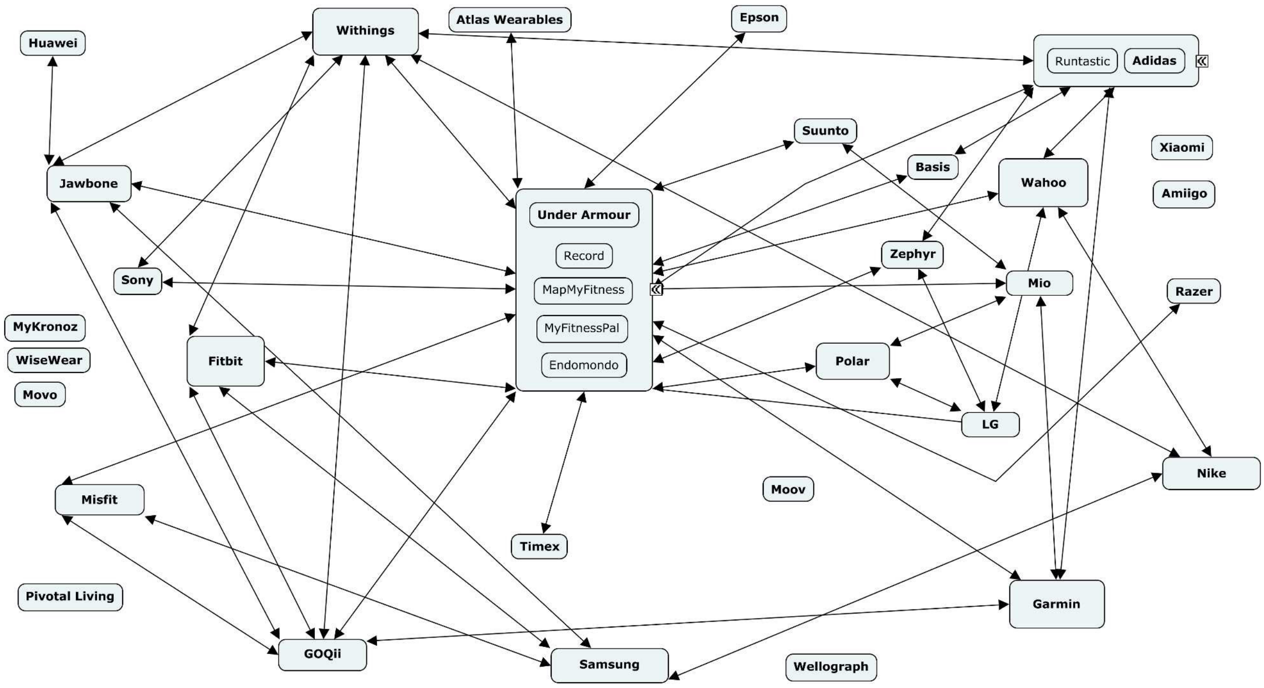

Figure 1: Relationships among databases of fitness tracker companies. Summer 2016

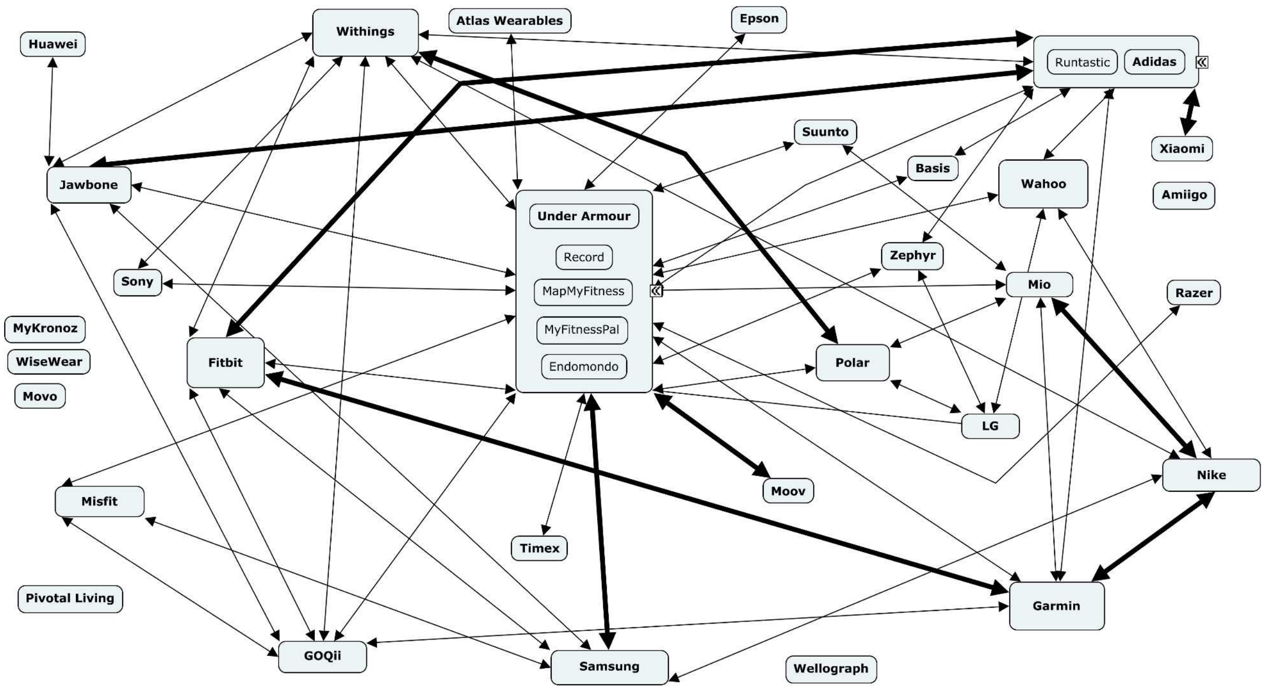

Figure 2: Relationships among databases of fitness tracker companies. Summer 2017

sharing networks requires a costly process of standardizing data, allowing connectivity, etc. Therefore, we can rewrite the equilibrium profits as follows:

$$\pi^* = T_k^* G_k^* + V_k^* D_k^* - c_k^*(G_k^*, D_k^*) - F_{k,l}(D_l)$$

$F_{k,l}(D_l)$ denotes the cost of sharing networks between the platform k and the platform l[7]. Following this expression, we can obtain the condition to guarantee that sharing networks can be a profitable strategy for platforms:

$$\frac{\partial T_k^*}{\partial C_k} G_k^* + \frac{\partial G_k^*}{\partial C_k} T_k^* > \frac{\partial c_k^*}{\partial G_k^*} \frac{\partial G_k^*}{\partial C_k} + \frac{\partial F_{k,l}}{\partial D_l} \frac{1}{\rho_k(\partial C_k/\partial D_l)} \tag{5}$$

On the left-hand side, it is considered the impact of the third-party access in the revenues. On the right-hand side, it is the impact of the third-party access in the marginal costs and in the costs of making both networks compatible. The intuition of this expression is simple: The access to other networks is profitable if, and only if, the increase in revenues is higher than the increase in costs [8].

Although this condition seems to support any non-costly third-party access, this is not always true. In real markets, two barriers limit the widespread adoption of third-party access. On the one hand, there are negotiation and coordination costs, and the larger the companies or the networks, the larger those costs are. On the other hand, the larger the network effects, the larger the incentive towards concentration in only one platform is. This effect implies that incumbents with big networks are less willing to grant access to their networks to new and small entrants because they may attract developers and may reduce incumbents profits. Sharing networks only make sense in markets where network effects are moderate and independent platforms have little market power because, in that way, they increase both, network effects and market power. For example, without sharing networks, the fitness tracker companies would be less attractive to developers, because there would be fewer potential users. But, if they share their networks, developers are attracted to platforms because they offer a large pool of users, and their market power increases.

However, in contrast with a merger in the Cournot model, even when only a subset of companies agrees on sharing networks, third-party access can be profitable. Sharing networks increases the network effects, so developers have a large willingness to pay, and platforms can exploit this characteristic to increase profits. An important difference between a merger in the Cournot model and shared access to networks in two-sided markets is the following: the merger in a Cournot model does not affect the consumers' utilities, but in a two-sided market consumers' utility may vary because of the changes in network effects. Prices may increase because of a large willingness to pay and not because there are fewer players in the market.

In Fig. 2 we can observe the situation of the fitness tracker ecosystem in June 2017. The bold lines represent the new connections that have appeared between July 2016 and July 2017. We observe that nine new connections have appeared among companies that benefit bilaterally from the third-party access.

Proposition 3. *Sharing of networks in two-sided markets can be profitable even if only a subset of companies agrees on sharing such networks. The increase in network effects can expand the market and offset the costs of coordinating platforms. If there are no costs and platforms are symmetric in size, shared access to networks is profitable for all companies.*

[7] We assume this function is increasing and differentiable. The intuition is that the larger the network, the higher the costs of coordinating networks are.

[8] We can express inequality (5) as: $T_k^* G_k^* (\varepsilon_{T,C}^k + \varepsilon_{G,C}^k) > C_k^*(\Delta D_l)(\mu + \gamma)$. Where $\mu = \frac{\partial c_k}{\partial G_k} \frac{\partial G_k}{\partial C_k}$ and $\gamma = \frac{\partial F_{k,l}}{\partial D_l} \frac{1}{\rho_k(\partial C_k/\partial D_l)}$.

3.4 Comparison with other works

Doganoglu and Wright (2006) and Salim (2009) show that prices converge to the equilibrium of a market without network effects. They assume that platforms grant full access to their networks and no side is subsidized, so the Lerner index is: $\frac{1}{|\varepsilon_{jj}^{k}|} = \frac{T_k - MC_k^d}{T_k}$. To obtain this expression in our framework, the following condition must be satisfied:

$$\frac{T_k}{\left|\varepsilon_{ii}^{k}\right|}\frac{\partial G_k}{\partial C_k}\frac{1}{V_k * D_k}\left(\rho_k \sum_{\forall l \neq k \in H} \frac{\partial C_k}{\partial D_l}\varepsilon_{ii}^{k,l} * D_l\right) = \frac{T_k}{V_k}\frac{\partial G_k}{\partial C_k}\frac{\partial C_k}{\partial D_k} \tag{6}$$

This condition requires the two-sided effect or the subsidy effect (the right-hand side) to be equal to the "shared networks" effect or the disincentive to subsidy the other side (the left-hand side). However, this expression can be simplified. Straightforward computation yields:

$$\left|\varepsilon_{ii}^{k}\right| * \varepsilon_{C,D}^{k} = \frac{1}{C_k}\left(\rho_k \sum_{\forall l \neq k \in H} \frac{\partial C_k}{\partial D_l}\varepsilon_{ii}^{k,l} * D_l\right) \tag{7}$$

$\varepsilon_{C,D}^{k} = \frac{\partial C_k}{\partial D_k}\frac{D_k}{C_k}$ denotes the elasticity of the technical features of the platform k with respect to the demand for the platform k.

Proposition 4. *Only if we assume total symmetry, full access to other networks, and constant values, we obtain the same conclusions than Doganoglu and Wright (2006) and Salim (2009).*

Proof. To obtain the same result than Doganoglu and Wright (2006) and Salim (2009), we need to assume:

1. Full access to networks, $\rho_k = 1$
2. The benefit an agent enjoys from interacting with the opposite side is constant and equal for all platforms, $\frac{\partial C_k}{\partial D_l} = \frac{\partial C_k}{\partial D_k} = c$
3. The effect of prices in demands is symmetric, $\frac{\partial D_k}{\partial V_k} = \frac{\partial D_k}{\partial V_l} = c$

If we make those assumptions, the condition (7) is satisfied. To the best of our knowledge, there is no work in the two-sided market literature which does not consider the assumption 3. Also, assumption 2 is common in the literature, although sometimes it is relaxed, Weyl (2010). □

Another interesting result is that shared access to networks can lead to a larger market power than in the cases predicted by Doganoglu and Wright (2006) or Salim (2009). The proof is trivial: the left-hand side has to be smaller than the right-hand side in (7). The market power could be higher because developers may value the presence of users a lot. In this way, platforms have no incentive to subsidize users. In fact, they may have an incentive to charge them higher prices. Although this may price out of the market some users, this effect can be offset by users in other networks.

Lastly, if we consider the inequality (5), we can obtain the conditions to guarantee the profitability of sharing networks in Doganoglu and Wright's and Salim's frameworks. In the case of Doganoglu and Wright (2006), they state that compatibility among networks is profitable if $\frac{\beta}{2} > F$. Where β denotes the value of the network benefits, and F denotes the cost of sharing networks. If we compare prices and demands with and without compatibility: $\frac{\partial T_k}{\partial C_k}G_k = \frac{\beta}{2}$ and $\gamma = F$. This is a particular case of the inequality (5). In the case of Salim (2009), no inequality represents the profitability of accessing to competitors' networks in her original work, but we can obtain such inequality from (5)[9]. As a summary, profits are not always larger when sharing networks. It depends on the assumptions we make about the utility functions and demands.

4 Conclusions

We propose a two-sided market model in which we analyze the consequences of shared networks among platforms. We address the Lerner index of platforms with and without access to competitors' networks. We find that when platforms access to competitors' networks, their market power increases. When the number of networks on the sharing agreement increases, or when the rights to access increase, the market power also increases. We analyze the conditions under which such sharing agreements are profitable, and we illustrate our findings with an example in the fitness tracker market. We find that if there are no costs and platforms are symmetric in size, shared access to networks is profitable for all companies. We compare our results with the literature, and we show that previous models are particular cases of our model. Lastly, we highlight the assumptions of previous works that constrain their conclusions about market power and profits.

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[9] We do not derive the expression because it will require explaining Salim's framework. However, the intuition is straightforward, if network effects are higher than differentiation effects, access to competitors' networks is profitable.