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Indirect Network Effects with Two Salop Circles: The Example of the Music Industry

Ralf Dewenter, Justus Haucap und Tobias Wenzel

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Institut für Volkswirtschaftslehre

Ehrenbergstraße 29
Ernst-Abbe-Zentrum

D-98 684 Ilmenau

Telefon 03677/69-4030/-4032
Fax 03677/69-4203

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Indirect Network Effects with Two Salop Circles: The Example of the Music Industry*

Ralf Dewenter, TU Ilmenau, 98684 Ilmenau

Justus Haucap, University of Erlangen–Nuremberg, 90403 Nuremberg

Tobias Wenzel, University of Erlangen–Nuremberg, 90403 Nuremberg

Abstract

This paper analyses the interdependency between the market for music recordings and concert tickets, assuming that there are positive indirect network effects both from the record market to ticket sales for live performances and vice versa. Using a model with two interrelated Salop circles we show that prices in both markets are corrected downwards when compared to the standard Salop model. Furthermore, we show that the effects of file sharing on firms' profitability and on variety are ambiguous. File sharing can increase profits through increased concert ticket demand and thereby also lead to additional market entry and additional variety.

JEL-Classification: L13, L82, Z10.

Keywords: Music Industry, Indirect Network Effects, Salop Model, File Sharing.

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1 Introduction

The music industry is going, once again, through a phase of rapid technological change. The digitalisation of music has made copyright enforcement much more difficult and costly, and there is a heated and very controversial debate about the effects of file sharing possibilities (see, e.g., Oberholzer-Gee and Strumpf (2007); Liebowitz (2007)). While most of the debate focuses on the question of how file-sharing affects record sales, firms' profits and music distribution systems (see, e.g., Alexander (2002); Peitz and Waelbroeck (2006)), there is also a limited literature on the effects of peer-to-peer networks on vertical product differentiation (quality) (e.g, Bayaan (2004)) and on concert ticket sales (in particular Curien and Moreau (2005); Gayer and Shy (2003, 2006),). Interestingly enough, there is hardly any theoretical economic literature on the relationship between music variety and the extent of file-sharing. To the best of our knowledge, the only notable exemption is the paper by Curien and Moreau (2005), who analyse how file sharing affects both record and concert ticket sales in a monopoly model. They assume—as we do—that piracy tends to boost demand for live performances and benefits artists, given the currently prevailing contracts. As sampling becomes easier, the monopolist's profits may even increase through file sharing, as may variety in Curien and Moreau (2005). Our paper builds on this research and explores how file-sharing, both record and concert ticket sales, and variety are interrelated and affected by the extent of file sharing in (imperfectly) competitive markets with differentiated goods. The key differences between Curien and Moreau (2005) and our paper are (a) that we analyse an (imperfectly) competitive market instead of a monopoly and (b) our model does not only analyse effects from record to ticket sales but also feedback effects from ticket to record sales.

For this purpose our paper analyses a model with two Salop circles (Salop, 1979) where demand for a given product in the one market (e.g., the record market) affects product demand in the other market (e.g., concert tickets). Hence, we assume that—as music consumption is also a *social* phenomenon, as many individuals tend to partially define themselves through their music consumption—the demand for concerts is increasing in record sales while the demand for records itself is also increasing in concert ticket sales.

While our paper aims at helping to explain and understand some recent trends in the the music industry, the model we develop is also innovative in its own, as it is the first paper to analyse competition in two Salop circles with indirect network effects.[1] Another example which fits our framework may be the relationship between books and movies (based on these books). For example, Harry Potter books and movies may be complements and exhibit indirect network effects. The reading of a Harry Potter book may provide a higher utility if more people also watch the movie, while at the same time the movie is the more attractive the more books are sold. In principle, any complementary products that exhibit these social network effects may serve as examples.

To our knowledge the only other papers that integrate two Salop circles are Reisinger and Schnitzer (2007) and Alexandrov et al. (2008), but they analyse vertically related markets with an inner Salop circle of upstream suppliers and an outer Salop circle of downstream retailers. In contrast, we analyse two separate Salop circles with complementary products.

[1]Note that even though there are indirect network effects present between the two products, our model is not a two-sided market model in the sense of Armstrong (2006) and Rochet and Tirole (2006). In two-sided markets there is typically one intermediary who promotes transactions between different types of consumers between which there are indirect network effects. In contrast, in our model there is a group of consumers who demands several types of products between which indirect network effects exist.

The remainder of the paper is now organised as follows: The next section introduces and analyses the model before section 3 extends the model to file sharing. In section 4 we analyse the resulting welfare effects, and our main results and conclusions are summarised in section 5.

2 The Model

Let us consider the market for records (or other forms of music recording) on the one hand and the market for music shows and performances on the other hand. For both markets we assume that consumers are located around a Salop circle with n different varieties offered by independent firms/bands. We assume that there are two types of consumers. While there are N consumers (called music lovers) that receive utility from both musical recordings and live music shows (concerts), there are also M consumers which do not like to attend shows, but only receive utility from recordings. The latter group will be called listeners. A given music lover j is assumed to receive the following utility from buying a music recording of variety i:

$$U_R = V_R - tl_j + \theta s_i - p_i,$$

where l_j denotes j's distance from her most preferred variety of music, while t measures the associated "transportation" costs. The number of live concerts of band i is denoted by s_i, i.e. we assume that a music lover's utility from a given music recording i is increased by θs_i if there are also s_i live concerts associated with the band's album. In our model s_i corresponds to the share of music lover that attend a concert by variety i.[2] In contrast, for

[2]Note that the indirect network effect depends only on the share of music lovers that attend the concert by variety i. Thus, the strength of the indirect network effect is independent of the market size and the presence of music listeners. The same applies to the indirect network effect from music recordings on the concert market.

simple music listeners θ is assumed to be zero, i.e., they do not receive any additional utility from live concerts. Hence, the number of live performances is utility enhancing for music lovers and a tool of vertical product differentiation for music lovers while it is not relevant for the M music listeners (i.e, $\theta = 0$ for music listeners, while $\theta > 0$ for music lovers). The record price, p_i, is deducted from consumers' utility. The gross utility from consuming recorded music,V_R, is assumed to be sufficiently high to ensure that all music lovers and listeners buy records. We also assume that the n varieties are located equidistantly on the circle of circumference one with both types of consumers being uniformly distributed around the circle (i.e., the N music lovers are uniformly distributed around the circle, and the M music listeners are also uniformly distributed around the circle).

Now let the music lovers' utility from attending a live concert be given by

$$U_C = V_C - dl_j + \delta q_i - w_i,$$

where V_C is the gross utility of attending a concert, l_j denotes j's distance from her most preferred music variety, while d measures the associated transportation costs in the live concert market. There is again a complementarity between records and live concerts so that the utility from live concerts is enhanced by a factor of δ the more records are sold. Hence, there are indirect network effects from both the record market to the live concert market (the strength of which is measured by δ) while the strength of the indirect network effects from the live concert market to the record market are measured by θ. The ticket price per live concert is denoted by w_i.

To ensure equilibrium existence, we have to impose a restriction on parameter values. In the Appendix, we provide the details for how we derive this restriction:

Assumption 1 $16td(N+M) > 9N(\theta+\delta)^2 + 36M\theta\delta.$

Put differently, we have to assume that the degree of product differentiation in the markets for records and concerts is sufficiently large compared to the network effects between the two markets.

The indifferent music lover (q_m) and music listener (x_m) in the music record market and the marginal consumer in the live concert market (s_m) are given by

$$V_R - tq_m + \theta s_i - p_i = V_R - t\left(\frac{1}{n} - q_m\right) + \theta s - p,$$

$$V_R - tx_m - p_i = V_R - t\left(\frac{1}{n} - x_m\right) - p,$$

$$V_C - ds_m + \delta q_i - w_i = V_C - d\left(\frac{1}{n} - q_m\right) + \delta q - w.$$

Hence, the respective demands are given by

$$q_i = 2q_m = \frac{1}{n} + \frac{p - p_i + \theta(s_i - s)}{t}, \tag{1}$$

$$x_i = 2x_m = \frac{1}{n} + \frac{p - p_i}{t}, \tag{2}$$

and

$$s_i = 2s_m = \frac{1}{n} + \frac{w - w_i + \delta(q_i - q)}{d}. \tag{3}$$

Taking into account the interdependencies between q_i and s_i, we can reformulate the two respective demand functions as

$$q_i(p_i, w_i) = \frac{1}{n} + \frac{6\theta(w - w_i) + 4d(p - p_i)}{4dt - 9\theta\delta}, \tag{4}$$

and

$$s_i(p_i, w_i) = \frac{1}{n} + \frac{6\delta(p - p_i) + 4t(w - w_i)}{4dt - 9\theta\delta}. \tag{5}$$

Hence, the profit function that a representative firm confronts can now be written as follows:

$$\pi_i(p_i, w_i) = Np_iq_i(p_i, w_i) + Mp_ix_i(p_i) + Nw_is_i(p_i, w_i). \tag{6}$$

Solving the first-order conditions yields the following equilibrium prices and quantities:

$$p = \frac{t}{n} - \frac{3\delta}{2n}\frac{N}{M+N}, \tag{7}$$

$$w = \frac{d}{n} - \frac{3\theta}{2n}(1 + \frac{3\delta}{2t}\frac{M}{M+N}) \tag{8}$$

and, unsurprisingly, given the model set-up

$$s_i = q_i = \frac{1}{n}.$$

Note that the resulting prices are lower than in the simple Salop model. If we ignore the music listeners and set $M = 0$, so that we only focus on the two interdependent demand functions q_i and s_i we can rewrite the two prices as

$$p = \frac{t}{n} - \frac{3\delta}{2n}, \tag{9}$$

and

$$w = \frac{d}{n} - \frac{3\theta}{2n}. \tag{10}$$

That means that both prices are corrected downwards when compared to the standard Salop model. This result contrasts with other models of two-sided markets or complementary products where usually the price for one good or service is lower while the prices for the other product or service increases when compared to a reference model without complementarities or indirect network effects. In our model of two interdependent Salop circles, this changes because, in contrast to other models, there is no market expansion, but only a business stealing effect. Hence, firms compete aggressively in order to obtain customers. The more consumers' utility of live concerts and, therefore, their demand for them is affected by record sales (as measured by δ) the lower is the price for records and vice versa. If the indirect network effects from one market to the other are very strong, one price may even turn negative, in principle.

Obviously, the downward correction of the record price is the lower the fewer customers are interested in concerts. If the fraction of music lovers in the population, as measured by $N/(M+N)$, becomes smaller, the downward bias of the record price, p, is also reduced. Similarly, the downward correction of the concert ticket price, w, is the more significant the more music listeners there are (i.e., the higher $M/(M+N)$). The intuition is as follows: The more music listeners (who are not interested in concerts) there are, the higher is the opportunity cost (in terms of foregone revenues) of lowering the record price (as it only stimulates demand for music concerts for a fraction of the population). Hence, with many music listeners firms rather keep record prices up and stimulate record sales to music lovers by "cross-subsidising" ticket prices.

Inserting equilibrium prices into the profit function, we obtain equilibrium profits of each record company:

$$\Pi^* = \frac{(N+M)}{n}\left[\frac{t}{n} - \frac{3\delta}{2n}\frac{N}{(M+N)}\right] + \frac{N}{n}\left[\frac{d}{n} - \frac{3\theta}{2n}\left(1 + \frac{3\delta}{2t}\frac{M}{M+N}\right)\right]. \tag{11}$$

The network effects have a negative impact on profitability. The higher δ and θ, the lower is the firms' profit. The reason is the aforementioned downward pressure on prices for records and concerts due to the interrelated demands for the two products. Concerning the degree of product differentiation, measured by d and t, the model delivers the standard predictions. The higher the transportation costs, the higher are firms' profits. The relationship between profits and the number of competitors in the market is also standard. It can be shown that, given our assumption, equation (11) decreases in n.

In a next step, we proceed by analysing the musical diversity provided by the market. As we assume that each firm represent a single artist, this corresponds to endogenising the number of firms. Suppose there is a fixed cost of f per firm, then the number of entrants is determined by solving $\Pi^* = f$ for n. More explicitly, the number of different artists in the market (musical diversity) is given by:

$$n = \sqrt{\frac{(N+M)}{f}\left[t - \frac{3\delta}{2}\frac{N}{(M+N)}\right] + \frac{N}{f}\left[d - \frac{3\theta}{2}(1 + \frac{3\delta}{2t}\frac{M}{M+N})\right]}. \quad (12)$$

Comparative statics concerning diversity correspond with the ones concerning profits. A larger degree of product differentiation increases diversity, and stronger complementarity effects reduce diversity.

3 File Sharing

Let us now analyse how file-sharing affects the equilibrium. For this purpose we assume that only a fraction α of the customer masses of N and M is actually paying for recorded music while the fraction $(1-\alpha)$ is engaging in piracy or file sharing. The representative firm's profit maximisation problem now becomes

$$\pi_i(p_i, w_i) = \alpha N p_i q_i(p_i, w_i) + \alpha M p_i x_i(p_i) + N w_i s_i(p_i, w_i).$$

Our restriction on parameter values to guarantee equilibrium existence modifies as follows:

Assumption 2 $16td(N+M)\alpha > 9N(\alpha\theta+\delta)^2 + 36\alpha M\theta\delta.$

Deriving the first-order conditions and solving for symmetric equilibria yields the following equilibrium values

$$p = \frac{t}{n} - \frac{3\delta}{2n}\frac{N}{\alpha(M+N)},$$

and

$$w = \frac{d}{n} - \frac{3\theta}{2n}(\alpha + \frac{3\delta}{2t}\frac{M}{M+N}).$$

File-sharing has opposite effects on the prices for records and concerts. It decreases the price for records, but increases the price for live concerts. Note that this effect of file-sharing relies on the presence of complementarities between the two markets.

To understand our results, suppose first that there are no complementarities, that is, $\delta = \theta = 0$. Then equilibrium prices would not be affected by file-sharing. File-sharing would only affect firms by reduced profitability in the market for records as only a proportion α of consumers would actually pay for records. The market for live concerts would not be affected at all. Next suppose that $\delta > 0$, but still $\theta = 0$. That is there is only a positive complementarity from record sales on the utility from concerts. Then increased file-sharing reduces the equilibrium price for records and leaves the price for concerts unchanged. The intuition goes as follows: As shown above, a positive δ induces firms to lower their price in the market for records to attract additional customers in the market for live music. An increase in file-sharing decreases the opportunity costs of lowering the price for records as only a fraction α pays for record. And hence, in equilibrium the price for records is reduced. Now suppose there is additionally a positive complementarity from concert visits onto record sales. Due to the complementarity prices for concerts are lower than in a standard Salop model. However, this downward correction depends on the degree of file-sharing. The more file-sharing the lower the incentives to reduce the price for concerts to attract sales in the record market as the benefit in the record market are reduced with more file-sharing.

Inserting equilibrium prices into profits gives

$$\Pi^* = \frac{\alpha(N+M)}{n}\left[\frac{t}{n} - \frac{3\delta}{2n}\frac{N}{\alpha(M+N)}\right] + \frac{N}{n}\left[\frac{d}{n} - \frac{3\theta}{2n}(\alpha + \frac{3\delta}{2t}\frac{M}{M+N})\right]. \tag{13}$$

Comparative statics concerning the degree of product differentiation and the size of the network effects yield the same results as without file-sharing. More interesting is the impact of file-sharing on profitability. Differentiating profits with respect to α yields

$$\frac{\partial \Pi}{\partial \alpha} = \frac{2t(N+M) - 3N\theta}{2n^2}. \tag{14}$$

This expression can be positive or negative. It is positive if $\frac{t}{\theta} > \frac{3}{2}\frac{N}{N+M}$ and negative if the converse holds. Hence, file sharing can have a positive impact on profits if the interdependency from concerts on record sales is sufficiently high. As seen above increased file-sharing has a positive effect on concert prices but a negative effect on record prices. Thus, the overall effect depends on the size of these two effects. If t is high, revenues from record sales make a large proportion of profits. Then, file-sharing, that is a lower value of α, has a detrimental effect on firm profits. However, if t is relatively low, income from record sales is relatively unimportant and file-sharing has a positive impact on profits.

The economic literature has shown several avenues by which file-sharing may increase profits: Peitz and Waelbroeck (2006) show that due to sampling effects record companies may gain from downloading. In Gayer and Shy (2006) different players in the music industry are affected differently by file-sharing. While record companies lose from file-sharing, artists may gain due to cross-effects onto the market for concerts and other merchandising. We add to these results by providing a further way. If network effects from concert attendance on record sales are significant, then file-sharing can be positive for record company profits because firms compete and price less aggressively in the concert ticket market, as stimulating record sales is less rewarding.

Endogenising diversity in the music market, we get:

$$n = \sqrt{\frac{\alpha(N+M)}{f}\left[t - \frac{3\delta}{2}\frac{N}{\alpha(M+N)}\right] + \frac{N}{f}\left[d - \frac{3\theta}{2}(\alpha + \frac{3\delta}{2t}\frac{M}{M+N})\right]}. \tag{15}$$

We are interested in the impact of file-sharing on musical diversity. More file-sharing (lower α) can increase or decrease diversity as measured by n. This follows immediately from the impact of file-sharing on profits as shown above. If file-sharing increases profits it increases the incentives to enter, and hence diversity rises.

4 Welfare

Finally, we are interested in the welfare properties of our equilibrium and, in particular, in the welfare effects of file-sharing.

There are three factors that impact on total welfare: i) transportation costs in the record and in the concert market, ii) fixed costs of establishing a firm, and iii) the indirect network effects between the record and the concert market:

$$\begin{aligned} W &= -2n(N+M)\int_0^{\frac{1}{2n}} tx\ dx - 2nN\int_0^{\frac{1}{2n}} dx\ dx - nf + Nn\frac{\theta+\delta}{n} \quad (16) \\ &= -2n(N+M)\int_0^{\frac{1}{2n}} tx\ dx - 2nN\int_0^{\frac{1}{2n}} dx\ dx - nf + N(\theta+\delta) \end{aligned}$$

Note, however, that the indirect network effects are independent of the number of artists in the market. Thus, as in the standard Salop model welfare is maximised when the marginal reduction in transportation costs equals the additional fixed cost of further firm entry. This welfare optimal number of firms is given by:

$$n^w = \sqrt{\frac{(N+M)t + Nd}{4f}}. \tag{17}$$

4.1 No File-Sharing

While in the standard model excess entry prevails, i.e., the number of entrants exceeds their welfare optimal number, this does not need to be the case in a model with network effects. As demonstrated above, prices are corrected downwards in comparison to the standard Salop model which translates in lower profits and, hence, a lower number of entrants.

A comparison between the efficient and the competitive number of firms yields that there is excessive entry if

$$3(N+M)t + 3Nd > 6N(\delta + \theta) + \frac{9\delta\theta NM}{t(N+M)}. \tag{18}$$

Otherwise, there is insufficient entry. Both outcomes are compatible with our assumption concerning parameter values. The condition above reveals that excess entry is more likely to prevail if transportation costs are high and network effects small.

4.2 File-Sharing

In a situation with file sharing there is excessive entry if

$$(N+M)(4\alpha - 1)t + 3Nd > 6N(\delta + \alpha\theta) + \frac{9\delta\theta NM}{t(N+M)}, \tag{19}$$

while there there is insufficient entry otherwise. Again both outcomes are compatible with our assumptions concerning parameter values. Unfortunately, the question whether file-sharing is welfare enhancing or not, cannot be unambiguously answered. The welfare results of file sharing are mixed, as virtually anything is possible. As shown above, an increase in file-sharing can either increase or decrease variety. Thus, in situations of excess entry, more file-sharing is beneficial for welfare if it reduces variety, but it is detrimental to welfare if it increases variety. Unfortunately, either is possible, depending on parameter values. In contrast, in situations of insufficient entry, increased copying is welfare enhancing if it increases variety while it is welfare reducing if it reduces variety. Again, either is possible. In summary, the impact of file-sharing on welfare is therefore ambiguous and the welfare effects depend on the exact situation (i.e., parameter values).

5 Summary and Conclusions

This paper has analysed the interdependency between the market for music recordings and concert tickets, assuming that there are positive indirect network effects both from the record market to ticket sales for live performances and vice versa. Using a model with two interrelated Salop circles we have shown that prices in both markets are corrected downwards when compared to the standard Salop model. Furthermore, we have shown that the effects of file sharing on firms' profitability and on variety are ambiguous. File sharing can increase profits through increased concert ticket demand and thereby also lead to additional market entry and additional variety.

Similarly, file-sharing may potentially increase welfare if it induces additional market entry in cases of an inefficiently small variety or if it reduces firms' profitability and, thereby, market entry if variety is inefficiently large.

Appendix

For our equilibrium to exist the second order conditions must hold. We consider the more general case with file-sharing. The case without file-sharing can be reproduced by setting $\alpha = 1$. The Hessian of our optimisation problem is

$$H = \begin{pmatrix} -\frac{8Nd\alpha}{4td-9\theta\delta} - \frac{2M\alpha}{t} & -\frac{6N(\alpha\theta+\delta)}{4td-9\theta\delta} \\ -\frac{6N(\alpha\theta+\delta)}{4td-9\theta\delta} & -\frac{8Nt}{4td-9\theta\delta} \end{pmatrix}. \tag{20}$$

For the second-order conditions to be fulfilled the Hessian needs to be negative semi-definite. That is the first leading principle minor needs to be negative and the determinant needs to be positive. This is ensured if two conditions are met:

$$4td > 9\theta\delta, \tag{21}$$

and

$$16td(N+M)\alpha > 9N(\alpha\theta+\delta)^2 + 36\alpha M\theta\delta. \tag{22}$$

It can then be shown that the second condition is more restrictive. Reformulating, the first condition can be expressed as $16td(N+M)\alpha > 36(N+M)\theta\delta\alpha$. Then, $9N(\alpha\theta+\delta)^2+36\alpha M\theta\delta > 36(N+M)\theta\delta\alpha$, and hence the second condition is more restrictive. Thus, to satisfy the second-order conditions it is sufficient to assume:

$$16td(N+M)\alpha > 9N(\alpha\theta+\delta)^2 + 36\alpha M\theta\delta. \tag{23}$$

.

In case there is no file-sharing the condition simplifies to:

$$16td(N+M) > 9N(\theta+\delta)^2 + 36M\theta\delta. \tag{24}$$

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