Magnatune: Variable Pricing for Music[1]

Tobias Regner and Javier A. Barria

Intelligent Systems & Networks group
Department of Electrical and Electronic Engineering
Imperial College of Science, Technology and Medicine
Exhibition Road, SW7 2BT, London

{t.regner,j.barria}@ic.ac.uk

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Abstract:

The paper analyses the behaviour of customers of the online music label Magnatune. They are allowed to pay what they want for music albums, as long as the payment is within a given price range ($5-$18).
We develop a model that is based on reciprocal theories of social preferences pioneered by Rabin (1993) and extended by Dufwenberg and Kirchsteiger (2004). We study the relationship between artists/labels and customers and use a moral hazard model for our analysis. It takes social preferences into account and it also considers the importance of free sampling of experience goods. The predictions of our model are empirically tested with the field data we obtained.
Comprehensive pre-purchase access at Magnatune supports music discovery and sets it apart from conventional online music stores. We conclude that this open contracts design encourages people to make a voluntary payment. The results of our empirical analysis validate this, as the average payment is $8.20, far more than the minimum of $5 and even higher than the recommended price of $8.

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1. Introduction

This paper covers and combines two areas of high recent interest. Social preferences have been increasingly studied in theoretical and empirical research.[2] Our paper provides an empirical test of voluntary contributions using data from an online music store. The music business is of particular interest as this industry struggles to adjust its conventional business model to the challenges of online P2P file sharing networks. Conventional online music stores attempt to implement Digital Rights Management (DRM) systems in order to stop illicit copying. However, effective copy protection appears to be impossible to achieve as P2P file sharing still thrives. Moreover, the common DRM systems restrict customers in their consumption in various ways.[3]

The niche label Magnatune (www.magnatune.com) goes another way. It lets customers choose from a given price range. They can pay what they want for music. Moreover, Magnatune offers a free and comprehensive music discovery tool. An online radio service lets customers try out songs they are interested in.
We collected a data set of all the label's transactions over 18 months and our paper analyses the payments that customers made. We conclude that – against the first intuition – this concept pays off. The average payment per album is not only significantly higher than the minimum price requested ($5), but it is also higher than the recommended price ($8) suggested on the web site.

We study the relationship between artists/labels and customers and use a moral hazard model for our analysis. It takes social preferences into account and it also considers the importance of free sampling of experience goods (e.g. music).
Information goods are experience goods. Consumers do not know what they are worth to them until they experience them (Shapiro and Varian (1999)). Their exact value to the consumer is quite unknown ex ante. The valuation rather develops until the good has been experienced often enough and the true worth has been established.
Magnatune offers a free and comprehensive music discovery tool. An online radio service lets customers try out songs conveniently. This pre-purchase access to the album allows customers to make an informed buying decision. When customers have full pre-purchase access to songs they are interested

[2] See Camerer (2003) for a survey of the literature in behavioural economics.
[3] The usage of P2P networks has not decreased despite numerous legal and technological activities of the music industry. Commonly, DRM restricts music discovery with no or very limited sample possibilities and restricts music listening with a limited number of permitted CD burns and transfers to mobile devices. Moreover, file formats may be incompatible with player software.

in, they can experience the information good long enough to determine how much it is worth to them and decide whether they really want to buy it.
This full pre-purchase access can also be regarded by customers as kind behaviour of labels (as it allows them to make an informed choice). Customers are willing to reciprocate by making a high voluntary payment, if they have social preferences. Selfish customers would free ride and would only pay the minimum.

Our theoretical model describes the moral hazard relationship between artists/labels and customers. We model social preferences by incorporating reciprocity into the utility function, something first done by Rabin (1993). In particular we follow the concept of sequential reciprocity of Dufwenberg and Kirchsteiger (2004). The moral hazard aspect of our model is inspired by the literature that started with Fehr, Gächter and Kirchsteiger (1997). Labour relations are studied where the worker's effort is not contractible. They describe the benefits of contracts that give a mutual opportunity to reciprocate. We transform their model from the labour market to the context of information goods. Due to file sharing payment for information goods becomes non-contractible. Payment moral hazard arises as modelled in Regner (2004).

The following section describes the music label Magnatune in detail. Section 3 contains our theoretical model. Section 4 describes our data set, while section 5 analyses it. The conclusions are in section 6.

2. The music label Magnatune

The label was founded in October 2003 and it has around 200 artists on contract. Magnatune prides itself of having a very strict selection process to guarantee high quality. The revenue is evenly split between artist and Magnatune. File quality and format is up to the customer. Even CD-quality files can be downloaded and the formats on offer give a good choice: WAV, MP3, OGG, FLAC and AAC. The payment is variable as customers can set the price themselves. The given price range for an artist's album is $5 to $18 and Magnatune recommends $8. The actual price is selected by the customer in a pop-up menu where $8 is the default setting.
Payment is processed by credit card or PayPal. It is not compulsory to leave an e-mail, customers can remain anonymous at Magnatune. Albums can be downloaded online or bought as a CD. A small fee ($4.97) for the physical costs of material and shipping is due for CD purchases. Magnatune is based in the USA, but as an online store it has customers around the world.
Magnatune's artists are categorised in various different genres. There is a wide range of music available from classical music to Electronica, Jazz and Blues, Metal&Punk, New Age, Rock and Pop, World and several more. Magnatune can be seen as a niche label that offers music of relatively unknown artists. Mainstream music of famous artists is not sold. Therefore,

the focus of Magnatune – and the paper's – is music of less-known artists and subsequently uncertain quality.
These experience goods aspects are well taken into account at Magnatune as music discovery is greatly facilitated. Full streaming access to all songs is provided in low or high quality. An online radio service can be used to listen to genre selections or artists' albums. Visitors of the site are allowed to test the available music as often as they want and sample possibilities are unlimited. Essentially, customers have all possible means available to find out how much a song/album is worth to them, before having to make a decision on the payment. This stands in stark contrast to the usual practice of conventional online music stores where merely 30 seconds snippets of songs are available for sampling if at all.

3. Model

We analyse the relationship between the label and artists on one side and customers on the other. Artists create music, which is purchased online by customers via the label's web site. The interests and characteristics of artists and their labels are usually quite different in the music industry and they should rather not be treated as one entity. However, we believe that Magnatune is an exception to that.[4] It shares revenues equally with the artists and it really only intermediates. A direct connection between the payment of the customer and the income of the artist can be seen. We therefore do not distinguish between artists and the label and refer to them as M in the model.

The model focuses on two important aspects of information goods markets. Potential consumers of information goods (like online music) are increasingly difficult to exclude from consumption due to the wide availability of files in P2P networks. Information goods are also experience goods and their actual value might be unclear to customers ex ante.

Payment moral hazard describes the uncertainty of principals with respect to the payment of agents in information goods markets. The relationship between principal (label or artist) and agent (customers) is about the agent making a payment in exchange for the utility of consuming the music. While this contractual relationship is very trivial to enforce for physical goods (CDs) of the traditional music industry, it is far from that for "weightless" music (downloads). P2P networks make (music) files non-excludable, e.g. they could be consumed without paying for them. The principal – artists and labels – does not know whether consumed goods have been paid for by agents or at least they cannot enforce payment. This information asymmetry causes non-contractibility of the payment. The different contract cases principals can choose from are described in detail in Regner (2004).

[4] In fact, Magnatune's slogan is: "We're a record label. But we're not evil." (www.magnatune.com)

Magnatune customers are able to experience the products before purchase, which is very important in the context of information goods. Pre-purchase access is not limited to 30 seconds snippets of songs, but full streaming access to all files is possible. Additionally, customers can use an online radio service to try out Magnatune songs. This comprehensive pre-purchase access to the album allows customers to make an informed buying decision. While there is always uncertainty regarding the ex post utility of an information good in a conventional sale[5], Magnatune customers are much better aware of the ex post utility of music they buy.
Without much chance to experience the information good, customers risk ending up with a disappointing purchase. This uncertainty reduces the willingness to pay of customers who consider a purchase based on the sample or description of the music.
On the other hand, when customers have full pre-purchase access to songs they are interested in, they can experience the information good long enough to determine how much it is worth to them and decide whether they really want to buy it. They can much better avoid disappointment.

We model the relationship between label/artists and customers in a Principal-Agent framework with moral hazard. The label/artists offer music online on the web site and customers purchase albums. The payment of customers is not enforceable[6] and is therefore subject to moral hazard. Moreover, the value of consumption depends on the amount of pre-purchase access to music.
In the standard approach of contract theory the principal implements efficient, second-best contracts based on incentive compatibility and participation constraints.[7] The set up of Magnatune allows for an alternative contract design. Endogenous incomplete contracts are deliberately left open. The agents have the opportunity to respond to the action of the other. Thus, both sides are encouraged to reciprocate. Fairness and reciprocity can also be regarded as the enforcement device of this contract. The fact that in our model the customer is free to choose the payment from a given range adds this feature to the contract design.
Therefore, our model consists of two stages. First, the label/artist decides whether it allows free comprehensive pre-purchase access to the music or not. Then, the customers make their purchase and payment decision. Their value from consumption is v. The label/artists receive the payment p.

Endogenous incomplete contracts have been frequently analysed in labour market situations. Fehr, Gächter and Kirchsteiger (1997) are the first to

[5] It can be reduced by short samples or recommendations, for instance, but never completely avoided.
[6] Substitutes are available for free in P2P file-sharing networks.
[7] In the information goods context of the music industry this would be a high fixed price enforced by strong copy protection and law or a low fixed price that matches the transaction costs of file sharers (time, moral issues for instance).

point out the benefits of mutual opportunities to reciprocate in moral hazard environments. They analyse a simple labour market with firms, workers and excess supply of workers.[8] Our approach to model the moral hazard aspect is similar, albeit adjusted to the described payment moral hazard in information goods markets. Moreover, we integrate the impact of the free sampling on the search of information goods. The following table summarises the way open contracts work in the described situations.

TABLE 1: THE POSITIVE ASPECTS OF OPEN CONTRACTS		
labour market	information goods market	
Effort moral hazard	payment moral hazard	Uncertainty about quality
• Effort not enforceable	• Payment not enforceable	• Value of music songs unknown to individual
• Quality is sub-optimal Low effort / shirking	• Revenue is sub-optimal Illicit copying	• Value of consumption is sub-optimal
• Open contracts encourage reciprocity and increase effort	• Open contracts encourage reciprocity and increase revenue	• Open contracts encourage reciprocity and increase value
• Moral hazard solved	• Moral hazard solved	• Better selection of songs

In order to explain social preferences we do not give up the assumption that individuals maximise their utility. We merely allow their utility to reflect social concerns as well. It matters to them as well how much other individuals receive. A few theoretical approaches exist and they are surveyed in Fehr and Schmidt (2003) and Camerer (2003): altruism, inequality aversion and intentions-based approaches. We focus on concerns for reciprocity to model the behaviour of individuals with social preferences. However, this is just one possible theoretical approach and it appears fair to assume that they all play their part to explain social preferences. A more general model would have to combine aspects of the different theories. This has also been done, but for the scope of our model we concentrate on the intentions-based approach. We integrate reciprocity based on the seminal work of Rabin (1993) for normal form games and Dufwenberg and Kirchsteiger (2004) for extended form games.
The utility function of socially minded individuals increases not only in their material payoffs but also in the psychological payoffs which depend on the individuals' kindness to others and beliefs about that. The resulting games are solved using the psychological games framework of Geanakoplos, Pearce

[8] Three different contracts are simulated in experiments. While contract terms were exogenously enforced in the first treatment, workers were able to reciprocate in the second and both firms and workers were able to reciprocate in the third treatment. Effort levels of workers were significantly higher in the last treatment and a contract that gives the opportunity for mutual reciprocity was found to improve efficiency.

and Stacchetti (1989). While the action set a_i describes the choices of player i (e.g. the access provided by M or the chosen payment of the customer), b_{ij} defines the belief of i about the choices of player j, whereas $\tilde{b}_{iji}$ is i's belief about what j believes are i's choices. This framework of beliefs allows us to express the kindness and beliefs about the kindness of individuals towards another individual. This is achieved by comparing an actual payoff Π to the equitable or fair payoff of a player, Π^e.
The equitable payoff of an individual is the average of his best and worst outcome based on the choices of the other individual.[9] For agent j it is given by:

$$\Pi_j^e(b_{ij}) = \frac{1}{2}(\max\{\Pi_j(a_i, b_{ij})\} + \min\{\Pi_j(a_i, b_{ij})\}) \tag{1}$$

It can be seen as a reference point for how kind i is to j as this kindness κ_{ij} is expressed by relating the actual payoff j is given by i to the equitable payoff of j:

$$\kappa_{ij}(a_i, b_{ij}) = \Pi_j(a_i, b_{ij}) - \Pi_j^e(b_{ij}) \tag{2}$$

Similarly i's belief about the kindness of j to i is:

$$\kappa_{iji}(b_{ij}, \tilde{b}_{iji}) = \Pi_i(b_{ij}, \tilde{b}_{iji}) - \Pi_i^e(\tilde{b}_{iji}) \tag{3}$$

Incorporating kindness and the beliefs about it gives us the following utility function with a material payoff as the first term and the reciprocity payoff in the second term that is weighted by the reciprocity sensitivity α ($\alpha = 0$ is the special case of pure self-interest).

$$U_i = \Pi_i(a_i, b_{ij}) + \alpha_i \cdot \kappa_{ij}(a_i, b_{ij}) \cdot \kappa_{iji}(b_{ij}, \tilde{b}_{iji}) \tag{4}$$

The condition to solve the game is that in equilibrium all beliefs and second order beliefs are correct. It is also important to mention that beliefs of players are updated over the course of the game. Once an action of a player has taken place, beliefs involving randomisation about this action are replaced by pure choice beliefs. The individuals apply Bayesian updating. We will simplify notation in this case by skipping the index, e.g. b_{ij} becomes b, if j has already made his choice.

We distinguish between two levels of pre-purchase access to music. No or very limited possibilities to sample songs as it is commonplace in conventional online music stores restricts the sampling of customers.

[9] We use the average in our analysis because it is straightforward. Using another intermediate value is also possible and it does not affect the qualitative results. See also Dufwenberg and Kirchsteiger (2004) footnote 7.

Comprehensive pre-purchase access (as provided by Magnatune) allows sufficient sampling and customers are well-informed about music before they make a purchase. We assume that streaming access to songs is not a substitute for buying them as customers want to own their music. Moreover, we assume that songs are real experience goods: Artists are not famous enough and they have not acquired enough reputation so that customers know their music already, which would make the sampling obsolete.
The value of an album's consumption depends therefore on the extent of pre-purchase access. When customers have full access and can sample songs on offer easily, they are able to pick the albums they really enjoy. They know their value from consumption is the full ex post value of music v. Limited access leaves them with uncertainty about the ex post value. They might not find the albums they will actually enjoy most or they possibly choose music that turns out to be disappointing. Knowing this, their purchase decision is based on the expected value εv which is less than the full ex post value v. We assume N is the number of albums C has initial interest in. The ex post value v of the albums 1 to N is equally distributed from 0 to $v_{\max}$ (e.g. \$15) with μ (e.g. \$8) as the mean and expected value. Then we define $v = \arg\max(v_1, v_2, v_3, ..., v_N) = v_{\max}$ as the value for C under full access and $\varepsilon v = \arg\max(\varepsilon v_1, \varepsilon v_2, \varepsilon v_3, ..., \varepsilon v_N) = \mu$ as the value under limited access. This guarantees that full pre-purchase access increases the value of the customer's purchase.

The payment for an album depends on the chosen access and whether the customer decides to be kind or nasty. Given full pre-purchase access the nasty choice of the customer would be to just pay the minimum price $p_{\min}$ required for the purchase, while the kind choice is a voluntary payment of p_{vol} which is necessarily below the actual value v of the album. When pre-purchase access is limited the kind choice of customers would be to simply pay the default price of the store, which is $\bar{p}$. The nasty choice of customers is to try obtaining the file on P2P networks for free. We assume that some customers (γ of the whole population) will succeed in this and they do not pay for consumption. Only the remaining fraction $1-\gamma$ pay the store and the price that applies to customers making the nasty choice is the price under DRM taking leakage to the P2P networks into account: $p_{DRM} = (1-\gamma)\cdot\bar{p}$.
The fraction of file sharers γ is defined to be $0 < \gamma < 1$. Their access to P2P networks gives them less efficient sampling possibilities than at M and their valuation is also the expected value εv.

Assumption 1: The label/artist can either provide limited pre-purchase access or comprehensive free pre-purchase access. This affects the customer's value of consumption. Full access allows her to select albums properly and she makes no bad picks. Her value from consumption is v.

Limited pre-purchase access causes uncertainty about the ex post quality of albums and her valuation decreases to the expected value: $\varepsilon v < v$

Assumption 2: The payment of customers is either $p_{\min}$ for the required minimum, p_{DRM} when the store uses DRM but piracy occurs, $\bar{p}$ for the default store price and p_{vol} for the high voluntary payment: $p_{\min} < p_{DRM} < \bar{p} < p_{vol}$

These are the 'material' payoffs of the sequential game for the user and the researcher. Its structure is similar to the sequential prisoner's dilemma game:

limited access, kind behaviour:

$$\Pi_C^{lk} = \varepsilon v - \bar{p},\ \Pi_M^{lk} = \bar{p} \tag{5}$$

limited access, nasty behaviour:

$$\Pi_C^{ln} = \gamma \cdot \varepsilon v,\ \Pi_M^{ln} = (1-\gamma) \cdot \bar{p} \tag{6}$$

full access, kind behaviour:

$$\Pi_C^{fk} = v - p_{vol},\ \Pi_M^{fk} = p_{vol} \tag{7}$$

full access, nasty behaviour:

$$\Pi_C^{fn} = v - p_{\min},\ \Pi_M^{fn} = p_{\min} \tag{8}$$

The following assumptions are necessary to keep the payoffs of our game in line with the sequential prisoner's dilemma.

Assumption 3: When no streaming access is allowed and the customer behaves kind, her payoff equals zero: $\varepsilon v - \bar{p} = 0$

Assumption 4: With full pre-purchase access the payoff of the kind customer exceeds her payoff under limited access: $v - p_{vol} > \gamma \cdot \varepsilon v$

Assumption 5: Offering free access is profitable for the label/artist when a voluntary payment is made (compared to limited access): $p_{vol} > (1-\gamma) \cdot \bar{p}$

The following numerical example illustrates the payoffs of the game. It builds on the actual prices of Magnatune. The minimum price to be paid under full access is \$5, the fixed price in online stores is \$8 and the kind voluntary payment under full access is \$12. The utility of listening is \$15, when the customer is uncertain about the value due to the limited pre-purchase access the utility is only \$8. The 'leakage' in a DRM environment is

assumed to be $2. This represents the part of customers that turns to P2P file sharing. Store revenues ($8) are reduced by this.

TABLE 2: PAYOFF MATRIX		M	
		Full access	Limited access
C	Kind	3 , 12	0 , 8
	Nasty	10 , 5	2 , 6

Our stage game differs from the usual Prisoner's Dilemma game in two non-significant ways.
The benefits of pre-purchase access and its lack of costs mean that M's payoff when C plays kind can be larger when he plays "free access" than "limited access". This is not the case in the prisoner's dilemma game. However, since "nasty" is C's dominating strategy in the game, this does not affect the outcome.
It depends on the degree of piracy whether M's payoff when C plays nasty is greater under option "limited access" or "free access". If piracy is assumed to be ubiquitous and unstoppable (e.g. $\gamma = 1$), then the revenue under DRM is zero and he prefers "free access". The paper focuses on the case where revenues under DRM are higher and he prefers "limited access". Although less likely, piracy could also occur when full pre-purchase access is provided. This would make it very probable that M's "limited access" is greater than his "full access" payoff.

3.1. Benchmark model with self-interested individuals

We first analyse a benchmark model under the self-interest hypothesis. When the label/artists provide comprehensive pre-purchase access, M expects kind voluntary payments with probability μ_0. However, since M knows that customers are selfish, μ_0 equals 0 and M will therefore only allow limited access:

$$\Pi_M^l = \gamma \cdot \bar{p} > \mu_0 \cdot p_{vol} + (1 - \mu_0) \cdot p_{\min} = \Pi_M^f, \text{ if } \mu_0 = 0 \tag{9}$$

Selfish customers will tend to turn to file sharing networks as they can obtain songs for free. The resulting utility for a customer with self-interest preferences is her 'monetary' payoff:

$$\Pi_C^n = \gamma \cdot \varepsilon v \tag{10}$$

3.2. Mixed population with self-interested and socially minded individuals

We now include individuals with social preferences in the user population. As explained earlier we focus on concerns for reciprocity to model the behaviour of socially minded individuals. Their utility function increases not

only in their material payoffs but also in the psychological payoffs which depend on their kindness and their beliefs about the kindness of the other individual towards themselves.
The equitable payoff of an individual is the average of his best and worst outcome based on the choices of the other individual. In the case of the customer C it is given by:[10]

$$\Pi_u^e(a_r, b_{ru}) = \frac{1}{2}(\max\{\Pi_u(a_r, b_{ru})\} + \min\{\Pi_u(a_r, b_{ru})\}) \tag{11}$$

Appendix A contains the detailed analysis of C's equitable payoffs, kindness functions of agents and beliefs about kindness.
The utility of C when she behaves kind (voluntary payment) and when she behaves nasty (minimum payment) are:

$$U_C^{fk} = (v - p_{vol}) + \alpha_C \cdot \tfrac{1}{2} \cdot (p_{vol} - p_{\min}) \cdot \tfrac{1}{2} \cdot (\tilde{\theta} \cdot (v - p_{vol}) + (1 - \tilde{\theta}) \cdot (v - p_{\min}) - (1 - \tilde{\theta}) \cdot (1 - \gamma) \cdot \varepsilon v) \tag{12}$$

$$U_C^{fn} = (v - p_{\min}) + \alpha_C \cdot \tfrac{1}{2} \cdot (p_{\min} - p_{vol}) \cdot \tfrac{1}{2} \cdot (\tilde{\theta} \cdot (v - p_{vol}) + (1 - \tilde{\theta}) \cdot (v - p_{\min}) - (1 - \tilde{\theta}) \cdot (1 - \gamma) \cdot \varepsilon v) \tag{13}$$

The condition for the existence of a fair, positive reciprocity equilibrium is:

$$U_C^k(a_C, b_{CM}, \tilde{b}_{CMC}) > U_C^n(a_C, b_{CM}, \tilde{b}_{CMC}) \tag{14}$$

This is fulfilled if:

$$\alpha_C \cdot \tfrac{1}{2} \cdot (\tilde{\theta} \cdot (v - p_{vol}) + (1 - \tilde{\theta}) \cdot (v - p_{\min}) - (1 - \tilde{\theta}) \cdot \gamma \cdot \varepsilon v) > 1 \tag{15}$$

Since in equilibrium beliefs must be correct, it follows that the condition must hold for $\theta = 1$, if in equilibrium M allows full access. $\theta = 1$ means the belief is a voluntary payment will be made, which has to be fulfilled in equilibrium.

$$\alpha_C > \frac{2}{v - p_v} = \bar{\alpha}_C \tag{16}$$

Conversely the condition must not hold for $\theta = 0$ so that in equilibrium C decides to make the minimum payment only. $\theta = 0$ implies that M does not believe a voluntary payment will be given. The customer will have to prefer making the minimum payment ($U_C^n > U_C^k$) so that in equilibrium beliefs are correct.

[10] The equitable payoff of C depends on the actual access choice of M (a_r) and whether M believes C is nasty or kind (b_{ru}).

$$\alpha_C < \frac{2}{v - p_{\min} - \gamma \cdot \varepsilon v} = \underline{\alpha}_C \tag{17}$$

A positive reciprocity equilibrium exists. The customer will make a voluntary payment, if her sensitivity to reciprocity is large enough: $\alpha_C > \overline{\alpha}_C$. The possibility of $\alpha_C > \underline{\alpha}_C$ corresponds to the nasty equilibrium.
A voluntary payment follows full pre-purchase access, if the difference between value and payment is greater than $\frac{2}{\alpha}$. In other words, if the fairness weight α is very small it seems very implausible that a voluntary payment will be given and even if an individual has reciprocity concerns the generated value of an answer has to exceed the price paid by more than just the tip. On the other hand, the minimum payment will be made in equilibrium, if the value minus the minimum price and minus the leaked value under DRM is less than $\frac{2}{\alpha}$.

For intermediate values $\frac{2}{v - p_v} < \alpha_C < \frac{2}{v - p_{\min} - \gamma \cdot \varepsilon v}$ the customer will randomise with probability $\hat{\theta} = \frac{\frac{2}{\alpha_C} - (v - p_{\min}) + \gamma \cdot \varepsilon v}{p_{\min} + \gamma \cdot \varepsilon v - p_v}$. The utility of making a voluntary payment (U_C^k) is equal to the utility of paying the minimum (U_C^n), when C chooses to make a voluntary payment with probability $\hat{\theta}$ for intermediate values of α_u.

Since we have established conditions for C to make a voluntary payment once M has allowed full access, we now have to analyse whether M will ever provide full access in the first place. He knows that the customer will always pay the minimum when $\alpha_C < \frac{2}{v - p_{\min} - \gamma \cdot \varepsilon v} = \underline{\alpha}_C$ and therefore he will never allow full access in that case.
He also knows that C will act reciprocally once her sensitivity to reciprocity α_C is large enough. That means he assumes C will reward the choice of full access with a voluntary payment and will possibly reply to limited access with piracy. The equitable payoff of the customer is therefore the average of the full access plus voluntary payment (Π_C^{fk}) and the limited access plus minimum payment (Π_C^{ln}) payoffs:

$$\Pi_C^e = \tfrac{1}{2} \cdot (v - p_v + \gamma \cdot \varepsilon v) \tag{18}$$

The analysis of the utility of M is similar to the one of C and its details are given in Appendix B.

The condition for M to make the full access decision is:

$$U_r^{e^h}(a_r, b_{ru}, \tilde{b}_{rur}) > U_r^{e^l}(a_r, b_{ru}, \tilde{b}_{rur}) \tag{19}$$

This is fulfilled if:

$$\alpha_M \cdot (v - p_v - \gamma \cdot \varepsilon v) \cdot \tilde{\kappa}_{MCM} > \gamma \cdot \varepsilon v - p_v \tag{20}$$

Since in equilibrium beliefs must be correct, it follows that the condition must hold for $\eta = 1$, if in equilibrium M provides full access. This is always true since all terms on the left hand side are non-negative and the right hand side is negative. The sensitivity to reciprocity α is non-negative by definition, the second term is positive based on assumption 4 and $\tilde{\kappa}_{MCM}$ – the perceived kindness of C – equals $\frac{1}{2} \cdot (p_v - p_{\min}) > 0$ for $\eta = 1$. Finally, it follows from assumption 5 that the right hand side is negative. The intuitive equilibrium of high effort (and beliefs about that) followed by a tip results.
Conversely the condition must not hold for $\eta = 0$ so that in equilibrium M decides to offer limited access:

$$\alpha_M \cdot (v - p_v - \gamma \cdot \varepsilon v) \cdot \tilde{\kappa}_{MCM} < \gamma \cdot \varepsilon v - p_v \tag{21}$$

This condition outlines the possibility of a "self-fulfilling expectations" equilibrium that is reached when M's sensitivity to reciprocity is large enough.
This can only happen when M's reciprocity motivation is really high as it needs to offset the material gain plus the gain from C's reciprocal behaviour when M provides full access.

Our analysis of M's decision has now covered the case when the customer's sensitivity to reciprocity is not high enough ($\alpha_C < \underline{\alpha}_C$ means the customer will never make a voluntary payment and therefore M will always offer limited access) and the case when she is sufficiently motivated by reciprocity ($\alpha_C > \overline{\alpha}_C$ means the customer will reciprocate and M will therefore give full access unless his sensitivity to reciprocate is too high). The case of intermediate values of $\underline{\alpha}_C < \alpha_C < \overline{\alpha}_C$ requires further analysis. However, there are no qualitatively new results to obtain. If the customer's randomising probability of being kind θ is high enough, M will provide full access when he is sufficiently motivated by reciprocity. "Self-fulfilling expectations" equilibria are possible once again when the customer's sensitivity to reciprocate is too high.

3.3. Summary

The model explained when customers make a voluntary payment. Social preferences are necessary which we incorporated into the utility function with a reciprocity payoff. Once reciprocity gains outweigh the material loss of

making the higher payment (p_v instead of $p_{\min}$), customers will prefer to make a voluntary payment. However, C and M have to be sufficiently motivated by reciprocity for this to happen.

Reputation concerns are another possible theoretical explanation for generous payments. It has been shown that reputation plays a significant role in online environments like ebay, for example[11], and we explore if concerns for reputation are a possibility for voluntary payments in the music store context of our model.
Once customers decide to purchase an album of an artist, they know that they do not enter a specific relationship with the artist. The artist might appreciate the voluntary payment of a customer and she might even be identifiable by the email address, but still the next album will be produced for the general audience and not for a specific customer.
This is important because it excludes reputation concerns as the motivation for high voluntary payments of rational customers. This would be the case, if a customer gives an amount that is more than required to the artist in order to encourage her to put high effort into the next album as the customer signalled she appreciates it.
Moreover, customers might be rather uncertain about their future relationship with an artist even though they might enjoy the first album. Tastes could change and the frequency of transactions is rather low (maybe one album a year). Reputation effects (of customers) do not seem to matter in this environment.

As concerns for reputation do not play a role we conclude that the premium exceeding the minimum price of $5 should be motivated by social preferences.

The following hypothesis will be empirically tested with our data.

Hypothesis 1: *The population of customers is indeed mixed and contains individuals with self-interest and as well with social preferences. Therefore, the average payment is significantly greater than the minimum price.*

4. Description of the Data Set

Our data set goes back to the actual start of Magnatune's service in September 2003 and contains all 14,367 album purchases from then until January 2005. A part from the payment we also collected the purchase date, an encrypted identifier of the customer, his/her gender and country of residence, the artist, the music genre, the means of payment, the type (download or CD) and whether an e-mail address was left or not. In addition to these variables we computed the time difference between purchases, the

[11] See Bajari and Hortacsu (2004) for a survey of the literature on ebay's reputation mechanism.

total amount of purchases and the number of a respective purchase of a customer. Moreover, we created a dummy variable for female customers, if no email was left, if a CD was purchased, if PayPal was used and also various country and genre dummies.[12]
The number of purchases has been fairly stable over time and there is only minor fluctuation since October 2003.

TABLE 3: DESCRIPTIVE STATISTICS							
Variable	obs	mean	median	mode	st.dev.	min	max
Payment [$]	14,367	8.197	8	8	2.301	5	24
Total purchases	7,620	1.86	1	1	2.657	1	49
time difference [days]	14.367	14.57	0	0	45.43	0	429
"female" dummy	10,718	0.087	0	0	0.282	0	1
"no e-mail" dummy	14,367	0.044	0	0	0.206	0	1
"CD" dummy	14,367	0.039	0	0	0.195	0	1
"PayPal" dummy	14,367	0.297	0	0	0.457	0	1

The average payment for an album is $8.197, the median and mode of the distribution are both $8. The minimum payment made is the lower limit of the price range: $5. Customers were allowed to pay in Euros and in British pounds, too. The same price range (5-18) was applied to these currencies, while our data set contains the (converted) dollar amounts. This is the reason why the maximum payment in the data set exceeds the actual upper limit of the price range. The different exchange rates have been taken into account in December 2004 as the price ranges for payments in Euros and pounds have been modified (they are now 4€ to 14€ with 6€ recommended and £3 to £10 with £4 recommended).

The data has been generated by 7,620 different customers; most of them (4,986) purchased only one album. On average customers bought 1.86 albums. The most albums a customer purchased are 49. The time difference shows the time (expressed in days) between purchases. The first purchase of a customer has a "time difference" of zero. The following rows describe the dummy variables "female", "no email", "CD" and "PayPal". 8.7% of the customers with gender data have been female.[13] Only 4.4% of customers have chosen not to leave their e-mail. The purchase of proper CDs has been introduced in October 2004 which explains the low percentage of CDs bought (3.9%). They have been quite popular though despite the additional cost for shipping and packaging. PayPal has been used for 29.7% of

[12] Information about customers' gender and their country of residence could not be collected for the entire data set.
[13] The association of a gender to the purchase was based on the name of the customer. This procedure performed unambiguous results for approximately 75% of the observations. The remaining purchases could not be identified in terms of gender.

purchases, while almost all of the other purchases have been handled via credit card.

Table 4 shows a selection of countries where Magnatune albums have been bought. It includes the countries with the most observations (USA, Canada, UK etc.), but also some smaller countries where sufficient data was available. The majority of purchases come from the USA. The collection of country data has been performed in the period of 09-12/2004.

TABLE 4: PAYMENT OVER COUNTRIES							
Country	obs.	mean	median	mode	st.dev.	min	max
Canada	371	8.08	8	8	1.82	5	18
Switzerland	81	9.28	8	8	2.98	5	18
Germany	190	8.21	8	8	2.38	5	22.03
Spain	55	7.67	8	8	1.49	5	12.24
France	163	8.52	8	8	2.09	5	18
Israel	8	6.75	5	5	1.98	5	10
Italy	65	8.67	8	5	3.85	5	22.03
Japan	110	7.74	8	8	2.23	5	16
Mexico	30	5.90	5	5	1.42	5	10
Singapore	13	7.46	8	8	1.51	5	10
UK	366	8.65	8	8	2.36	5	18
USA	3,838	8.18	8	8	2.14	5	18

A number of different genres are offered at Magnatune. The music is grouped into the genres Classical, Electronica, Jazz and Blues, Metal&Punk, New Age, Rock and Pop, World and Others. Classical music is the most popular genre with over 4,000 purchases. World, Electronica, Rock and Pop and New Age follow with around 2,000 purchases each.

5. Analysis of the Data Set

We are going to highlight some aspects of the data before running an actual regression.
Customers who leave an email tend to spend more on a purchase. The average payment is $8.23 when customers left their email, while it is $7.82 when customers preferred to remain anonymous.
The two payment options credit card ($8.21) and PayPal ($8.16) average very similar payments.
CD buyers pay a small fee ($4.97) for the physical costs of material and shipping. Still, the sale of CDs ($8.93) generates a higher payment than the sale of downloadable files ($8.17).
The gender averages are $8.24 for female and $8.28 for male customers. This seems to contradict as the overall average payment is $8.20. However, bear in mind that purchases with identifiable gender do not include the

entire data set. For instance, “no e-mail” purchases average a lower payment and they are part of the sub-group with unidentifiable gender. This explains the effect in part.
Approximately 63% of sales come from the US. Average payments vary quite a lot in other countries (e.g. $9.28 in Switzerland and $8.65 in UK, but $7.67 in Spain, $6.75 in Israel and $5.9 in Mexico). This variation in the voluntary payment with respect to the country of residence can be explained with different underlying wealth/GDP per capita. It might be promising to further analyse the country differences and their cause, which will be done in future versions of the paper. For the moment, the wealth effect seems to be a good explanation for different tendencies to make a voluntary payment and the variations should not be regarded as evidence for different social preferences over the countries.
The first payment of customers averages $8.26, while the second averages $8.19. Customers pay on average $8.09 for their 3rd to 6th purchase and beyond the 7th purchase the average payment is $8.07. The number of albums already purchased appears to have an impact on the amount a customer is willing to pay.
The average payment decreases with the total of purchases a customer has made. The average payment of one-time purchases is $8.29. That means returning customers’ first purchase averages $8.20.

The payment is the dependent variable in our regression and the equation we estimate is

$$p = k + b \cdot X + \varepsilon$$

where k is the constant, b is the vector of the coefficients, X is the vector of our variables and ε is the error term. The explanatory variables are the number of purchase, the total purchases of the respective customer, the time difference and the dummies for female, no email, PayPal, CD customers, for the countries and genres. Table 5 lists the variables and their coefficients with respective t-values for our estimations.
The given price range restricts the payment of customers. Therefore, the distribution of the payment is left-censored at $5 and right-censored at $24. A censored regression model appears appropriate for our data. The Tobit model takes limits of the range of the dependent variable into account, to ensure unbiased and consistent estimates. The Tobit maximum likelihood estimates are shown in Table 5. These are the results of the standard Tobit model, which assumes a single distribution function for the dependent variable. This approach seems plausible since the decision on whether to make voluntary payment or not and the decision how much to pay in excess of the minimum (given one has chosen to make a voluntary payment) are not clearly separated ones. However, further investigation will be made to verify this. A two-equation model of Cragg (1971) would be an alternative to take the separate decisions into account. (Amemiya (1984))

TABLE 5: ESTIMATION RESULTS			
Explanatory variable	Coefficient	t-value	Statistical significance at 5%
Number of purchase	-.0290598	-5.07	*
Total purchases	.0039501	0.82	
Time difference	.0003323	5.83	*
Genre Ambient	-.0427097	-2.78	*
Electronica	.0312163	2.64	*
Rock	.0528198	4.44	*
New Age	.033398	2.79	*
Classical	.0255465	2.44	*
World	.0119233	1.04	
Jazz	.0082982	0.50	
Relaxing	.0484266	1.58	
Blues	.0200675	0.51	
Metal	.00592	0.33	
Christian	.0534403	1.93	
No e-mail	-.1243076	-9.72	*
PayPal	-.0232467	-4.17	*
CD	.106605	7.90	*
female	-.0058116	-0.65	
US	.0023809	0.38	
UK	.0632366	3.95	*
Japan	-.0679165	-2.32	*
Germany	.0178387	0.81	
Switzerland	.1510024	4.54	*
Canada	.0077808	0.49	
France	.0499744	2.11	*
Mexico	-.4172472	-6.74	*
Italy	.0064013	0.17	
Spain	-.0402331	-1.00	
Singapore	-.0643245	-0.77	
Israel	-.280097	-2.49	*
Constant	2.041647	196.97	*
Number of observations: 14,367 Log likelihood = -5058.0709 Pseudo R2 = 0.0389 2,081 left-censored observations, 18 right-censored observations			

The number of purchase is statistically significant at the 5%-level and it affects the payment negatively. It seems that initial payments are rather high, while payments of frequent customers decrease slightly over time. We will get back to this result later. The total number of purchases of a customer is not significant based on the regression results. However, the time difference between purchases affects the payment positively.

The regression confirms that customers who prefer to remain anonymous pay less. When no e-mail is left, the payment is significantly less. This fits into the psychological picture of free riders. The payment type "PayPal" results also in significantly lower payments. On the other hand, customers who buy CDs pay significantly more. They might appreciate getting a CD with cover art more than the postage and package premium they have to pay when they order a CD. Finally, the dummy for female customers is not significant.
The country dummies show that payment is clearly affected by where customers live. The effect of purchases from Switzerland, UK and France is significant and positive. The effect of purchases from Mexico, Israel and Japan is significant and negative. As explained earlier the different wealth levels seem to cause that and rather not cultural differences. Japan is clearly an exception here, though. Currency conversions cause a slight bias here. The fact that the price range was directly transformed into Euros and pounds might have led Europeans to spend more (While $8 are recommended to customers paying in dollar, £8 were suggested to customers paying in pounds). Framing effects might have occurred. Price ranges were adjusted with respect to exchange rates in 12/2004. This structural break will be taken into account in future versions.
Some genre dummies are significant among the 11 we have analysed. The genre 'Ambient' has a negative impact on the payment. The genre 'Rock' has the most significant positive impact, other genres where customers tend to spend more are Electronica, New Age and Classical.

The censored regression model is based on maximum likelihood and it assumes a normal distribution of the error term and homoscedasticity. A Bera-Jarque test confirmed the normality assumption.
Our estimation results give some indication about what affects the voluntary payment for music. Naturally, the biggest explanatory factor for the payment is the actual utility for the respective customer which is not measurable. Understandably, the fit of the regression is not particularly good with 4%. However, our data analysis shows that Magnatune customers on average pay even more than what is actually recommended. Only 2,081 of all 14,367 purchases were at the required minimum of $5, the majority of purchases were paid with the recommended $8 and the average of all purchases is at $8.20. Interestingly, factors like anonymity or getting a CD have a significant impact on the payment. The fact, that frequent customers seem more inclined to pay less once they already made several purchases is clearly worth further investigation.

The first payment of customers averages $8.26, while the second averages $8.19. Customers pay on average $8.09 for their 3rd to 6th purchase and. The number of albums already purchased appears to have an impact on the amount a customer is willing to pay.
The average payment decreases with the total of purchases a customer has made. While the average payment for one-time purchases is $8.29, the

average payment beyond the 7th purchase is only $8.07. There seems to be a decreasing individual trend line for frequent customers. However, the average payment of first-time buyers is stable around $8.26 and they are also "joining" Magnatune at a stable rate over the months.

One open question is therefore why average payments tail off with the number of purchase increasing. We are going to list and discuss a few possibilities for this behaviour.
Frequent customers like the music less and therefore pay less for it. This seems possible as we have no information about the taste and utility of customers, but it is not very likely.
Voluntary contributions might not be linear over time and income. Therefore, generosity possibly decreases when higher amounts (accumulated purchases over time) are at stake. However, the literature in experimental economics does not support this. For instance, Fehr and Tougareva (1995) do not find significant differences across conditions in their gift exchange games when high amounts were at stake (one condition involved the equivalent of a ten weeks' income).
Customers realise they can free ride and do so when they use the service again and again. This could be an explanation and the issue of an evolutionary stable equilibrium is clearly relevant in this context.
Frequent customers apply a 'bulk discount' concept. Since customers really have the choice of how much to pay for albums, they might apply an imaginary bulk discount. Having bought albums already in the past, they might think they should get them now for a bit less and award themselves with the discount.

6. Conclusions

Our model explains the paying behaviour of Magnatune customers who consistently pay more than the requested minimum price and even pay more on average than the recommended/default price. We conclude that reputation effects cannot play a role in this environment. Therefore, social preferences are the likely motivation of the customers that make voluntary payments.
Reciprocity is the source of social preferences in the model. The comprehensive and free pre-purchase access of Magnatune allows customers to make an informed buying decision. This is regarded as kind behaviour by sufficiently socially-minded customers and it triggers a kind reaction. They make a voluntary payment, while self-interested customers only pay the minimum. All customers maximise their utility.

Our empirical analysis shows that the average payment is $8.20, far more than the minimum of $5 and even higher than the recommended price of $8. Several factors have an impact on the size of the payment. The purchase of a CD (instead of the mere download) has a positive effect as well as some

genres, e.g. “rock”. The number of purchase and the anonymity of the customer affect the payment negatively. Several country dummies are also significant.

Compared to a conventional online music store that charges a fixed price of – for instance – $8 an album (and offers only limited sampling possibilities if at all) Magnatune makes more visitors acquainted with its songs and thus turns more visitors of the site into customers; and they still pay more than the recommended price of $8.
Still, despite the positive results of voluntary contributions and variable pricing for music it is important to stress that a niche of the market has been analysed and the results for rather unknown artists cannot be easily applied to the mass market. Nevertheless, the open contracts design of Magnatune should be regarded as a promising alternative to strictly DRM-based music online stores. In a possible life-cycle of artists the niche market of Magnatune takes its position in an early stage where artists are not well-known. Then, the experience good aspect of pre-purchase access is relatively more important and voluntary contributions motivated by social preferences work more likely than for rich and famous artists.

The paper analysed a newly collected data set and comes up with a clear initial result. Future versions of it will fine tune the econometric analysis and focus on dynamic aspects of the payment behaviour.

7. Appendix

Appendix A:
We now include individuals with social preferences in the customer population. As explained earlier we focus on concerns for reciprocity to model the behaviour of socially minded individuals. Their utility function increases not only in their material payoffs but also in the psychological payoffs which depend on their kindness and their beliefs about the kindness of the other individual towards themselves.
The equitable payoff of an individual is the average of his best and worst outcome based on the choices of the other individual. In the case of the customer C it is given by:[14]

$$\Pi_C^e(a_M, b_{MC}) = \tfrac{1}{2} \cdot (\max\{\Pi_C(a_M, b_{MC})\} + \min\{\Pi_C(a_M, b_{MC})\}) \qquad (22)$$

The best payoff for the customer is the result of a full access choice of M, the worst payoff results when M only provides limited access. The average of the

[14] The equitable payoff of C depends on the actual access choice of M (a_M) and whether M believes C makes a voluntary payment or not (b_{MC}).

two is the equitable payoff of the customer. This serves as a reference point for how kind M is to C. Recall that assumption 3 says $\varepsilon v - \bar{p} = 0$:[15]

$$\Pi_C^e = \tfrac{1}{2} \cdot ((v - p_{MC}) + (\varepsilon v - p_{MC})) = \tfrac{1}{2} \cdot (v + \varepsilon v) - p_{MC} \tag{23}$$

We calculate the equitable payoff for M in the same way. He receives his highest payoff, if the customer makes a voluntary payment and his worst when she does not:[16]

$$\Pi_M^e = \tfrac{1}{2} \cdot (p^k - p^n) \tag{24}$$

In order to determine how kind or not individuals are, we relate the actual payoff they give to the other player's equitable payoff. The kindness functions of C and M towards each other are:

$$\kappa_{CM}(a_C, b_{CM}) = \Pi_M(a_C, b_{CM}) - \Pi_M^e(a_C, b_{CM}) \tag{25}$$

$$\kappa_{MC}(a_M, b_{MC}) = \Pi_C(a_M, b_{MC}) - \Pi_C^e(a_M, b_{MC}) \tag{26}$$

Similarly, C's belief about the kindness of M to C is:

$$\tilde{\kappa}_{CMC}(b_{CM}, \tilde{b}_{CMC}) = \Pi_C(b_{CM}, \tilde{b}_{CMC}) - \Pi_C^e(\tilde{b}_{CMC}) \tag{27}$$

Finally the perceived kindness of C by M is:

$$\tilde{\kappa}_{MCM}(b_{MC}, \tilde{b}_{MCM}) = \Pi_M(b_{MC}, \tilde{b}_{MCM}) - \Pi_M^e(\tilde{b}_{MCM}) \tag{28}$$

Incorporating kindness and the beliefs about it gives us the following utility function with the material payoff Π as the first term and the reciprocity payoff in the second term that is weighted by α, the individual's sensitivity to reciprocity.

$$U_C(a_C, b_{CM}, \tilde{b}_{CMC}) = \Pi_C + \alpha_C \cdot \kappa_{CM} \cdot \tilde{\kappa}_{CMC}$$

$$U_M(a_M, b_{MC}, \tilde{b}_{MCM}) = \Pi_M + \alpha_M \cdot \kappa_{MC} \cdot \tilde{\kappa}_{MCM} \tag{29}$$

The utility of customer and M does not only depend on their material payoff. The reciprocity payoff is added. Essentially utility is increased by reciprocity when the sign of an individual's kindness κ matches the sign of the perceived kindness of the other individual ($\tilde{\kappa}$). Both are negative when the individuals behave unkind to each other. This nasty or negative reciprocity equilibrium of the game is when M decides to provide limited access and C subsequently tries to get the music from P2P networks. This is also the outcome when purely self-interested individuals play as shown above.

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[15] We now replace M's action by the chosen access level and his belief about C's action (kind or nasty behaviour) by p_{MC}.

[16] Now b_{MC} – the customer's belief of M's action – is already known. The customer's action a_M is either p^k or p^n.

Does a positive reciprocity equilibrium exist and what are the conditions for that? Note that the equitable payoff of M when he offers full access is:

$$\Pi_M^e = \tfrac{1}{2} \cdot (p_v - p_{\min}) \tag{30}$$

Thus, the customer's kindness when she makes a voluntary payment (and M provides free access) is therefore:

$$\kappa_{CM}^{fk} = p_v - \tfrac{1}{2} \cdot (p_v - p_{\min}) = \tfrac{1}{2} \cdot (p_v - p_{\min}) > 0 \tag{31}$$

While if she only pays the minimum (and M provides full access) the kindness of C is:

$$\kappa_{CM}^{fn} = p_{\min} - \tfrac{1}{2} \cdot (p_v - p_{\min}) = \tfrac{1}{2} \cdot (p_{\min} - p_v) < 0 \tag{32}$$

In order to determine how kind C believes M is after providing full access, we need to specify C's belief of what M believes is C's choice after the full access decision. This second order belief $\widetilde{b}_{CMC}$ can be either $p_{\min}$ or p_v and we assign the probability $\widetilde{\theta} \in [0;1]$ to C's belief of the voluntary payment. The payoff of C resulting from M's limited access choice is assumed to be zero (the nasty equilibrium where copying follows limited access) and the payoff C believes M intends to give to C when he chooses full access is:

$$\Pi_C^f = \widetilde{\theta} \cdot (v - p_v) + (1 - \widetilde{\theta}) \cdot (v - p_{\min}) \tag{33}$$

The equitable payoff for C is the average of these two payoffs (Π_C^f and the payoff of $\Pi_C^l = \widetilde{\theta} \cdot (\varepsilon v - \overline{p}) + (1 - \widetilde{\theta}) \cdot \gamma \cdot \varepsilon v = (1 - \widetilde{\theta}) \cdot \gamma \cdot \varepsilon v$ in the nasty equilibrium):

$$\Pi_C^e = \tfrac{1}{2} \cdot (\widetilde{\theta} \cdot (v - p_v) + (1 - \widetilde{\theta}) \cdot (v - p_{\min}) + (1 - \widetilde{\theta}) \cdot \gamma \cdot \varepsilon v) \tag{34}$$

Therefore, the believed kindness of M towards C after choosing full access is:

$$\widetilde{\kappa}_{CMC}^f = \tfrac{1}{2} \cdot (\widetilde{\theta} \cdot (v - p_v) + (1 - \widetilde{\theta}) \cdot (v - p_{\min}) - (1 - \widetilde{\theta}) \cdot \gamma \cdot \varepsilon v) \tag{35}$$

We are now in a position to calculate the utility of C when she makes a voluntary payment and when she does not.

$$U_C^{fk} = \Pi_C^k + \alpha_C \cdot \kappa_{CM}^f \cdot \widetilde{\kappa}_{CMC} \tag{36}$$

$$U_C^{fk} = (v - p_{vol}) + \alpha_C \cdot \tfrac{1}{2} \cdot (p_{vol} - p_{\min}) \cdot \tfrac{1}{2} \cdot (\widetilde{\theta} \cdot (v - p_{vol}) + (1 - \widetilde{\theta}) \cdot (v - p_{\min}) - (1 - \widetilde{\theta}) \cdot (1 - \gamma) \cdot \varepsilon v) \tag{37}$$

$$U_C^{fn} = \Pi_C^n + \alpha_C \cdot \kappa_{CM}^n \cdot \widetilde{\kappa}_{CMC} \tag{38}$$

$$U_C^{fn} = (v - p_{\min}) + \alpha_C \cdot \tfrac{1}{2} \cdot (p_{\min} - p_{vol}) \cdot \tfrac{1}{2} \cdot (\widetilde{\theta} \cdot (v - p_{vol}) + (1 - \widetilde{\theta}) \cdot (v - p_{\min}) - (1 - \widetilde{\theta}) \cdot (1 - \gamma) \cdot \varepsilon v) \tag{39}$$

The condition for the existence of a fair, positive reciprocity equilibrium is:

$$U_C^k(a_C, b_{CM}, \tilde{b}_{CMC}) > U_C^n(a_C, b_{CM}, \tilde{b}_{CMC}) \tag{40}$$

This is fulfilled if:

$$\alpha_C \cdot \tfrac{1}{2} \cdot (\tilde{\theta} \cdot (v - p_{vol}) + (1 - \tilde{\theta}) \cdot (v - p_{\min}) - (1 - \tilde{\theta}) \cdot \gamma \cdot \varepsilon v) > 1 \tag{41}$$

AppendixB:

Since we have established conditions for C to make a voluntary payment once M has provided full access, we now have to analyse whether M will ever offer full access in the first place. He knows that the customer will never make a voluntary payment when $\alpha_C < \frac{2}{v - p_{\min} - \gamma \cdot \varepsilon v}$ and therefore he will never provide full access in that case.
He also knows that C will act reciprocally once her sensitivity to reciprocity α_C is large enough. That means he assumes C will reward the full access choice with a voluntary payment and will reply to limited access with "copying". The equitable payoff of the customer is therefore the average of the full access plus voluntary payment (Π_C^{fk}) and the limited access plus "copying" ($\Pi_C^{\ln}$) payoffs:

$$\Pi_C^e = \tfrac{1}{2} \cdot (\Pi_C^{fk} + \Pi_C^{\ln}) = \tfrac{1}{2} \cdot ((v - p_v) + \gamma \cdot \varepsilon v) \tag{42}$$

The choice of full access means the kindness of M to C is:

$$\kappa_{MC}^f = (v - p_v) - \tfrac{1}{2} \cdot (v - p_v + \gamma \cdot \varepsilon v) = \tfrac{1}{2} \cdot (v - p_v - \gamma \cdot \varepsilon v) > 0 \tag{43}$$

Accordingly M's kindness to C with limited access is:

$$\kappa_{MC}^l = \gamma \cdot \varepsilon v - \tfrac{1}{2} \cdot (v - p_v + \gamma \cdot \varepsilon v) = \tfrac{1}{2} \cdot (\gamma \cdot \varepsilon v - (v - p_v)) < 0 \tag{44}$$

Once again we have to specify second order beliefs to calculate how kind M thinks C is towards him. M's belief of what C believes is M's choice is $\tilde{b}_{MCM}$. We assign the probability $\tilde{\eta} \in [0;1]$ to M's second order belief of full access ($\tilde{\eta} = 1$ means the belief is full access, $\tilde{\eta} = 0$ means it is limited access). In order to find M's equitable payoff we take the average of the best and worst outcome for him. The best is when the customer always behaves kind following the two options of M (limited and full access weighted by $\tilde{\eta}$), the worst is when the customer behaves nasty.

$$\Pi_M^e = \tfrac{1}{2} \cdot ((\tilde{\eta} \cdot p_v + (1 - \tilde{\eta}) \cdot \bar{p}) + (\tilde{\eta} \cdot p_{\min} + (1 - \tilde{\eta}) \cdot (1 - \gamma) \cdot \bar{p}) \tag{45}$$

Hence, the belief of M about C's kindness from choosing in a reciprocal way is the actual[17] minus the equitable payoff of M:

$$\widetilde{\kappa}_{MCM} = \tfrac{1}{2} \cdot (\widetilde{\eta} \cdot p_v + (1-\widetilde{\eta}) \cdot (1-\gamma) \cdot \overline{p} - (1-\widetilde{\eta}) \cdot \overline{p} - \widetilde{\eta} \cdot p_{\min}) \tag{46}$$

$$\widetilde{\kappa}_{MCM} = \tfrac{1}{2} \cdot (\widetilde{\eta} \cdot (p_v - p_{\min}) - (1-\widetilde{\eta}) \cdot (\overline{p} - (1-\gamma) \cdot \overline{p})) \tag{47}$$

The utility of M when he provides full access (and expects a voluntary payment) is:

$$U_M^f = p_v + \alpha_M \cdot \tfrac{1}{2} \cdot (v - p_v - \gamma \cdot \varepsilon v) \cdot \widetilde{\kappa}_{MCM} \tag{48}$$

When he chooses limited access (and expects "copying") it is:

$$U_M^l = \gamma \cdot \overline{p} + \alpha_M \cdot \tfrac{1}{2} \cdot (\gamma \cdot \varepsilon v - (v - p_v)) \cdot \widetilde{\kappa}_{MCM} \tag{49}$$

The condition for M to make the full access decision is:

$$U_M^f(a_M, b_{MC}, \widetilde{b}_{MCM}) > U_M^l(a_M, b_{MC}, \widetilde{b}_{MCM}) \tag{50}$$

This is fulfilled if:

$$\alpha_M \cdot (v - p_v - \gamma \cdot \varepsilon v) \cdot \widetilde{\kappa}_{MCM} > \gamma \cdot \varepsilon v - p_v \tag{51}$$

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