Pay-What-You-Want in Competition*

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Abstract

This paper presents an analysis of Pay-What-You-Want (PWYW) in competition which explains its entry and limited spread in the market. Sellers choose their pricing schemes sequentially while consumers share their surplus. The profitability and popularity of PWYW depend not only on consumers' preferences, but also on market structure, product characteristics and sellers' strategies. While there is no PWYW equilibrium, given a sufficiently high level of surplus-sharing and product differentiation, PWYW is chosen by later entrants to avoid Bertrand competition. The equilibrium results and their market characteristics are consistent with empirical examples of PWYW.

JEL classification: D11, D42, D43, L11.

Keywords: Pay-what-you-want, competition, product differentiation, market behaviour, market structure.

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1 Introduction

Pay-What-You-Want (PWYW) is a pricing scheme in which a good is up for sale and the consumer, should he decide to buy, chooses the price to pay for it. Despite the standard prediction of consumer free-riding, PWYW has in fact become increasingly popular in recent years, arguably due to the extensive media coverage after the success of Radiohead's album "In Rainbows".[1] Many other businesses have followed the example of Radiohead: in the period between March 2014 to April 2015, there were 113 instances of PWYW cited in news and academic articles, the majority of which are still currently operating (see Table 1 in the Appendix for a complete list). In recent years PWYW has also gained much attention in the academic literature, with publication in journals such as Science (Gneezy et al., 2010), Proceedings of the National Academy of Sciences (PNAS) (Gneezy et al., 2012) and Management Science (Schmidt et al., 2014) (see Greiff and Egbert (2016) for a survey of the literature).

The popularity of PWYW raises two questions. Firstly, how such a pricing scheme can exist: why do sellers adopt PWYW despite the possibility of getting no revenue, and accordingly, why do consumers pay a positive amount without having to do so? Although numerous studies have attributed the success of PWYW to consumers' non-selfish behaviours, heterogeneity in preferences means that PWYW is prone to an adverse selection problem: selfish consumers self-select into the PWYW seller's market and free-ride, causing the seller to make a loss. Second, the empirical examples of PWYW (listed in Appendix A) show a distinct cluster of sellers operating in the food, music and online retail industries (such as games and softwares) – industries characterised by im-

[1] In 2007, the band Radiohead released their album "In Rainbows" using PWYW. Hundreds of thousands of fans chose to pay a positive amount for the album, and the band in fact profited from this pricing format, making more money than from digital downloads of all their other studio albums combined (see `http://musically.com/2008/10/15/exclusive-warner-chappell-reveals-radioheads-in-rainbows-pot-of-gold/`, accessed 3-Dec-2017).

perfect competition against fixed-price competitors, selling non-resalable goods of low marginal cost, with some level of product differentiation. If indeed PWYW has the potential to generate more profits than fixed-pricing, why have these competitors, and sellers in other industries, stuck to fixed-pricing? No matter which view is taken, be it the standard prediction that consumers free-ride and that PWYW would be unsuccessful, or that consumers are sufficiently pro-social that PWYW would be profitable, it is puzzling that the spread of PWYW in the market so far can only be described as partial.

This paper aims to address the above questions in an industrial organisation framework of competing pricing strategies with three or more sellers. Previous studies of PWYW focus primarily on the role of consumer preferences, such as altruism, social norms and self-signalling (see, for example, Kim et al. (2009), Gneezy et al. (2012), or Greiff and Egbert (2016) for an extensive survey of the PWYW literature) to motivate above zero payments. With the exception of the duopoly models of Chen et al. (2017) and Chao et al. (2017) which are discussed below, existing theoretical models typically assume a monopolist seller (Isaac et al., 2015; Chao et al., 2015; Kahsay and Samahita, 2015; Mak et al., 2015). Our analysis differs in that we focus on the seller characteristics that are likely to favour PWYW under different market structures, including monopoly and price competition, and extend the analysis to three sellers (or more, under homogeneous product competition). Sellers' entry into the market and their choice of pricing schemes are modelled in a sequential setting, with and without product differentiation. Our model generates equilibrium predictions which account for the partial spread of PWYW in the market, whereby either both sellers choose fixed-pricing or that PWYW competes against fixed-pricing.

In prior work, the success of PWYW has been attributed to preferences for fairness, self-signalling and social norms. In contrast, our model shows that even when consumers have so-

cial preferences, this is not enough to induce a seller to adopt a voluntary payment scheme such as PWYW. The emergence of PWYW as an equilibrium strategy also requires certain market and product characteristics. However, when these conditions are fulfilled, PWYW is a simple and cheap strategy that a later entrant can adopt to escape the Bertrand trap, given a fixed-price competitor already exists in the market. We confirm the model's predictions using the existing examples of PWYW in the market. The parameters that are predicted to sustain the choice of PWYW by a seller include a low marginal cost for the good, a high level (or not too high, in the case of product differentiation) of surplus-sharing, a low proportion of free-riders and an intermediate range of product differentiation – which are in line with the empirical examples of PWYW. Our results have far-reaching implications given the popular use of PWYW as a serious alternative to piracy in industries such as music and online games.

The need to study PWYW in competition has been recognised by Greiff and Egbert (2016) who identify gaps in the surveyed literature regarding what conditions are required for PWYW to be feasible for high cost goods, and how PWYW fares in the long-run. While most of the existing literature has focused on short-term experiments, the few empirical studies that have followed PWYW sellers over the long run concern low cost goods and find that in general, though PWYW brings in more customers, the average prices paid decrease over time (Riener and Traxler, 2012; Schons et al., 2014). Greiff and Egbert (2016, p. 20) postulate that "over longer time spans, the success of PWYW pricing will depend on the availability of substitutes and, therefore, on market structure." The same sentiment is echoed in Natter and Kaufmann (2015), who identify the demand for more knowledge on the effect of competition on PWYW's effectiveness. The lack of research on PWYW's feasibility in competition with other sellers is a clear gap in the literature that has so far only been addressed theoretically in Chen et al. (2017) and Chao et al. (2017) with the

assumption of two sellers, and experimentally in Schmidt et al. (2014) and Krämer et al. (2017). While our paper provides an analysis with three or more sellers, it is worthwhile to compare our equilibrium results in the case of two sellers with the existing duopoly studies above, which we do in later sections.

While both Chao et al. (2017) and Chen et al. (2017) provide equilibrium analyses of simultaneous oligopoly competition with PWYW, neither of them presents a theoretical mechanism explaining the phenomenon often observed in real life, the entry of PWYW into a market with fixed-price incumbents. Our paper contributes the first complete and tractable model of firm behaviour that not only incorporates product differentiation, but also accounts for the later entry of real world PWYW sellers and their partial spread in the market. Chao et al. (2017), while very closely related to ours, is an independent paper we were unaware of upon initially constructing our model. Using a simple surplus-sharing mechanism, we replicate their equilibrium results under homogeneous goods competition and furthermore generalize the results with additional sellers and under product differentiation. In both cases, a competing seller only chooses PWYW facing a fixed-price seller if there is a sufficiently high level of surplus-sharing, otherwise the Bertrand result obtains. In particular, our unique sequential setting provides insights into the dynamics of sellers' strategies. A first mover will always choose fixed-pricing, while later entrants will only choose PWYW given the above favourable conditions. This equilibrium outcome is empirically consistent with the majority of PWYW examples, where the PWYW seller typically enters a market with an existing fixed-price competitor.

The only laboratory experiments so far that have tested the feasibility of PWYW under competition are Schmidt et al. (2014) and Krämer et al. (2017). In contrast to our prediction of a coexistence equilibrium, given buyers are sufficiently altruistic Schmidt et al. (2014) predict that

both sellers use PWYW (Prediction 3). When there is one PWYW seller facing a fixed-price seller, PWYW will achieve maximum market penetration (Prediction 2). However, the authors concede that this may not hold if buyers still opt for fixed-pricing due to, for example, self-image concerns, and this is indeed what they find with around 20% of buyers still choosing fixed-pricing despite the presence of PWYW. Consequently, the authors find that given the choice, 85% of sellers also prefer to set a fixed price. However if buyers are not sufficiently altruistic, both papers predict an equilibrium where both sellers choose fixed-pricing. Krämer et al. (2017) compare the performance of PWYW in competition with a fixed-price seller. The authors predict and show that PWYW captures almost the whole market, in contrast to our prediction and the real world examples where a substantial proportion of buyers prefer a fixed price to PWYW. This difference is explained by the assumption that PWYW provides an additional benefit to the seller (through the buzz or word-or-mouth advertising generated), meaning that buyers do not feel bad about accepting a PWYW offer. This assumption will hold in situations where the buzz or media coverage of PWYW is sufficiently large.

The rest of this paper will be structured as follows: we develop the model in Section 2, starting with the monopoly case followed by competition in Section 3. Product differentiation is introduced in Section 4. Section 5 ties all the results together with the existing empirical examples of PWYW, and Section 6 concludes. All proofs are provided in the Appendix.

2 Model

While the literature on PWYW consumers' social preferences is extensive, a rich model of consumer behaviour capturing all the aspects previously mentioned, such as guilt, fairness and reci-

procity, will unnecessarily complicate the model. This paper has a different goal and focuses instead on seller behaviour. From *the seller's* point of view it is sufficient to observe and take as given that consumers are either free-riders or fair (who may pay more the higher their valuation for the good, as empirically shown in Schmidt et al. (2014) and Krämer et al. (2017), or instead opt out for any of the motivations above). This can be captured in a simple linear model of a consumer who maximises his net surplus, as done in, for example, Greiff et al. (2014), Chen et al. (2017), and in standard industrial organisation models of consumer preferences such as Economides (1986) and Perloff and Salop (1985).[2]

Each consumer is assumed to have unit demand. For simplicity, consumer i's total utility from purchasing the good at price p is assumed linear according to the following:

$$U_i = u_i - p.$$

u_i is the good's consumption utility, or alternatively, i's willingness to pay for the good. It is assumed to be uniformly distributed between zero and k times the good's constant marginal cost $c > 0$, which is public knowledge, so that $u_i \sim U(0, kc)$. k is a scaling term which varies with the support of the consumption utility distribution, to capture the fact that some goods may be valued by consumers more than their marginal cost.[3] Moreover, $k > 1$ so that production of the good is efficient. The population size is normalised to 1, and the utility of no purchase is zero. We assume there is no fixed cost of production, and the seller sells no other type of good.[4]

[2] In Chen et al. (2017), a component for inequity-aversion is added to the utility function. Chao et al. (2017) also use a guilt-aversion component to model consumer preference. For the purpose of tractability in our analysis of varying market structures, we have opted to use the simpler surplus-sharing mechanism described here.

[3] For goods with extremely low marginal cost c, high consumption utility is captured by a high value of k. Alternatively, replacing the upper bound of the consumption utility distribution with $kc + \varepsilon$, $\varepsilon > 0$, produces qualitatively similar results. This also captures the case of goods with zero marginal cost, where ε then acts as a positive fixed cost.

[4] While in some instances PWYW may be used as a promotional tool to help cross-sell a complementary product

When the seller lets the consumer pay what he wants (PWYW), this triggers different reactions in consumers given heterogeneous fairness concerns. Assume a proportion θ, $0 < \theta \leq 1$, are free-riders, who would always take the good for free.[5] Previous studies have consistently found that a proportion of the population of individuals free-ride unconditionally, and that this behaviour type is stable (Kurzban and Houser, 2005; Fischbacher et al., 2001). Hence, it is reasonable to assume that θ is an exogenous market parameter, which can vary by country or industry. Cross-country variations in free-riding behaviour have been found in Kocher et al. (2008). It is also plausible to consider goods with a charity component to attract fewer free-riders compared to other goods.

The remaining $1-\theta$ consumers, however, are fair: they will pay at least c and therefore will not purchase the good if their consumption utility u_i is less than c. They will even split the surplus $u_i - c$ out of reciprocity for the seller having chosen a PWYW scheme, or any of the previously mentioned social preferences.[6] Let λ be the proportion of surplus shared with sellers, $0 < \lambda \leq 1$.[7] This parameter represents the strength of social preferences in the economy, and can also be interpreted as an exogenous social norm – typically assumed to be 0.5 in an equal sharing rule, but in a richer and more generous economy the norm may be to give more and vice versa (see, for example, Gächter and Herrmann (2009) who find cross-cultural variations in reciprocity).[8]

by the same seller, for tractability we have assumed that only one product is offered by the seller.

[5] The analysis for $\theta = 0$ is straightforward and is left to the reader.

[6] See also the literature on gift exchange, for example Fehr et al. (1998) where sellers offer high quality and consumers reciprocate by paying prices which are substantially higher than the sellers' reservation prices.

[7] $\lambda = 0$ is simply the case of fixed-pricing at cost.

[8] Assuming that the surplus-sharing parameter is heterogeneous such that λ_i is uniformly distributed with expected value λ yields similar results.

The fair consumer's PWYW payment is therefore defined to be[9]

$$p_i = c + \lambda(u_i - c).$$

Observe that since λ and c are assumed exogenous, PWYW payment is deterministic. This means that given the seller offers PWYW, social norms dictate that consumers pay p_i. Substituting this payment into the utility function then gives the consumer's PWYW utility:[10]

$$U_i = u_i - c - \lambda(u_i - c).$$

Again, we stress that social norms dictate that fair consumers do not buy the good if $u_i < c$.

2.1 Monopoly

Under fixed-pricing (FP), a monopolist's profit can be expressed as

$$\pi_{FP} = \int_p^{kc} \frac{1}{kc}(p-c)du = (p-c)\left(1 - \frac{p}{kc}\right)$$

[9]PWYW revenue from fair consumers can therefore be interpreted as that from a two-part tariff, where the surplus-sharing component defines the entry fee and c is the price paid per unit good. To this extent, our analysis in this paper is therefore related to the literature on non-linear pricing.

[10]This particular choice of reduced-form utility, despite its simple structure and extensive use in the literature cited above, may seem arbitrary and deserve more motivation. Note that this utility function can be derived from, for example, the inequity aversion model of Fehr and Schmidt (1999). If the fair consumer simply compensates the PWYW seller by paying c, he will get a surplus of $u_i - c$ while the seller will get a profit of zero. Advantageous inequity aversion will result in a utility reduction of $\lambda(u_i - c)$, which under PWYW will instead be shared with the seller.

using the familiar $(p-c)q$ notation. Performing the usual profit maximisation calculation, we have optimal price, quantity and profit as follows:

$$p_{FP} = \frac{c(k+1)}{2} \qquad q_{FP} = \frac{k-1}{2k} \qquad \pi_{FP} = \frac{c(k-1)^2}{4k}.$$

Under PWYW, a monopolist's profit can be expressed as

$$\begin{aligned}\pi_{PWYW} &= \theta \int_0^{kc} \frac{1}{kc}(-c)du + (1-\theta)\int_c^{kc} \frac{1}{kc}(c+\lambda(u-c)-c)du \\ &= \frac{(1-\theta)\lambda c(k-1)^2}{2k} - \theta c.\end{aligned}$$

Hence,

Proposition 1. *The monopolist will choose PWYW if and only if*

$$\lambda > \hat{\lambda} = \frac{(k-1)^2 + 4\theta k}{2(1-\theta)(k-1)^2},$$

which increases with θ *and decreases with* k*.*

Not surprisingly, the condition for PWYW to be chosen over FP is that λ, the level of surplus shared, is high enough, or θ, the proportion of free-riders, is low enough. Additionally, if k, the scaling term corresponding to the support of u_i, is high enough, many fair consumers will have a sufficiently high valuation for the good and thus make a correspondingly high PWYW payment. Thus, PWYW achieves endogenous price discrimination which is more profitable than a fixed-price monopoly. This is illustrated in Figure 1. When the proportion of free-riders is high, PWYW profit

is negative. As λ increases and θ decreases such that

$$\lambda > \frac{2\theta k}{(1-\theta)(k-1)^2},$$

PWYW profit becomes positive, but still less than fixed-price profit. Only when λ exceeds the threshold $\hat{\lambda}$ above will PWYW yield higher profit than fixed-pricing. As k increases, the λ-intercepts of these boundaries stay the same but the curves stretch to the right, increasing PWYW profit.

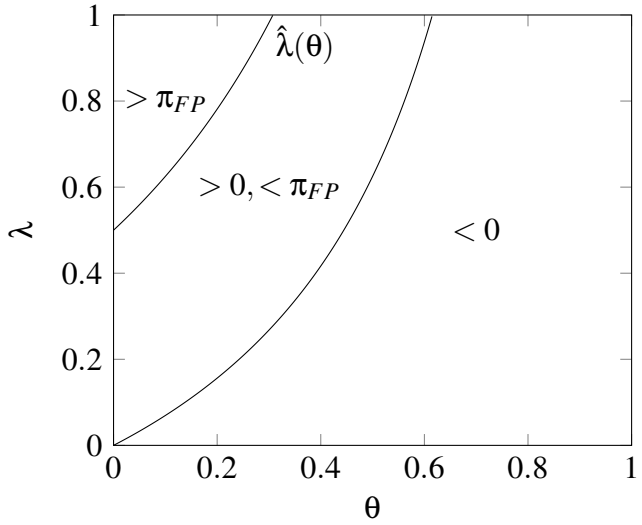


Figure 1: Profit regions for PWYW monopolist, $k = 5$

To illustrate why PWYW is rarely chosen by a monopolist, consider Fehr and Schmidt (1999, Table III) who estimate the proportion of individuals experiencing zero disutility from advantageous inequality to be around 0.3. Using this estimate for the number of free-riders θ suggests that for the seller to choose PWYW over FP, even when λ is very close to 1, requires the good to be valued more than twice its cost on average ($k/2 > 2.40$). As the average level of surplus-sharing decreases, the average valuation needs to increase. In a typical economy with a $\lambda = 0.5$ norm,

PWYW profit will never exceed fixed-price profit.

3 Competition

In this section we will present an analysis of homogeneous goods competition with $n > 1$ sellers. Suppose that n competing sellers offer the same product and they can choose their preferred pricing schemes. Assume the product precludes resale.[11] At each stage $s = 1, 2, ..., n$, a seller enters the market and chooses between FP or PWYW. In the last stage $s = n + 1$, any seller that chooses FP now chooses his price. If there are multiple FP sellers, the choice of price occurs simultaneously.

The sequentiality in entry closely models what we see in practice, whereby PWYW has commonly entered a market previously dominated by fixed-price sellers.[12] It takes into account frictions such as menu costs, marketing expenses and customer self-selection which are costly and time-consuming, thus preventing sellers from quickly adopting an alternative pricing scheme, at least in the short- to medium-run. This means that a new entrant is able to observe the choice of pricing scheme of the incumbent(s) and make their own choice taking this knowledge into account. Given multiple FP sellers, however, the simultaneity in price competition captures the repeated interaction through the flexibility in prices which sellers can adjust dynamically, once a FP-scheme is chosen.[13]

The full representation of the game and the resulting end nodes, for $n = 3$, are shown in Figure 2. All decisions are common knowledge.

At the end of stage $n + 1$, the consumers make their purchase decisions. When all n sellers

[11] With resale, a FP competitor or free-riding consumer can drive out the PWYW seller by buying a sufficiently large amount of the good at zero cost to resell them at a positive price.

[12] Assuming simultaneity yields qualitatively similar results.

[13] Letting sellers choose prices sequentially corresponds to a situation in which prices, once set, are fixed.

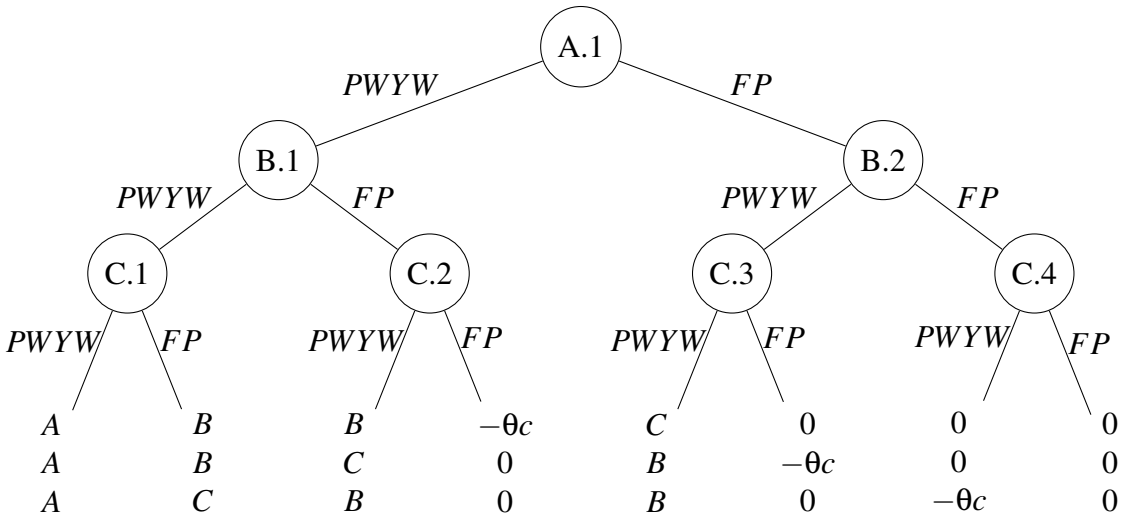


Figure 2: Competition between three sellers

choose PWYW, consumers randomise such that each seller gets an equal share of the market and shares the monopolist PWYW profit, denoted by A where

$$A = \frac{(1-\theta)\lambda c(k-1)^2}{2nk} - \frac{\theta c}{n}.$$

When all n sellers choose FP, consumers go to the seller with the lowest price or randomise if prices are the same. Hence we assume that the usual Bertrand result applies where all sellers set $p = c$ and make zero profit.

When there are $n-1$ PWYW sellers and one FP seller, the free-riders will randomise among the PWYW sellers which means that each PWYW seller gets $1/(n-1)$ of the free-riders in the market. The fair consumers will go to the seller at which they will pay the lower price, be it the fixed price p or their PWYW price p_i. Going to a PWYW seller means that they are obliged, through fairness norms, to pay p_i. Consumers with high consumption utility may consequently prefer to go to the FP seller and pay a lower fixed price.

At first sight, this choice may seem inconsistent with the fair buyer's motivation to pay a positive price under PWYW. However, it can be argued that when choosing pricing schemes, buyers (who know they will be obliged by social norms to pay a higher price for higher consumption utility under PWYW) simply choose what would in the end give them a higher surplus, and only conditional on choosing PWYW does the fairness mechanism *appear to* kick in. A similar market segmentation is also seen in Chao et al. (2017) where fair consumers with high valuation have higher reference prices, and hence experience higher guilt cost for paying less under PWYW. The assumption that (even fair) consumers choose the seller at which they can pay a lower price is crucial to capture the preference for fixed-pricing seen in empirical examples. PWYW involves a certain degree of uncertainty regarding the correct behaviour (Park et al., 2017) and some consumers may seek to avoid this moral deliberation and obligation (Schmidt et al., 2014). This is also demonstrated in the experiments by Gneezy et al. (2012) and Kim et al. (2009) where fewer people buy a good when it is offered under PWYW than when there is a fixed price.[14]

Define

$$u_p = c + \frac{p-c}{\lambda}$$

to be the consumption utility at which a fair consumer is indifferent between paying p_i, his PWYW payment, and the fixed price p. Therefore, when $c \leq u_i < u_p$, he prefers to choose PWYW and randomise among the $n-1$ PWYW sellers, when $u_i = u_p$ he is indifferent, and beyond u_p he is better off purchasing at the fixed price than sharing his consumer surplus with a PWYW seller. This is illustrated in Figure 3.

[14]Commonly suggested alternatives, such as letting PWYW consumers pay the competitor's fixed price less epsilon, or share a proportion of surplus defined as the competitor's fixed price less marginal cost, will not capture the choice of a subset of consumers who prefer to pay a fixed price. As per Schmidt et al. (2014, pp. 1222-1223), "some customers may opt for a [FP] seller because they are happy to buy the product for a low posted price, but they would feel 'cheap' if they paid this low price voluntarily."

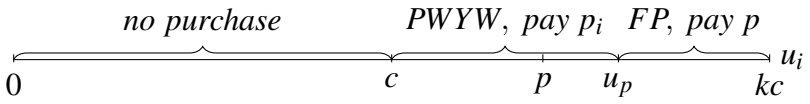


Figure 3: Fair consumer's action when PWYW and fixed-pricing both exist

Clearly the fixed-price seller chooses the profit-maximising price p taking into account that this price will determine demand for both himself and his PWYW competitors. He will no longer get all the consumers with valuation greater than p since the θ free-riders go to the PWYW sellers. Out of the fair consumers, he will only get those with $u_i \geq u_p$ (see Figure 3). Hence the fixed-price seller will not set $p \geq c(\lambda k - \lambda + 1)$, as $u_p \geq kc$ and he would then get no customer. He will also not set $p \leq c$, as this will yield zero or negative profit. Therefore his fixed price will lie in $(c, c(\lambda k - \lambda + 1))$, and his profit can be expressed as[15]

$$\pi_{FP} = \frac{1-\theta}{kc} \int_{u_p}^{kc} (p-c) du.$$

The profit maximising-price is thus

$$p^* = c\left(1 + \frac{\lambda(k-1)}{2}\right)$$

and $u_p = c(k+1)/2$. Hence, the FP seller earns

$$C = \frac{(1-\theta)\lambda c(k-1)^2}{4k},$$

while the $n-1$ PWYW sellers share the remaining fair consumers and free-riders resulting in each

[15]The set $(c, c(\lambda k - \lambda + 1))$ is non-empty since $\lambda > 0$ and $k > 1$.

earning

$$B = \frac{(1-\theta)\lambda c(k-1)^2}{8(n-1)k} - \frac{\theta c}{n-1}.$$

When two or more sellers choose FP and the remaining seller(s) chooses PWYW, all free-riders go to the PWYW seller(s). The fair consumers will again choose the lower of $\{p, p_i\}$ where their indifference point is as illustrated in Figure 3. However, with two or more FP sellers competing in price we obtain a Bertrand outcome: competition will drive down the price to marginal cost. Consequently, $u_p = c$, all fair consumers will randomise among the FP sellers and none will choose to buy from the PWYW seller(s). Each FP seller earns zero profit while the PWYW seller(s) incurs a (shared) loss of $-\theta c$ from exclusively selling to free-riders.

The resulting profit for each seller is shown in Figure 2. To describe the equilibrium results, define the following:

Definition 1. *In a **FP equilibrium**, all sellers choose FP.*

Definition 2. *In a **PWYW equilibrium**, all sellers choose PWYW.*

Definition 3. *In a **coexistence equilibrium**, both PWYW and FP exist in the market.*

The equilibrium outcomes will now be summarised in Proposition 2, and illustrated in Figure 4.

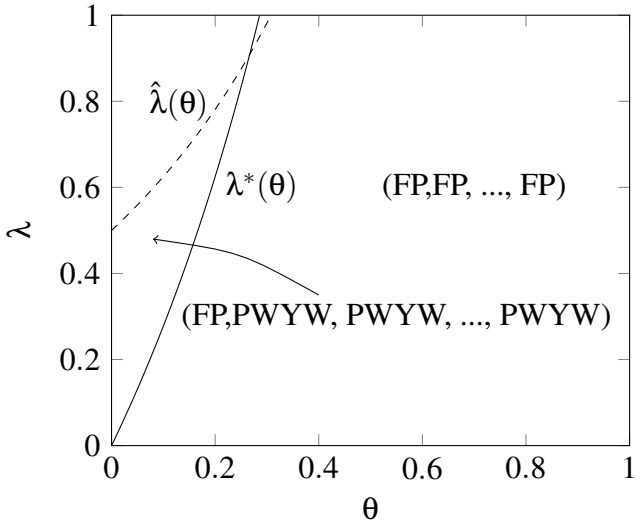
Proposition 2. *Given*

$$\lambda^* = \frac{8\theta k}{(1-\theta)(k-1)^2},$$

which increases with θ and decreases with k, when n competing sellers choose pricing schemes sequentially and then enter into a simultaneous price competition, the subgame perfect equilibrium is either coexistence or FP. Specifically,

i if $\lambda > \lambda^*$*, the first seller to enter the market chooses FP, while all subsequent entrants choose PWYW.*

ii if $\lambda \leq \lambda^*$*, all sellers choose FP.*



Dashed line represents the corresponding monopolist threshold $\hat{\lambda}$ above which PWYW is chosen.

Figure 4: Subgame perfect Nash equilibria, $k = 5$

In equilibrium, either all n sellers compete in a Bertrand price competition and earn zero profit, or if there is sufficiently high surplus-sharing in the market every new entrant will choose PWYW to avoid price competition against the FP first mover. As long as λ is sufficiently high or θ is sufficiently low, there is positive residual PWYW profit and later entrants will choose PWYW, with the first mover reaping the majority of the market profit. This is anticipated by the first mover, who would thus always choose FP. Only when the PWYW profit becomes negative do later entrants prefer the Bertrand competition. All pure strategy equilibria are unique.

Note that λ^* decreases as k, and hence the support of u_i, increases. As the good becomes more valuable to consumers, choosing PWYW becomes more profitable for later entrants as their residual profit (when the first mover has chosen FP) increases. Setting $\theta = 0.3$ (Fehr and Schmidt,

1999), the average valuation of the good needs to be at least 2.62 times its cost for PWYW to be chosen by later entrants, even when λ is very close to 1 which is not often seen in practice. When $\lambda = 1/2$, the average valuation needs to be even higher (4.37) which may be less realistic. On the other hand, we see that for low values of θ it is possible to sustain PWYW sellers in competition for lower values of λ compared to the monopoly situation.[16] This is due to the opportunity cost of adopting FP: as a monopolist, choosing FP leads to positive profit, while the Bertrand competition profit is zero. Hence the switching point to FP occurs at a higher value of λ as a monopolist than in competition.

It might appear that our results are simply driven by the zero profit feature of the Bertrand model, that given PWYW is sufficiently profitable it would naturally be chosen as an alternative to fixed-pricing. While this explains the choice of the second mover at node B.2 in Figure 2, we argue that the equilibrium path at other nodes, for example B.1, and hence A.1, is not necessarily obvious. Given a first mover choosing PWYW, our model predicts that the second mover would reap more profit using a fixed price. This relies on our assumption that consumers with high valuation would rather pay a fixed price than face the moral obligation of paying a higher price under PWYW, in contrast to other predictions such as Schmidt et al. (2014) where full market penetration under PWYW leads to the PWYW equilibrium.

Assuming $n = 2$ allows for comparisons against previous theoretical models of PWYW in duopoly competition. Our model yields an FP equilibrium if $\lambda \leq \lambda^*$ and a mixed equilibrium where the first mover chooses FP and the second mover chooses PWYW otherwise. This is similar to the results in Chao et al. (2017), where consumers are assumed to be guilt-averse and sellers compete

[16] This relationship is reversed if $\theta > (k-1)^2/12k$ and $k < 13.93$. In this region it is more difficult for PWYW to survive competition, as the lower proportion of fair buyers contributes even lower profit due to the presence of the FP competitor. However, as can also be seen in Figure 4, the existence of this case also requires $\lambda \approx 1$ which is less common.

in a simultaneous setting. However our equilibrium results differ from those in Chen et al.'s (2017) model with product differentiation where setting transport cost equal to zero yields the PWYW equilibrium. The difference stems from their assumption of no free-riders, which is relaxed here, and the way that fair consumers choose their seller when both PWYW and FP are available. In Chen et al. (2017), surplus is defined according to the 'next best option': given the FP seller's price p, the fair consumer's PWYW payment is $c+\lambda(p-c)$, which is always less than p if $\lambda < 1$. This means that all consumers will buy from the PWYW seller, and consequently there is no equilibrium with PWYW competing against FP. This contrasts with our definition of surplus-sharing and our assumption of heterogeneous consumption utility, giving rise to fair consumers who do not buy at all, those who buy from the PWYW seller, and those who go to the FP seller to pay a fixed price, thus yielding the coexistence equilibrium.

In summary, no equilibrium exists where all sellers choose PWYW. Instead, PWYW is used as a strategy by later entrants to avoid Bertrand competition. Consequently, this makes PWYW a simple and cheap alternative to other costly marketing strategies such as differentiating products or introducing switching costs. For the first mover, the 'threat' of a competitor choosing PWYW is likewise beneficial in preventing the Bertrand equilibrium of zero profit.

4 Product Differentiation

Almost all products in the market are differentiated in some dimension and goods that are completely homogeneous are extremely rare. However, even taking this into consideration, many PWYW examples seem to be concentrated in markets where the level of differentiation is intermediate, such as food, music and softwares (see the list of PWYW examples in Table 1 in the

Appendix). While adopting PWYW seems to be more profitable for relatively imperfect substitutes than close-to-homogeneous goods, the adoption of PWYW does not quite reach the other extreme: products which are highly differentiated through exclusive brand names are still sold predominantly at fixed prices. In this section, we study a model of PWYW competition with product differentiation which can explain this finding.

Assume three sellers A, B, and C are evenly spaced on a Salop circular city with circumference 1.[17] The sellers are thus located at $x = 0, 1/3, 2/3$ respectively. Consumers are uniformly distributed on the circumference. We continue to assume unit demand. For simplicity, and as commonly assumed in models of horizontal product differentiation including Hotelling (1929), consumption yields constant surplus $v = E(u) = kc/2$ as firms are assumed to be risk-neutral. This is a considerable simplification from the homogeneous product model with heterogeneous consumption utility studied in previous sections, however it facilitates the analysis to generate tractable results under product differentiation.

Consumers pay a transportation cost $t > 0$, such that a consumer located at $x \in [0, 1/3]$ incurs disutility tx if he purchases from Seller A located at 0, and $t(1/3 - x)$ from Seller B located at 1/3. The transport cost is the only factor differentiating the goods sold at the three different sellers, which means that each consumer will only consider buying from the two sellers closest to him. The consumer above will thus never buy from Seller C located at 2/3. All three sellers have the same profit and cost structures as before, with constant marginal cost c. We assume also that v, and hence k, is sufficiently large such that the market is fully covered: all consumers will purchase a unit in equilibrium.

[17] We assume three sellers to obtain an insightful yet tractable analysis. Assuming two sellers with both Salop's circular city and Hotelling's linear city yields the same qualitative results.

Sellers choose their pricing scheme sequentially and prices are set at the end (simultaneously, if all sellers choose FP). With all sellers choosing FP, the equilibrium outcome is simple to calculate: all sellers set $p_A = p_B = p_C = c + t/3$ and get a third of the market with profits $\pi_A = \pi_B = \pi_C = t/3$.[18] This result is intuitive: the higher the degree of differentiation, the higher the sellers are able to charge in mark-up over the cost of the good, while in the limit as $t \to 0$ we get the Bertrand equilibrium again.

Suppose now that all sellers adopt PWYW. When the consumer buys from a PWYW seller, his PWYW payment continues to be defined by the surplus-sharing mechanism as per Section 2: $p_i = c + \lambda(v - c)$. Note that we have assumed the surplus-sharing component is derived from the consumer's total surplus from the good, not counting any reduction from transport cost. Transport cost moderates product differentiation insofar as it determines the consumer's choice of sellers, without creating heterogeneity in PWYW payment. We argue that this is a realistic representation of a fair consumer who has to consume a good slightly different from his first choice, but upon arriving at the seller, in keeping with social norms pays according to the good's pure consumption utility, without penalising the seller for the extent of product differentiation.[19]

For clarity in the analysis, assume no free-riders. The utility of a consumer located at $x \in$

[18] A consumer at $x \in [0, 1/3]$ will be indifferent to purchasing at either Seller A or Seller B if his utility from purchasing at Seller A, $U = v - p_A - tx$, equals the utility from purchasing at Seller B: $U = v - p_B - t(1/3 - x)$. His location is thus $x = (p_B - p_A + t/3)/(2t)$. Hence, from maximising $\pi_A = (p_A - c)x$ with respect to p_A and by symmetry, we get $p_A = p_B = p_C = c + t/3$ and $x = 1/6$. That is, the indifferent consumer for each pair of sellers is located exactly in the middle of each of the three arcs.

[19] While this is mainly done for tractability, another plausible interpretation of the model is a setting whereby a product, while sufficiently differentiated, has a commonly understood fair value. For example, a Radiohead album is a differentiated product with a relatively well-known fair price: almost all consumers have arguably experienced buying a music album. Combined with adherence to social norms, consumers therefore have a relatively narrow estimate of what they should pay for it in a PWYW setting. While in reality those who prefer not to pay this fair value can simply abstain from buying, we have assumed in the model that the market is covered. Consequently the transport cost t merely determines the consumers' choice of sellers, and once this choice is made, p_i is paid. Another realistic interpretation is that given the two sellers' products are not perfect substitutes, a consumer may want to help keep his preferred seller in the market by paying the fair price p_i rather than discounting it by his transport cost.

$[0,1/3]$ who buys from Seller A is $U = v - tx - (c + \lambda(v-c))$, while from Seller B his utility is $U = v - t(1/3 - x) - (c + \lambda(v-c))$. As the payment for the good is identical at both sellers, the indifferent consumer is located exactly in the middle of the arc at $x = 1/6$. Each of sellers A and B thus serves half the consumers in the arc $[0,1/3]$. Applying this logic to the remaining two arcs, all three sellers share the market equally and $\pi_A = \pi_B = \pi_C = \lambda(v-c)/3$. This is independent of the transport cost: when the consumer pays what he wants, his payment is deterministic. Consequently each seller always gets a third of the PWYW market profit regardless of the degree of product differentiation.

Suppose now that there are two PWYW sellers and 1 FP seller in the market: Seller A adopts FP, Seller B adopts PWYW and Seller C adopts PWYW. Consider again the arc $[0,1/3]$. The indifferent consumer is now located at $x = (t/3 - p_A + c + \lambda(v-c))/(2t)$. Since Seller A faces the same competition against a PWYW seller in the arc $[2/3,0]$, his total demand is thus equal to $2x$. It is straightforward to derive the profit maximising price of Seller A:

$$p_A = c + \frac{t/3 + \lambda(v-c)}{2}$$

which implies

$$x = \frac{1}{12} + \frac{\lambda(v-c)}{4t}$$

and profits are

$$\pi_A = \frac{1}{t}\left(\frac{t}{6} + \frac{\lambda(v-c)}{2}\right)^2.$$

For Seller B, his total demand is $1/3 - x$ in the arc $[0,1/3]$ and 1/6 in the arc $[1/3,2/3]$ since he

shares the demand equally with the PWYW competitor Seller C at 2/3. PWYW profits are thus

$$\pi_B = \pi_C = \frac{5\lambda(v-c)}{12} - \frac{\lambda^2(v-c)^2}{4t}.$$

Suppose now there are two FP sellers and 1 PWYW seller in the market: Seller A again adopts FP, Seller B adopts PWYW and Seller C adopts FP. The total demand faced by Seller A is thus $x = (t/3 - p_A + c + \lambda(v-c))/(2t)$ in the arc $[0, 1/3]$ and 1/6 in the arc $[2/3, 0]$. The profit maximising price for both Seller A and Seller B is thus

$$p_A = p_B = \frac{2t}{9} + c + \frac{\lambda(v-c)}{3}.$$

This implies that

$$x = \frac{1}{18} + \frac{\lambda(v-c)}{3t}.$$

FP profits are thus

$$\pi_A = \pi_C = \frac{1}{t}\left(\frac{2t}{9} + \frac{\lambda(v-c)}{3}\right)^2$$

while PWYW profits are

$$\pi_B = \frac{5\lambda(v-c)}{9} - \frac{2\lambda^2(v-c)^2}{3t}.$$

The equilibrium results are stated in the following proposition:

Proposition 3. *When three competing sellers of differentiated products choose pricing schemes sequentially and then enter into a simultaneous price competition, the subgame perfect equilibrium is either coexistence or FP. Specifically, each seller's strategy in order of entry is:*

i if $\lambda < t/(3(v-c))$, *(FP,FP,FP),*

ii *if* $\lambda = t/(3(v-c))$, *all sellers randomise and thus all eight combinations of PWYW and FP by the three sellers are equilibrium outcomes,*

iii *if* $t/(3(v-c)) < \lambda < 16t/(39(v-c))$, *(FP,PWYW,PWYW),*

iv *if* $16t/(39(v-c)) \leq \lambda < t/(2(v-c))$, *(FP,FP,PWYW),*

v *if* $\lambda = t/(2(v-c))$, *the first two entrants choose FP while the third entrant randomises between PWYW and FP,*

vi *if* $\lambda > t/(2(v-c))$, *(FP,FP,FP).*

In short, the first mover always chooses FP. If the second mover chooses PWYW, the third mover always follows with PWYW. In no equilibrium do all sellers choose PWYW except when $\lambda = t/(3(v-c))$ where all profits are the same regardless of pricing scheme and all sellers randomise.

All pure strategy equilibria are unique. When the surplus-sharing norm is low, PWYW is attractive to consumers but yields low profit to the seller and hence FP is preferred by all sellers. As λ increases, PWYW becomes more attractive to sellers facing FP competitor(s), while demand is still sufficiently high. In the region $t/(3(v-c)) < \lambda < 16t/(39(v-c))$, two PWYW sellers are supported in the market. As λ continues to increase, PWYW profitability continues to increase but demand decreases at the same time as the PWYW good becomes more "expensive" due to the high surplus-sharing norm. In $16t/(39(v-c)) \leq \lambda < t/(2(v-c))$ only one PWYW seller is supported in the market. When $\lambda > t/(2(v-c))$ demand is insufficient for even one PWYW seller and hence all three sellers choose FP.

As seen above, variations in k (and hence v), c and t affect the range of values for which PWYW

obtains. As consumer valuation k increases, v also increases and all of the threshold values for λ in Proposition 3 decrease. On the one hand, PWYW becomes more attainable for lower values of surplus-sharing, but when surplus-sharing is high PWYW is less appealing for consumers as the amount paid to the PWYW seller increases. The effect of marginal cost c is similar: all thresholds of λ are decreasing in c. For low values of λ, as c increases, $v = kc/2$ also increases and the higher valuation for the good increases PWYW profit. However, when λ is high, the higher PWYW payment results in lower demand making fixed-pricing more profitable.

The effect of varying t, the degree of product differentiation, is the precise opposite: as t increases, all thresholds for λ in Proposition 3 also increase. This means that an equilibrium of three FP sellers can be turned into a mixed equilibrium with PWYW when λ is sufficiently high, while a mixed equilibrium may no longer obtain when λ is low.

Consider the limiting case with homogeneous products: as $t \to 0$, an FP seller facing two PWYW competitors can simply set $p = c + \lambda(v-c) - \varepsilon$ and capture all adjacent consumers and hence 2/3 of the market. Therefore, an increase in t serves to guarantee that some consumers will go to the PWYW seller as the location of the indifferent consumer x moves closer to the FP seller. With two FP sellers and one PWYW seller, an increase in t also drives demand to the PWYW seller from the two FP sellers who no longer set $p = c$. In both cases, an increase in t serves to increase demand for the PWYW seller when there are FP seller(s) in the market. However, this increase in demand will only convince a FP seller to switch to PWYW when the level of surplus-sharing norm is above the thresholds given in Proposition 3 vi (where FP was chosen due to low demand), that is, in the range

$$\frac{t_0}{2(v-c)} < \lambda < \frac{t_1}{2(v-c)}.$$

When the level of surplus-sharing is low such that PWYW results in high demand but is not sufficiently profitable, yet another increase in demand from product differentiation will not induce the FP seller to switch to PWYW as the amount paid by each consumer is still too low to overtake the profit increase as a FP seller. In fact, in the range

$$\frac{t_0}{3(v-c)} < \lambda < \frac{t_1}{3(v-c)}$$

an FP equilibrium will obtain in place of the (FP,PWYW,PWYW) equilibrium.

It is worth discussing the key differences between this model and that in Chen et al. (2017). Besides the extension to a Salop model with three competitors, we have assumed here that the transport cost is not included in the surplus-sharing calculation: once the consumer 'arrives' at the PWYW seller, he considers his surplus to be the pure consumption utility less the cost of the good. In Chen et al. (2017), the consumer utility from purchasing at the PWYW seller is defined to be $U = v - tx - (c + \lambda(v - tx - c))$. When the consumer has the choice of PWYW and FP sellers, his surplus is defined to be $p_t - c$, in line with the 'next best option' where p_t is the (fixed) price at which he is indifferent between buying from either seller. As a result, the location of the indifferent consumer and hence demand is independent of λ, the surplus-sharing parameter. The FP profit is lower compared to that derived here, giving rise to a PWYW equilibrium whenever λ exceeds a threshold value which is increasing in transport cost, or a FP equilibrium otherwise. While the FP equilibrium is consistent with the results obtained here, as seen in the empirical examples it is rare to see a market dominated by PWYW. Moreover, we find that the relationship between surplus-sharing, transport cost and the likelihood of PWYW in equilibrium is also not as straightforward as Chen et al. (2017) suggest: while a higher level of surplus-sharing makes PWYW more profitable,

given our assumptions above this is only true up to a point, beyond which higher surplus-sharing will drive away customers to the fixed-price competitor. Similarly, given a sufficiently high surplus-sharing norm, as the level of product differentiation increases, PWYW is more profitable up to a point, beyond which FP would be preferred.

5 Discussion and Empirical Observations

This paper studies the profitability of PWYW relative to fixed-pricing both as a monopolist and in competition, which has so far received little attention in the literature. In this section, the results from the analysis will be discussed in relation to the empirical examples of PWYW which are compiled in Table 1 in the Appendix.[20] These examples come from previous academic literature and following Google news alerts for "pay-what-you-want" from March 2014 to April 2015. While the list is not exhaustive and is skewed towards instances which generate a lot of publicity, it does offer some limited insight into the types of businesses that use PWYW. This also means that the proportion of sellers that are reported to have used PWYW for a limited time or have since discontinued PWYW at 32% is possibly understated, as a new seller opening a PWYW store would arguably generate more publicity. We therefore focus on the 77 current PWYW sellers in the discussion that follows.

One obvious caveat is that the PWYW examples used in this discussion do not necessarily conform to the representative seller assumed in our analysis. We have made many simplifying assumptions to generate a tractable model. For example, we assume that any PWYW seller only sells one type of good, has zero fixed cost and positive marginal cost. In reality, many PWYW

[20]Refer to Appendix A for an explanation of how each example is classified according to its market and product characteristics.

sellers have used PWYW only for some good as a tool to up- or cross-sell another fixed-priced good, or only used PWYW temporarily. There may be a fixed cost of production while marginal cost may indeed be zero.[21] We have also assumed that once a pricing scheme is chosen, it is fixed (though prices are allowed to adjust in case of fixed-pricing), while in reality some firms have started off with fixed-pricing and switched to PWYW and vice versa despite the barrier of marketing and menu costs. Clearly, some assumptions are a closer match to reality than others. Nevertheless, to the extent that our assumptions hold in reality, our model could be regarded as a starting point for explaining real life behaviour. We would thus like to emphasise that the use of empirical examples in this discussion section is merely for descriptive and illustrative purposes, that is, we do not conduct any statistical test to derive our conclusions.

The majority of PWYW businesses can be found in the retail sector (SIC Division G): in the food industry or selling digital products online. A significant number of sellers are in the service industry (Division I), including hotels and tourist attractions. The vast majority of sellers operate in a competitive environment. As shown in Figure 4, even for low levels of free-riding, a PWYW monopolist requires a higher level of surplus-sharing norm in the market relative to competition. Not surprisingly, empirical examples of PWYW monopolists are limited to the few football clubs or tourist attractions in our sample.

As a way to increase the level of surplus-sharing in the market, many successful PWYW ventures have appealed to consumers' generosity, for example by explicitly stating that proceeds will be donated to charity (such as done by 14% of sellers). The success of Humble Bundle, the online game company which has consistently used PWYW, has been attributed precisely to its charity

[21] These deviations can be addressed by replacing the upper bound of the consumption utility distribution with $kc+\varepsilon$, $\varepsilon > 0$ as described in Footnote 3.

component.[22] In the behavioural literature, a charity component has the effect of increasing the perceived value of the good (Gneezy et al., 2012; Kahsay and Samahita, 2015) while at the same time increasing the image-sensitivity of the buyer (Gravert, 2017). One would then expect less free-riding and underpayment to occur as they result in self-image loss in the consumer. Consequently, the threshold level for surplus-sharing decreases. This is captured in our model more simply by assuming that the charity component attracts a higher level of surplus-sharing by consumers. When the norm of surplus-sharing is high enough, in the competitive equilibrium the market can support one or more PWYW sellers alongside a fixed-price seller. In particular, the first mover can avoid Bertrand competition by choosing a fixed price and ensuring that subsequent movers find PWYW more profitable. This is seen in the trend of PWYW sellers' entry into markets dominated by fixed-pricing, where they choose PWYW to avoid fierce competition and have instead appealed to the generosity of consumers. Correspondingly, a proportion of consumers do pay positive and high prices despite not having to do so (Kim et al., 2009; Riener and Traxler, 2012; Gneezy et al., 2012). For example, the company Activehours lets customers access their pay before payday, essentially borrowing money with PWYW interest. It has recently entered a homogeneous, fixed-price market, and has instead chosen to let customers pay what they want in an effort to gain their trust and appeal to their generosity.[23] Using PWYW is desirable both as a point of difference and to avoid the tough Bertrand-like competition in the market for lending. Furthermore, we do not see a market consisting of all PWYW sellers competing against each other, consistent with the equilibrium predictions of Propositions 2 and 3. This signifies the strategic role played by firms' choice regarding prices.

Our model also predicts in Proposition 3 the feasibility of PWYW given a sufficiently high level

[22] See http://www.techdirt.com/blog/entrepreneurs/articles/20100716/17423610253.shtml, accessed 3-Dec-2017.

[23] See http://www.mobilebeyond.net/activehours-ceo-says-employees-owed-2t/, accessed 3-Dec-2017.

of product differentiation. This is indeed what we see in our examples which confirms that the vast majority of PWYW sellers differentiate themselves either through geography or product characteristics, and very few are classified as undifferentiated.[24] Many PWYW sellers in different industries operating from a physical store, thus allowing for geographical product differentiation. Moreover, the lower social distance generated by the personal nature of the transaction can serve to encourage a higher surplus-sharing norm, thus benefiting PWYW relative to an anonymous online transaction (Hoffman et al., 1996; Regner and Riener, 2017).[25] As predicted by Proposition 3, when combined with high surplus-sharing, product differentiation makes PWYW increasingly profitable as the upper threshold value of surplus-sharing λ increases. However, there also exist a significant number of PWYW sellers operating online, where the lack of geographical differentiation is compensated by the low or zero marginal cost of digital products.[26] Proposition 3 predicts that as cost decreases when the surplus-sharing norm is high, PWYW becomes "cheaper" for consumers and is thus more likely to obtain in equilibrium.[27] Not surprisingly, PWYW sellers of digital products, such as Humble Bundle and Storybundle, have operated successfully online. On the other hand,

[24] See Appendix A for our classification where we propose a qualitative ranking of the level of differentiation. 'Differentiated' products are either geographically differentiated by having a physical location or characteristically differentiated by having no close substitutes. 'Undifferentiated' products include ridesharing, loan interest, money transfer service and a tax software, none of which has a physical location and all of which have relatively close substitutes compared to, for example, music from a particular artist. While this is a coarse way to capture product differentiation, no established measure currently exists.

[25] However, Gneezy et al. (2012) find that anonymity increases average payments, appealing to the crowding-out and self-image explanations. When a transaction is monitored by the seller, an intrinsically motivated buyer may feel that his payment is made out of obligation, not fairness, crowding out its self-signalling value. Our model accommodates both possibilities using the surplus-sharing parameter, which can increase or decrease with anonymity depending on the presence or absence of intrinsic motivation in the buyer.

[26] Given our classification in Appendix A, the partition of sellers into those with and without geographical product differentiation exactly corresponds to the partition of sellers into those with and without marginal cost, with the exception of theatres, movie shows, art galleries, tourist attractions and football games. These 21 sellers offer products that are geographically differentiated but incur no marginal cost.

[27] For homogeneous goods analysed in Section 3, a high value of marginal cost c correspondingly makes a high value of k unreasonable, due to consumers' budget constraints. As the threshold value of surplus-sharing λ, which must be exceeded for PWYW to be chosen, is decreasing in k, a low marginal cost also indirectly makes PWYW more attainable.

higher marginal cost items are less able to sustain the PWYW pricing model. This is seen in the examples of several hotels, such as Ibis, who have adopted PWYW for a period of time and then gone back to fixed-pricing. A low marginal cost is a standard requirement for a seller to be able to sustain PWYW (Chen et al., 2017; Krämer et al., 2017; Chao et al., 2015).

When it comes to differentiation in product characteristics, it is clear that the majority of sellers in the retail and service industries do differentiate their products. The combination of product differentiation and high surplus-sharing is often achieved through various marketing strategies to promote the success of PWYW, for example by artist Amanda Palmer. She offers a differentiated product and directly appealed to fans to pay more, hence endogenously increasing the level of surplus-sharing.[28] Additionally, cafes or restaurants such as Seva Cafe attract generous consumers by advertising their charity connections. Given a sufficiently high surplus-sharing norm, PWYW is chosen by later mover(s) to avoid Bertrand competition with the FP incumbent(s) (Proposition 3). An example of such entry behaviour is Kish restaurant (recounted in Kim et al. (2010)). As a new entrant in Frankfurt's restaurant market, the owner decided to adopt PWYW on their lunch menu as it was found to be more profitable than fixed-pricing. This is not an isolated incident, as can be seen in the entry of many PWYW sellers into predominantly fixed-price markets in Table 1.

In most other markets where sellers face consumers with low generosity or when there is a high number of free-riders in the economy, it is not possible to sustain even one PWYW firm in equilibrium. This is what we see in instances such as the restaurant Five Loaves and Two Fish in China which discontinued PWYW after only a few months, having suffered big losses with 20% of customers eating for free.[29] Consistent with our assumption of an exogenous surplus-sharing norm,

[28] See the transcript of Amanda Palmer's TED talk "The Art of Asking" (2013): `http://www.ted.com/talks/amanda_palmer_the_art_of_asking/transcript`, accessed 3-Dec-2017.

[29] See `http://www.bbc.com/capital/story/20140120-a-recipe-for-disaster`, accessed 3-Dec-2017.

the trend of successes and failures above has been attributed to cultural factors where PWYW does well in countries with high taxes and strong social welfare systems.[30] Using trust as a proxy, we find a 44% correlation between a country's measure of trust and the presence of PWYW there ($p < 0.01$).[31] PWYW garners a lot of enthusiasm and publicity in the beginning, but in reality may be tough to sustain in the long term if customers have low levels of surplus-sharing. While data on PWYW duration is not freely available, we observe that many other businesses have only chosen to experiment with PWYW through temporary promotions without committing to permanent use. This is consistent with previous studies of PWYW which find that average prices decline over time (Riener and Traxler, 2012; Schons et al., 2014).

Finally, we also note the low possibility of resale of PWYW goods. As shown in Table 1 and noted in Greiff and Egbert (2016), a large percentage of PWYW sellers sell experience goods with negligible marginal cost, such as theatre shows and tourist attractions, which have a low resale possibility. Goods with higher marginal costs, such as food and drinks, are often served directly to consumers which prevents a competitor from buying a large volume and reselling it at profit. Goods that technically allow resale are limited to digital products such as music and software, however in this case resale may not be legal.

6 Conclusion

This paper aims to explain the mixed popularity of PWYW pricing schemes in different sectors. Many PWYW examples can be found in monopolistically competitive markets with some level of

[30] Ibid.

[31] Trust measure data comes from the World Values Survey Wave 6 (2010-2014) and the European Values Study Wave 4 (2008) question: "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" A country's trust level is calculated using the proportion of responders answering "Most people can be trusted."

product differentiation, but few PWYW examples exist in perfect competition or as monopolists. While previous PWYW literature has studied consumers' social preferences and their behaviour when facing a PWYW seller, we focus on the seller's choice between fixed-pricing and PWYW pricing schemes while still retaining the social preference of consumers in a surplus-sharing mechanism. Sellers' strategies are studied in various types of markets where entry occurs sequentially, to capture the commonly later entry of a PWYW seller into a fixed-price dominated market. We show that the profitability of PWYW, and hence its popularity, depends not only on the preferences of consumers but also on the market structure, product characteristics and sellers' strategies. There is no equilibrium in which PWYW dominates the market. Given a sufficiently high level of surplus-sharing and product differentiation, PWYW can be chosen by later entrants as a simple strategy to avoid Bertrand competition. While the problem of adverse selection persists, in which PWYW attracts the free-riders and fair consumers with low valuation, in some cases this is still more profitable than entering into a price competition with the incumbent. If the level of surplus-sharing is too low, fixed-pricing dominates. These results are consistent with well-known empirical examples of PWYW.

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Appendices

A PWYW Examples

In Table 1 a summary of anecdotal evidence of PWYW is provided, based on media coverage (current as at 15 April 2015).[32] These are the most popular sellers found by following news alerts for "pay-what-you-want" since March 2014 and using examples commonly quoted in previous academic literature.

Each business has been listed by company name, per country (in case of multiple locations). Each listing is categorised according to the *Standard Industry Classification (SIC) Division*, which broadly describes its industry, and *Major Group*, which further categorises the seller according to the type of product sold.[33] Under *Market Structure*, a seller is classified as operating in Competition, except for football clubs, museums and other tourist attractions. These have been classified as Monopolists, where we have defined the market level to be the seller's city of operation. A business has *Geographical Product Differentiation* if it has a physical location, in contrast to online sellers. *Differentiation in Product Characteristic* refers to whether the product sold has a close substitute. While this is a coarse way to capture product differentiation, no established measure currently exists. Products that are classified as undifferentiated and have close substitutes include ridesharing, loan interest, money transfer service and a tax software. A product is classified as having no *Marginal Cost* if it is sold online or falls under one of the following categories: theatres, movie shows, art galleries, tourist attractions, and football games. A product is *Resalable* if it is

[32] The owner of One World Cafe, one of the most popularly cited examples of PWYW, has now turned to consulting other business owners and encouraging the use of PWYW in a large number of other restaurants. These are excluded from the table, since they focus specifically on religious or community aspects. The full list can be found on `https://www.oneworldeverybodyeats.org/find-a-cafe/`, accessed 3-Dec-2017.

[33] See `https://www.osha.gov/pls/imis/sic_manual.html`, accessed 3-Dec-2017.

not an experience good, which also excludes food and drinks, ridesharing, hotel stays, and tourist attractions. This leaves all online commodities such as softwares, music and games in the (perhaps not legally) resalable category.

Name	Product	City	Country	SIC Division[a]	SIC Major Group[a]	Market Structure	Geo PD[b]	PD[c]	MC[d]	Resale[e]
Current										
8k	Marketing	online	all	I	73	Competition		x	x	
Activehours	Loan Interest	online	US	H	61	Competition			x	x
Amanda Palmer	Music	online	all	G	59	Competition		x		x
American Museum of Natural History	Tourism	New York	US	I	84	Monopoly	x	x		
Annalakshmi	Food/Drink	Singapore	Singapore	G	58	Competition	x	x	x	
Antholojam	Games	online	all	G	59	Competition		x		x
Asher Fulero	Music	online	all	G	59	Competition		x		x
Aspiration[f]	Investment Management	online	US	H	62	Competition		x	x	

[a]Standard Industry Classification.
[b]Geographical product differentiation.
[c]Differentiation in product characteristics.
[d]Marginal cost.
[e]Resale possibility.
[f]Explicit charity component.

Available Light Theater	Theatre	Columbus	US	I	79	Competition	x	x		
Bond360	Movies	online	all	G	59	Competition		x		x
Cafe Liebling	Food/Drink	Munich	Germany	G	58	Competition	x	x	x	
Coeurage	Theatre	Los Angeles	US	I	79	Competition	x	x		
Dallas Theater	Theatre	Dallas	US	I	79	Competition	x	x		
Das Park Hotel	Hotel	Essen	Germany	I	70	Competition	x	x	x	
Das Park Hotel	Hotel	Linz	Austria	I	70	Competition	x	x	x	
David Cross	Movies	multiple	Canada	I	78	Competition	x	x		
David Cross	Movies	multiple	US	I	78	Competition	x	x		
De Culinaire Werkplaats	Food/Drink	Amsterdam	The Netherlands	G	58	Competition	x	x	x	
De Peper	Food/Drink	Amsterdam	The Netherlands	G	58	Competition	x	x	x	
Der Gewurz Laden	Food/Drink	Munich	Germany	G	58	Competition	x	x	x	
Fika London[f]	Food/Drink	London	UK	G	58	Competition	x	x	x	
Foco Cafe	Food/Drink	Fort Collins	US	G	58	Competition	x	x	x	
Giffing Tool	Software	online	all	G	59	Competition		x		x
Godel's Knot	Music	online	all	G	59	Competition		x		x
Humble Bundle[f]	Games	online	all	G	59	Competition		x		x

Infinite Skills[f]	Computer Training	online	all	I	82	Competition		x		x
Inverness Football Club	Sports	Inverness	UK	I	79	Monopoly	x	x		
Jeff Bridges[f]	Music	online	all	G	59	Competition		x		x
Jeff Rosenstock	Music	online	all	G	59	Competition		x		x
Kish (lunch)	Food/Drink	Frankfurt	Germany	G	58	Competition	x	x	x	
Lentil As Anything	Food/Drink	multiple	Australia	G	58	Competition	x	x	x	
Lost Constellation	Games	online	all	G	59	Competition		x		x
Lost Type	Software	online	all	G	59	Competition		x		x
Morningside Cafe	Food/Drink	London	UK	G	58	Competition	x	x	x	
Mosaic Coffee House	Food/Drink	Seattle	US	G	58	Competition	x	x	x	
Moshpit Tragedy Records	Music	online	all	G	59	Competition		x		x
Motto	Food/Drink	Beirut	Lebanon	G	58	Competition	x	x	x	
Mustard Seed Cafe	Food/Drink	El Paso	US	G	58	Competition	x	x	x	
National Aquarium	Tourism	Baltimore	US	I	84	Monopoly	x	x		
Noah Eli Gordon	Books	online	all	G	59	Competition		x		x

Noisetrade	Music and Books	online	all	G	59	Competition		x		x
Okay?	Games	online	all	G	59	Competition		x		x
One Working Musician	Music	online	all	G	59	Competition		x		x
Openbooks	Books	online	all	G	59	Competition		x		x
Panelsyndicate	Comics	online	all	G	59	Competition		x		x
Panera Cares	Food/Drink	multiple	US	G	58	Competition	x	x	x	
Patriot	Music	online	all	G	59	Competition		x		x
Perks of Life	Food/Drink	Eagle	US	G	58	Competition	x	x	x	
Radical.fm[f]	Music	online	all	G	59	Competition		x		x
SAME Cafe	Food/Drink	Denver	US	G	58	Competition	x	x	x	
Seva Cafe[f]	Food/Drink	Ahmedabad	India	G	58	Competition	x	x	x	
Shear Dimensions	Hairdresser	Olathe	US	I	72	Competition	x	x	x	
Simpletax	Tax Software	online	Canada	I	72	Competition				x
Soul Kitchen	Food/Drink	Red Bank	US	G	58	Competition	x	x	x	
Spor	Music	online	all	G	59	Competition		x		x
St James Town Cafe	Food/Drink	Toronto	Canada	G	58	Competition	x	x	x	
Stan's Studio	Food/Drink	Glasgow	UK	G	58	Competition	x	x	x	

Storybundle[f]	Books	online	all	G	59	Competition		x		x
The Good Pack[f]	Music	online	all	G	59	Competition		x		x
The Metropolitan Museum of Art	Tourism	New York	US	I	84	Monopoly	x	x		
The Museum of the Coastal Bend	Tourism	Victoria	US	I	84	Monopoly	x	x		
The Real Junk Food Project	Food/Drink	multiple	UK	G	58	Competition	x	x	x	
The Saltaire Canteen[f]	Food/Drink	Bradford	UK	G	58	Competition	x	x	x	
Third Eye Games	Games	online	all	G	59	Competition		x		x
Thom Yorke	Music	online	all	G	59	Competition		x		x
Topshelf Records	Music	online	all	G	59	Competition		x		x
Vortex Music Magazine[f]	Magazines	online	all	G	59	Competition		x		x
Wiener Deewan	Food/Drink	Vienna	Austria	G	58	Competition	x	x	x	
Wundercar	Ridesharing	multiple	Germany	E	47	Competition	x		x	
Wundercar	Ridesharing	Dublin	Ireland	E	47	Competition	x		x	
Wundercar	Ridesharing	Budapest	Hungary	E	47	Competition	x		x	

Wundercar	Ridesharing	Warsaw	Poland	E	47	Competition	x		x	
Wundercar	Ridesharing	Prague	Czech Republic	E	47	Competition	x		x	
Wundercar	Ridesharing	Copenhagen	Denmark	E	47	Competition	x		x	
Wundercar	Ridesharing	Helsinki	Finland	E	47	Competition	x		x	
Wundercar	Ridesharing	Istanbul	Turkey	E	47	Competition	x		x	
Xendpay	Money Transfer	online	all	H	60	Competition				
Discontinued										
Alfreton Town	Sports	Alfreton	UK	I	79	Monopoly	x	x		
Barnstaple Town	Sports	Barnstaple	UK	I	79	Monopoly	x	x		
Bath City[f]	Sports	Bath	UK	I	79	Monopoly	x	x		
Bitcoin Magazine	Magazines	online	all	G	59	Competition		x		x
Cards Against Humanity	Games	online	all	G	59	Competition		x		x
Cringletie House	Hotel	Edinburgh	UK	I	70	Competition	x	x	x	
Five Loaves and Two Fish	Food/Drink	Fuzhou	China	G	58	Competition	x	x	x	

Frome Town Football Club	Sports	Frome	UK	I	79	Monopoly	x	x		
Grant Kirkhope	Music	online	all	G	59	Competition		x		x
Ibis	Hotel	Singapore	Singapore	I	70	Competition	x	x	x	
Ibis	Hotel	New Delhi	India	I	70	Competition	x	x	x	
Jane Siberry	Music	online	all	G	59	Competition		x		x
Lincoln City	Sports	Lincoln	UK	I	79	Monopoly	x	x		
Lyft	Ridesharing	Chicago	US	E	47	Competition	x		x	
MacGameStore[f]	Games	online	all	G	59	Competition		x		x
Magnatune	Music	online	all	G	59	Competition		x		x
McPixel	Games	online	all	G	59	Competition		x		x
Munster Zoo	Tourism	Munster	Germany	I	84	Monopoly	x	x		
Pay As You Please	Food/Drink	Killarney	Ireland	G	58	Competition	x	x	x	
Payez Ce Que Vous Voulez Hotels	Hotel	Paris	France	I	70	Competition	x	x	x	
Propellerhead	Software	online	all	G	59	Competition		x		x
Proun	Games	online	all	G	59	Competition		x		x
Randall Theatre	Theatre	Medford	US	I	79	Competition	x	x		

Rushden & Diamonds	Sports	Wellingborough	UK	I	79	Monopoly	x	x		
Santorini Grill	Food/Drink	New York	US	G	58	Competition	x	x	x	
Serafina	Food/Drink	Dubai	UAE	G	58	Competition	x	x	x	
Sidecar	Ridesharing	multiple	US	E	47	Competition	x		x	
Stephen King	Books	online	all	G	59	Competition		x		x
Steve Hofstetter	Comedy	online	all	G	59	Competition		x		x
Terra Bite Lounge	Food/Drink	Seattle	US	G	58	Competition	x	x	x	
The Theater Project	Theatre	Brunswick	US	I	79	Competition	x	x		
The San Diego Symphony	Orchestra	San Diego	US	I	79	Competition	x	x		
Trent Reznor	Music	online	all	G	59	Competition		x		x
Urban Canine	Pet Grooming	Chicago	US	A	7	Competition	x	x	x	
Vincents Art Workshop[f]	Artwork	Wellington	New Zealand	I	84	Competition	x	x		
World of Goo	Games	online	all	G	59	Competition		x		x

Table 1: PWYW examples.

B Proofs

B.1 Proposition 1

$$\pi_{PWYW} = \frac{(1-\theta)\lambda c(k-1)^2}{2k} - \theta c > \frac{c(k-1)^2}{4k} = \pi_{FP}$$

implies

$$\lambda > \frac{(k-1)^2 + 4\theta k}{2(1-\theta)(k-1)^2} = \hat{\lambda}.$$

For existence of PWYW in equilibrium, it is easy to show that the set $\hat{\lambda} < 1$ is non-empty. It is also straightforward to derive the following:

$$\frac{d\hat{\lambda}}{d\theta} = \frac{(k+1)^2}{2(1-\theta)^2(k-1)^2} > 0 \qquad \frac{d\hat{\lambda}}{dk} = -\frac{2\theta(k+1)}{(1-\theta)(k-1)^3} < 0.$$

B.2 Proposition 2

First note that whenever there are at least two FP sellers already in the market, the next entrant will always choose FP. With at least two FP sellers in the market, price equals marginal cost and fair buyers will always choose FP, resulting in the PWYW seller(s) incurring a loss from catering to the demand of free-riders. Hence for any subsequent entrant it is better to set a fixed price and get zero profit than choose PWYW and get negative profit. The same logic also applies whenever the current entrant anticipates that there would be at least two future FP sellers.

When there is one FP seller already in the market, if the next entrant chooses FP he would get zero profit from the price competition. If he chooses PWYW, his profit depends on λ.

- If $\lambda < \lambda^*$, PWYW profit is always negative whenever there is at least one FP competitor,

regardless of what future entrants choose. Hence, he would rather choose FP himself than end up with a loss.

- If $\lambda > \lambda^*$, future entrants will also choose PWYW (that is, future entrants would avoid creating price competition with the other FP seller) since in a market with only 1 FP seller the PWYW sellers get positive profits:

$$B = \frac{(1-\theta)\lambda c(k-1)^2}{8(n-1)k} - \frac{\theta c}{n-1} > 0.$$

  Hence he would choose PWYW.

- If $\lambda = \lambda^*$, and all subsequent entrants except the very last entrant choose PWYW, the very last entrant will randomise since $B = 0$. The positive probability that the very last entrant chooses FP will however yield negative expected profit for the second last entrant, who would then rather choose FP and be assured of a zero profit. All sellers will thus expect that in total there would be at least two FP sellers, and consequently no seller would risk choosing PWYW and having to serve only free-riders.

In short, when there is one FP seller already in the market, the next entrant will always choose FP except if $\lambda > \lambda^*$ in which case all subsequent sellers will also choose PWYW.

Suppose now there is no FP seller currently in the market. The choice of the next entrant is as follows.

- If $\lambda < \lambda^*$, choosing FP will result in all subsequent sellers choosing FP as per the above, yielding zero profit. If he and all future entrants but the last one choose PWYW, the very last entrant would choose FP since being the only FP seller yields a higher profit than sharing the

monopolist PWYW profit (since $C > A$). The second last mover will thus prefer to choose FP and get zero profit, since $B < 0$. Hence, by backward induction, since each seller anticipates there would be at least two subsequent FP sellers, any other previous seller will choose FP.

- If $\lambda > \lambda^*$, if he chooses FP he would be the only FP seller in the market since all subsequent entrants would prefer to earn positive PWYW profit ($B > 0$) than compete in price and earn zero profit. His own profit will thus be C, which is greater than any profit he could get as a PWYW seller. He will thus take the chance to be the only FP seller.

- If $\lambda = \lambda^*$, and all subsequent entrants but the very last one choose PWYW, the very last entrant will choose FP and be the only FP seller in the market earning C, while all previous PWYW entrants would earn $B = 0$. The second last entrant would thus rather choose FP, let the last entrant randomise, and earn an expected profit of $C/2$. For the third last entrant, choosing PWYW earns him 0 at most. If he chooses FP and is the only FP seller in the market thus far, the next entrant will choose FP by the logic above while the last entrant will randomise. Thus, no matter the choice of the current seller, there will always be at least one future entrant choosing FP in addition to the probability 0.5 that the very last mover chooses FP. This means that the current seller will also prefer FP than risk negative expected profit from having to serve only free-riders.

In short, when there is no FP seller currently in the market, the next entrant will always choose FP.

It is easy to see that the arguments above hold for all $n \geq 2$. Thus, the first mover will always choose FP. If $\lambda > \lambda^*$, the second mover will choose PWYW, which will be imitated by all subsequent movers. If $\lambda \leq \lambda^*$, the second and all subsequent movers will also choose FP. These results are summarised in Proposition 2.

For the existence of PWYW in equilibrium, it is easy to show that the set $\lambda^* < 1$ is non-empty. It is also straightforward to derive the following:

$$\frac{d\lambda^*}{d\theta} = \frac{8k}{(1-\theta)^2(k-1)^2} > 0 \qquad \frac{d\lambda^*}{dk} = -\frac{8\theta(k^2+k-1)}{(1-\theta)(k-1)^4} < 0.$$

B.3 Proposition 3

The game tree in Figure 5 captures the profit structure of the competition between there sellers with product differentiation. Define the following:

$$A = \frac{5\lambda(v-c)}{12} - \frac{\lambda^2(v-c)^2}{4t}$$

$$B = \frac{1}{t}\left(\frac{t}{6} + \frac{\lambda(v-c)}{2}\right)^2$$

$$C = \frac{5\lambda(v-c)}{9} - \frac{2\lambda^2(v-c)^2}{3t}$$

$$D = \frac{1}{t}\left(\frac{2t}{9} + \frac{\lambda(v-c)}{3}\right)^2$$

First note that at C1

$$\frac{\lambda(v-c)}{3} < B$$

unless

$$\lambda = \frac{t}{3(v-c)},$$

in which case

$$A = B = C = D = \frac{\lambda(v-c)}{3} = \frac{t}{9}$$

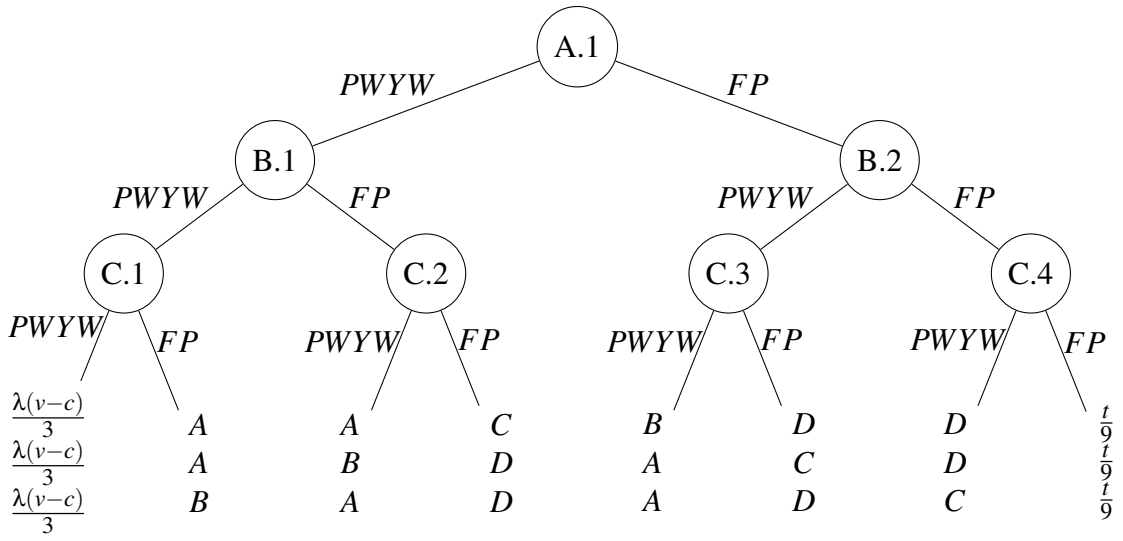

Figure 5: Competition between three sellers with product differentiation

and all sellers are indifferent between PWYW and FP.

At node C4, the third mover will always choose FP unless $C > t/9$ or

$$\frac{t}{3(v-c)} < \lambda < \frac{t}{2(v-c)}.$$

At nodes C2 and C3, the third mover will always choose FP unless $A > D$ or $t/(3(v-c)) < \lambda < 16t/(39(v-c))$.

All that remains is to check the choice of the second and first movers given the various regions for λ, yielding the equilibrium outcomes given in Proposition 3.