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Network competition and consumer churn

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Abstract

This paper examines the nature of connection and churn charges that would arise in a context of network competition. Connection charges are incurred when customers initially connect to a network while churn charges are imposed on customers that disconnect. It is demonstrated that in a competitive equilibrium, the weighted sum of connection and churn charges, rather than their individual levels, is determined. While connection costs are always a factor in determining network prices, churn costs are only relevant when churn is actually expected; but even then only on an expected basis. It is also demonstrated that churn charges do not perform a useful role in encouraging consumers to switch only when it is efficient to do so. Finally, the inter-temporal nature of connection charges is examined and it is demonstrated that such charges will be of an on-going or 'rental' nature rather than up-front. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

This paper examines the pass-on of consumer connection and churn costs to consumers. In many network industries it has become apparent that when consumers switch firms, costs are imposed on the 'losing' firm. In most cases, these churn costs are never recovered even though, in principle, they could be built

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into initial contract agreements as a severance clause. The purpose of this paper is to examine whether zero pass-on of churn costs is a prediction that might arise from contracting behaviour in an environment of network competition. The conclusion reached here is that, in equilibrium, there may be no pass-on; especially if there exist transaction costs associated with recovering churn charges as opposed to up-front connection fees. This is because, under efficient pricing conditions, both networks and consumers care about the sum of connection fees and churn charges rather than any specific one.

In a competitive market, both networks and consumers recognise that connection costs and churn charges soften future price competition. As a result, when attracting consumers initially, competitive bidding leads networks not to recover those costs ex ante and to utilise future profits to fund current discounts. Nonetheless, it is demonstrated that under perfect information, consumer churn decisions are socially efficient. When consumers possess private information regarding their value of churn, however, too much churn can result. The imposition of a churn charge does not, however, act to change or improve these incentives to restore inefficiency. Consequently, churn charges do no more than soften future price competition.

I also utilise this model to examine another aspect of connection pricing: the inter-temporal nature of fixed fees to consumers. While connection costs are incurred by the firm in one time period, consumers often pay for such costs on an on-going or line 'rental' basis rather than up-front. It is demonstrated here that the on-going nature of such charges is a natural implication of the fact that the existence of connection charges may soften price competition in the future. The likelihood of a higher price in the future causes networks to discount to consumers initially with the knowledge that any short-fall in costs will be recovered later on as their monopoly power over consumers is increased.

The issues in this paper are related to issues that arise when customers face switching costs if they choose to change to other firms. It is well known that the existence of such switching costs softens price competition (Klemperer, 1995). Also, when more flexible pricing structures can be offered in contracts, firms bear all of the potential switching costs upfront, recovering them from higher prices later on (Farrell and Shapiro, 1989; Chen, 1997; Taylor, 1999). This paper also demonstrates the role of switching costs on the nature of price competition. However, here switching costs are imposed on firms, rather than consumers, in the form of (sunk) connection costs and potential churn costs. Nonetheless, these influence firms' incentives to keep or attract customers at a later date and, consequently, the prices offered to those customers. The potential for churn causes them to offer more favourable terms to customers, anticipating the softening of price competition later on. As in the present paper, Farrell and Shapiro (1989) demonstrate that it is the sum of up-front and severance payments (our connection and churn charges) that matter rather than their individual components. Where this paper differs is in the initial incidence of costs as well as extensions related to issues in network churn.[1]

The next section of the paper introduces the basic model. It is demonstrated there that actual churn costs do not enter into networking pricing because, in equilibrium, churn is not expected to occur. If we introduce a random possibility of churn (as is done in Section 4), then churn costs do factor in if churn is expected to occur but not otherwise. However, it is expected churn costs and not actual churn costs that determine prices. In Section 5, we consider an alternative role for churn charges in encouraging efficient churn. To do so, we examine a situation where consumers' value for rival networks is unknown to firms. In this environment, churn may not be efficient. However, even here, although too much churn arises in equilibrium, churn charges themselves do not play a role in reducing this inefficiency. Finally, we turn to consider the inter-temporal aspects of connection and churn fees; demonstrating that, in equilibrium, recovery of connection costs will take place over time rather than up-front.

2. Basic model

There are two time periods in the model corresponding to two opportunities for consumers to choose the network, i or j, they wish to connect to. If, in period t (1 or 2), a consumer is connected to network i, they have indirect utility given by $v(p_i^t)$ where p_i^t is the price per call charged by network i. Let $q(p_i^t)$ be the resulting demand function. Networks are allowed to tailor their pricing plan to a particular consumer.[2] It is assumed that the subjective discount rate for consumers and networks is δ.

It is assumed that the two networks have identical costs. Each has a constant marginal cost, c, per call made and for each consumer there is a once-off connection cost of F. Fixed costs associated with the network that are common to all consumers are not considered but it would be straightforward to include these without altering the results below. In period 2, networks face additional costs of D per customer who switches from their network to the rival network.

[1] Farrell and Shapiro (1989) also look at non-price components of consumers' switching decisions; namely, suppliers' incentives to maintain quality. This was also a consideration of Hirschman (1969, Chapter 4) for a discussion of the interaction between consumer's alternative options and their incentives to place pressure on suppliers they are locked-in to.

[2] In models with customer-switching costs, Taylor (1999) demonstrates that when all customers must be offered the same price (i.e., there is no price discrimination between your own and competitor's customers), further inefficiencies arise. Here, because firms themselves incur the costs, and it is readily identifiable whose customer a particular agent is, it is reasonable to assume perfect price discrimination is possible.

2.1. Timeline

Competition takes place with multi-part tariffs where each network can offer a connection charge, f_i^t, a disconnection or churn charge, d_i, and a usage charge, p_i^t. The timeline for the game consists of two periods.

Period 1: Each network makes a take-it-or-leave-it offer, (f_i^1, d_i, p_i^1) and (f_j^1, d_j, p_j^1) respectively, to each consumer. Consumers then accept at most one offer.

Period 2: Each network makes a new take-it-or-leave-it offer, (f_i^2, p_i^2) and (f_j^2, p_j^2) respectively, to each consumer. Consumers then accept at most one offer.

The key assumption built into this timeline is that networks cannot commit to their period 2 pricing to any consumer. This gives salience to the churn problem as networks must compete later on, not only for their rival's consumers but also to retain their own consumers. Note that it is implicitly assumed that after period 2 there is no further possibility of churn. This assumption could be relaxed in a model with more time periods but it would not substantively change the results below.

Before continuing it is worth noting that, under these pricing assumptions, networks will always offer a usage charge equal to c. This is the price that results in the maximal consumer plus producer surplus in every time period and, given the ability to offer a fixed charge (or rebate), that will be the focus of competitive bidding and negotiation. As such, for the remainder of this paper, it will be taken as given that usage charges equal c and the resulting consumer value is $v \equiv v(c)$.

2.2. Period 2 pricing

Working backwards we can consider the pricing equilibrium that results if a consumer, having connected initially to network i, has agreed to a churn cost recovery of d_i. At this stage both networks bid for the consumer's custom. For network j, this will involve a bid of a connection fee so that the network just earns zero profits in that period. Consequently, $f_j^2 = F$.

Suppose that if a consumer is indifferent between two offers, it chooses to stay with its current firm. Network i will, therefore, offer a price that makes the consumer indifferent between this offer and its own while leaving it with maximal profit. It is easy to see that this can be achieved by offering a fixed charge equal to $F + d_i$. The consumer's second period utility is, therefore, $v(c) - F - d_i$. Similarly, for network j, the equilibrium period 2 offer of $F + d_j$ will leave the consumer with utility $v(c) - F - d_j$.

There are two key features of this equilibrium. First, no churn actually occurs. This is because the initial network can always out bid the rival network given the costs imposed on a customer who switches. Second, the consumer effectively bears the churn charge in the second period, even though no churn actually occurs. A consumer's forgone utility is precisely d_i; that they agreed to in period 1. Finally, the existence of new connection costs if the consumer switches networks, softens price competition, with the consumer bearing all of those potential costs, F.

2.3. Period 1 contracts

The period 2 outcomes highlight the importance of agreements signed in period 1. A key question is: if both networks bid for consumers in this period, will consumers end up agreeing, in equilibrium, to bear all or some of the churn costs that might arise? As stated in the following proposition, the answer is that this critically depends on the connection fee.

Proposition 1. *The unique equilibrium involves both networks offering and all consumers accepting a connection fee and discounted churn fee that sum to* $(1-\delta)F$.

Given that usage price is equal to c, the connection and churn charges are then set at the minimum level that just allows the network to break even. Given the usage charge, for i, f_i^1 and d_i must satisfy:

$$(f_i^1 - F) + \delta(F + d_i) \Rightarrow f_i^1 + \delta = (1 - \delta)F \tag{2.1}$$

The consumer is indifferent between contracts that satisfy this condition.

What this proposition shows is that consumers care about the sum of the connection fee and discounted churn charge when choosing among contracts. As such, consumers would be indifferent between a connection fee of $F(1 - \delta)$ and a churn charge of $F(1 - \delta)/\delta$. Notice that this means that a network offering a churn charge must discount the connection fee and vice versa. Also, even if only a connection fee is offered, it will not cover the full connection costs. This is because the network attracting a consumer in period 1 anticipates its ability to recover those costs in period 2. As a result, it need only be compensated for bearing those costs a single period. In effect, competitive bidding means that consumers will be charged a rental fee, per period, rather than a single up-front connection fee.

It is worthwhile to consider what factors may cause networks to favour connection fees above churn charges. If consumers had a higher discount rate than networks, say because they face capital market constraints, then networks will bias bids towards churn charges rather than a connection fee. On the other hand, if networks face potential transaction costs in actually recovering churn charges, this will bias bids towards connection fees rather than churn charges. This latter case is quite possible given potential difficulties in recovering payments from a consumer who no longer receives services from the network.

3. Random churn

In the basic model, churn was not socially efficient and did not occur. As a consequence, in period 2 bidding, when each firm priced competitively, consumers would have no incentive to change providers. In reality, however, some random events might arise between periods that give consumers an incentive to switch. For example, in consumers' eyes the services of each firm may no longer be homogenous and a consumer might want to switch when both firms are pricing competitively.[3] As a consequence, it may be efficient for churn to occur; even taking into account churn costs D. This section considers the competitive equilibrium outcomes when such random churn is possible.

Suppose that while both firms sell an homogenous product in period 1, there is some probability, $\rho > 0$, that a given customer will value another firm's product more highly than their current provider. That is, if the consumer currently subscribes to firm i, then with probability ρ, in period 2, they might increase their value for firm j's product by a scalar, $\theta > 1$; i.e., at $\theta v(p_j^2)$. Their value for firm i's product would remain the same regardless.[4]

3.1. Period 2 pricing

Once again, we work backwards. Suppose that a consumer has agreed to connect to network i but pay a charge, d_i, if they change networks in period 2. Both networks will bid for that consumer. If the consumer continues to value each network equally, the result will be the same as the previous model. This will not be the case in the event the consumer values the alternative network more. In this case, consumer will be indifferent between the two networks if:

$$v - f_i^2 = \theta v - f_j^2 - d_i \tag{3.1}$$

The lowest efficient price that could be offered by network j involves a connection charge of F. The lowest efficient price that would be offered by firm i is a rebate to the consumer of $D - d_i$ to cover any potential short-fall in churn costs.

The fixed payment (that is potentially negative for the case of network i) actually paid by the consumer will be set to give the consumer the utility it would receive at the lowest price offered by the rival network. This means that the

[3] In reality, the precise sources of customer decisions to switch suppliers is not certain and appears to differ among industries and also by stage of industry development (see, for example, Cai et al., 1998, for electricity retailers; and Katz and Aspden, 1998 and Madden et al., 1999 for internet service providers).

[4] It would not be difficult to allow the value of the consumer's existing network to change as well. This would not substantively alter the results below.

consumer's utility in period 2 will be the minimum of $v + D - d_i$ and $\theta v - F - d_i$, depending upon whether the consumer churns or not.[5] The consumer will only churn if $v + D - d_i < \theta v - F - d_i$ or $D + F < (\theta - 1)v$; that is, if the increased in value derived from network j as opposed to i exceeds the actual churn and new connection costs. In period 2, efficient pricing opportunities mean that churn will only occur if it is socially efficient for it to do so.

It is worth noting here what profits network i will earn in period 2. If the consumer continues to value each network equally, its profits are simply $F + d_i$. On the other hand, if the consumer values network j more but does not churn, its profits are $(1 - \theta)v + F + d_i$. Finally, if the consumer does churn, its profits are $d_i - D$.

3.2. Period 1 contracting

Anticipating the outcome in period 2, each network makes an offer of a period 1 price, connection and churn charge to each consumer. There are two cases to consider depending upon whether churn is efficient or not. Each is dealt with in turn.

Suppose that the consumer is *not* expected to churn. Then the contract offered will be a solution to:

$$\max_{f_i^1, d_i} v + \delta((1 - \rho)(v - F - d_i) + \rho(\theta v - F - d_i))$$

$$\text{subject to } (f_i^1 - F + \delta(\rho(1 - \theta)v + F + d_i) \geq 0$$

Note that as in the model of the previous section, the churn charge represents a simple transfer from the network to the consumer. Hence, it will be bid away given that usage prices can be set equal to c. Finally, as in Proposition 1, the sum of the connection charge, f_i^1 and discounted churn charge δd_i, is set so that the network breaks even. That is, $f_i^1 + \delta d_i = (1 - \delta)F + \delta\rho(\theta - 1)v$. The former term in this formula is the same as the rental charge derived in Proposition 1. The latter term reflects the possibility that increased competition in period 2 might not enable the firm to implement a fixed charge of F in that period. Hence, to compensate them for that potential lack of cost recovery, a higher overall fee must be agreed to.

Now suppose that a consumer is expected to churn if the opportunity arises. Then the contract offered will be a solution to:

$$\max_{f_i^1, d_i} v + \delta((1 - \rho)(v - F - d_i) + \rho(v - D - d_i))$$

$$\text{subject to } (f_i^1 - F + \delta((1 - \rho)F - \rho D + d_i) \geq 0$$

[5] Farrell and Shapiro (1989) demonstrate that contract renewals will drive consumers to the minimum utility they could realise by switching to another seller.

Once again, the usage price will equal c and the connection and churn charges will satisfy: $f_i^1 \delta d_i = F(1-\delta(1-\rho)) + \delta\rho D$ Notice that the network discounts any period 1 arrangement to reflect period 2 rents it will be able to earn.

What is interesting about these results is that the prices offered by the networks are not purely cost-reflective. Regulated utilities often argue that fixed fees should be equal to the consumer-specific costs that they incur in connection and disconnection. However, in a competitive market, these fees have an influence on future competition. The random churn model presented here demonstrates this potential effect. In the first case, when a consumer is not expected to churn, that consumer is able to extract a rebate from their current network. This represents a potential cost for the network that they must recover in period 1. Nonetheless, as in Proposition 1, churn costs are not a factor in determining prices, as they are never expected to arise. Hence, the higher churn charge there. In the second case, when a consumer has a probability of actually churning, the network may actually incur churn costs and may not potentially recover connection costs through future high pricing, the fixed fees charged are correspondingly higher. Note, however, in this case, it is expected churn costs and not actual churn costs that are the basis for the charges.

4. Private information

The examples in the previous two sections demonstrated the nature of connection and churn charges under ideal negotiating circumstances. Specifically, bidding at each stage took place under conditions of full information and an absence of transaction costs. In reality, networks may be unable to determine a consumer's precise value for switching to an alternative network. In this case, consumers may have such knowledge and can thereby be expected to overstate the value of the alternative network when negotiating with any given one. It may be argued, therefore, that a churn charge may impose a discipline on consumers to only churn when it is efficient to do so. As a result, placing weight on such charges rather than connection fees may actually lower transaction costs associated with private information. Here it is demonstrated that while private information potentially leads to inefficient churn, a set churn charge does not serve any role in improving consumer incentives.[6]

4.1. Period 2 pricing

To consider the effect of private information, the random churn model of the previous section is amended to include an assumption that, while the consumer

[6] In a related result in a model with customer-switching costs, Chen (1997) finds that when firms are constrained to charge the same price this may simply reduce firm profits without any corresponding increase in consumer welfare.

knows the value of θ – the relative value of the alternative network in period 2 – each network does not know this. Nonetheless, they do have knowledge of the probability distribution of θ, $\rho(\theta)$, and these priors are common knowledge. It is assumed that $\rho(\theta)$ is distributed uniformly over the interval [1,2]. These assumptions mean that, in period 2, a consumer's decision will based on the same criterion as before (3.1).

$$v(c) - f_i^2 = \bar{\theta}v(c) - f_j^2 - d_i \tag{4.1}$$

Here $\bar{\theta} = 1 + (f_j^2 - f_i^2 + d_i)/v$ is the marginal value such that a consumer with $\theta > \bar{\theta}$ will choose to switch while those with $\theta \leq \bar{\theta}$ will choose to remain with network i.

Each network will choose a bid, f_i^2 and f_j^2, respectively, that maximises their expected profits in period 2. For i and j, these profits are, respectively:

$$\pi_i(f_i^2) = f_i^2\left(1 + \frac{\bar{\theta}}{2}\right) + (d_i - D)\left(2 - \frac{\bar{\theta}}{2}\right) \tag{4.2}$$

$$\pi_j(f_j^2) = (f_j^2 - F)\left(2 - \frac{\bar{\theta}}{2}\right) \tag{4.3}$$

In a Nash equilibrium, each network will choose its price taking the price of the other network as given. The following proposition characterises the resulting equilibrium prices and churn level.

Proposition 2. *Suppose that network i is chosen by the consumer in period* 1 *and that consumer agrees to a churn charge of* d_i. *In period* 2, *the equilibrium prices are* $f_i^2 = \frac{1}{3}(9v + F - 2D) + d$ *and* $f_j^2 = \frac{1}{3}(v + 2F - D)$. *The marginal consumer type is, therefore,* $\bar{\theta} = 1 + (D + F)/3v$.

The proof is straightforward with the Nash equilibrium being found by differentiating (4.2) and (4.3) with respect to f_i^2 and f_j^2, respectively and solving the two equations simultaneously.

There are several key features of this equilibrium. First, a consumer's current network offers a price that is inflated by precisely d_i while the alternative price does not reflect this at all. Consequently, the previously agreed churn charge does not alter the consumer's choice based on (4.1). Given the equilibrium pricing, churn charges do not alter the consumer's churn incentives. Second, recall that churn will be efficient if the marginal consumer is of type $\bar{\theta} = 1 + (D + F)/v$. This is higher than the type in Proposition 2. This means that 'too many' consumers elect to switch networks from an efficiency perspective. Intuitively, a consumer's current network is reluctant to offer a rebate to keep a consumer whose value for the alternative network may not actually be high.

4.2. Period 1 contracts

Once again, period 1 contracts will be offered so that each network just breaks even. Given the period 2 prices derived in Proposition 2, this break-even constraint is:

$$f_i^1 - F + \delta\left(\frac{D^2 + F^2 + 2D(F - 18v) + 18Fv + 27v(2d + 3v)}{18v}\right) = 0 \qquad (4.4)$$

This implies that:

$$f_i^1 + 3\delta d_i = \frac{D^2 + 2D(F - 18v) + (F + 9v)^2}{54v} \qquad (4.5)$$

As in the previous section, there is a fixed relationship between connection fees and churn charges. This is not surprising given that the churn fee itself performs no useful efficiency function.

Note, however, that here these charges are strictly greater as a result of the inefficiency associated with private information in period 2. Utilising the results from Section 4, without private information, the connection fee and churn charge would satisfy:

$$f_i^1 + \delta d_i = \frac{F(v + \delta D) + \delta F^2 + \delta D(D + v)}{v} \qquad (4.6)$$

That loss in efficiency is passed on to consumers in period 1 as networks expect greater churn in period 2.

5. Inter-temporal recovery of connection costs

The models of the previous sections assumed that there were only two periods. We now turn to consider the inter-temporal nature of any fixed fees paid (connection or churn) in a many period model. For simplicity, we will ignore the costs associated with churn and also the imposition of churn charges. The results here will easily extend to that case. There are, however, costs associated with connecting a customer that are once off and sunk; while the customer remains with the firm. So, if a customer were to leave a firm, those costs would have to be incurred again upon re-connection. We consider here how networks recover such costs.[7]

In principle, the recovery of fixed connection costs need not take place up-front.

[7] Nilssen (1992) compares models where customer-switching costs arise every time a customer changes supplier versus the first time a customer chooses a given supplier. He finds that prices will be higher in the former case than the latter.

An alternative would be for the charge to be levied in certain intervals (say, monthly, quarterly or yearly). Moreover, this is precisely what is seen in many utility industries. One reason for this is that customers have higher capital costs than those firms and hence, by spreading the charge over time this represents an efficient allocation of such resources. However, rental rather than up-front charges occur between utilities and larger firms who presumably do not face the same capital constraints as say, residential customers. Moreover, a rental agreement can leave a firm vulnerable to non-recovery if it were to lose a customer. This suggests that the basic liquidity-constraints explanation for rental charges is not persuasive.

Here we suggest an alternative explanation based on on-going competitive pressure. The idea is that if a customer were to pay an up-front charge they would be vulnerable to later hold-up by the firm. This is because, at a later date, other firms would have to incur connection charges to attract the customer. This softens future price competition and makes the consumer vulnerable to higher future payments. As a consequence, the consumer, prior to connection negotiates a lower up-front payment. If there is initial competition for the consumer, the up-front charge is bid down to a rental level. In equilibrium, even without a binding long-term agreement, payments to recover connection charges take place each time period rather than up-front.

Suppose that, in each period, each firm makes an offer (p_i^t, f_i^t) to each customer. Price discrimination is possible,[8] so in each period the contract can be tailored to specific customers. In particular, you can make different offers based on whether a customer was connected to you in the past or not. The customer accepts the best offer in each period, taking into account their utility over time. Customers and each network have an identical discount rate of δ. If two offers are equivalent, the customer stays connected with its current provider (except in the initial period where the firm is chosen at random).

We derived the basic two-period result of this model in Section 1. There $f_i^1 = (1-\delta)F$ and $f_i^1 = F$; that is, connection costs are not recovered up-front but later through higher prices. It turns out that this basic two period result extends to any number of periods. Let T be the last period.

Proposition 1. *In equilibrium, $f_i^1 = (1-\delta)F$ for all $t < T$, and $f_i^T = F$. If there is an infinite time horizon, $f_i^t = (1-\delta)$ for all t.*

Proof. Suppose that in period T, $f_i^T = F$. Then in T–1, the customer's alternative firm will bid an amount so that it just breaks even over the remaining two periods. This means it will bid $(p_i^{T-1}, f_i^{T-1}) = (c,(1-\delta)F)$ as it expects to recover the remaining connection costs in period T. The customer's current firm will be able to

[8] The phenomenon is common to service or utility industries where price discrimination is considered possible.

retain the customer by matching this bid. That firm's expected profit over T–1 and T, therefore, equal F.

Given this outcome, in period T–2, the customer's alternative network will bid a break-even amount: $f_i^{T-2} = (1 - \delta(1-\delta) - \delta^2(1-\delta) - \delta^3)F = (1-\delta)F$. Once again this will be matched the customer's current firm whose expected profits from T–2 to T will again equal F.

Working recursively, the multi-period equivalent of the earlier fee is:

$$f_i^1 - F + \sum_{t=2}^{T} \delta^{t-1} f_i^t = f_i^1 - F + \delta(1-\delta)F + \delta^2(1-\delta)F + \cdots + \delta^{T-1}(1-\delta)F + \delta^T F \tag{5.1}$$

Simple algebra yields that: $f_i^1 = (1-\delta)F$, completing the proof.

This proposition demonstrates that in a competitive equilibrium, firms will bid down connection charges to a 'rental rate' initially and in subsequent periods. Firms will, therefore, recover connection charges over time rather than up-front. An up-front charge leaves the consumer vulnerable to hold-up but it is precisely this hold-up power that allows the firm to recover the rental rate in subsequent periods.

6. Conclusion

This paper has conducted a competitive analysis of the determination of connection and churn charges in a context of network competition. The language of telecommunications has been used because this is a common instance where firms incur costs as a result of connecting and disconnecting customers. However, the results of this paper could apply to other industries with similar cost characteristics.

The key result of the paper is that the individual connection and churn charges are indeterminate in a competitive equilibrium; although their weighted sum is determined. However, with asymmetric transaction costs or liquidity constraints it is possible that one or the other could be become favoured. This result took place utilising Bertrand-style competition and it is possible that under assumptions of product differentiation this result could be different.

It was also demonstrated that churn charges did not play a role in encouraging efficient churn. This is because the price offered by a rival network precisely offsets any incentive effects of such churn charges. In addition, the results showed that connection and churn charges would likely be recovered over time precisely because of the hold-up effect caused by the existence of customer connection and disconnection costs. These results are in many respects a first exploration of the consequences of ex post price competition for ex ante price competition. The development of this area will shed light on many service industries where there exist once-off costs associated with attracting a customer.

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