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Contracts as a Barrier to Entry in Markets with Nonpivotal Buyers[†]

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Considering markets with nonpivotal buyers, we analyze the anti-competitive effects of breakup fees used by an incumbent facing a more efficient entrant in the future. Buyers differ in their intrinsic switching costs. Breakup fees are profitably used to foreclose entry, regardless of the entrant's efficiency advantage or level of switching costs. Banning breakup fees is beneficial to consumers. The ban enhances the total welfare unless the entrant's efficiency is close to the incumbent's. Inefficient foreclosure arises not because of rent shifting from the entrant, but because the incumbent uses a long-term contract to manipulate consumers' expected surplus from not signing it. (*JEL* D11, D21, D43, D86, L13, L51)

Breakup fees, which are also known as early termination fees, are widely used in long-term contracts for a variety of services including wireless telephone, cable, satellite TV, and data carriage. If the customer who signed a long-term contract that includes an early termination fee switches to a rival provider, she has to pay the initial provider the termination fee. However, in most cases, early termination fees do not apply to switching plans within the same provider since providers generally offer most favored nation (MFN) clauses that allow signed consumers to choose lower-priced plans in the future.[1]

Many regulatory agencies are concerned that early termination fees hurt consumers by raising the cost of switching providers. The US Federal Communications Commission's (FCC) 2010 survey finds that wireless phone contracts might have

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[1] In the frequently asked questions on Verizon plans and services, as a reply to "Will I be charged a fee to change my plan or my minutes, messages or data allowance?" Verizon states "No, there's no cost to change your plan or your allowances in My Verizon. However, your monthly access charge, taxes and surcharges may increase depending on the price of the plan you choose." Thus, consumers can switch to a lower-priced plan without incurring additional fees. See http://www.verizonwireless.com/support/understand-and-change-your-plan-faqs/.

early termination fees of over \$300, depending on the phone type and plan.[2] The European Commission's 2009 directive ensures that electronic communication service contracts cannot be longer than two years and a one-year option must also be available in Europe.[3] The European Commission (2013, pp. 327–29) also "recommended that national regulators negotiate or set maximum termination fees (for internet service provision contracts) that are reasonable and do not become a barrier to switching provider." In September 2013, the Commission adopted a proposal for a regulation which (among other things) gives consumers "right to terminate any (telecom) contract after six months without penalty with a one-month notice period; reimbursement due only for residual value of subsidized equipment/promotions, if any" (EC 2013, p. 24).

Very recently breakup fees of long-term contracts in a business-to-business market have raised some anticompetitive concerns. In October 2015 the FCC opened an investigation into lock-up provisions offered by the four major incumbent network providers, AT&T, CenturyLink, Frontier, and Verizon, for the provision of business data services, also known as special access services, in a \$25 billion market.[4] The customers who are subject to these contract terms are firms or organizations that need to transport large amounts of data for their daily activities and communications, including telecom/internet service providers that do not own their own infrastructure, state and local governments, schools, libraries, healthcare providers, and many small- and medium-sized businesses. The main complaint behind the investigation was that "New network builders struggle to attract customers who are held hostage by AT&T and Verizon in lockup provisions that can extend up to seven years in length," as described by the chief executive officer of the Comptel trade group.[5] The main complaints arise from the incumbent plans' percentage commitment provisions that require buyers to commit a high percentage (from 80 to 95 percent) of their historical or existing purchases, where substantial punishment fees apply if buyers fail to reach their commitment.[6] The FCC acknowledged the concern by referring to past Commission statements, in particular: "By locking in customers with substantial discounts for long-term contracts and volume commitments before a new entrant that could become more efficient than the incumbent can offer comparable volume and term discounts, it is possible that even a relatively inefficient incumbent may be able to forestall the day when the more efficient entrant is able to provide customers with better prices." In May 2016, the FCC adopted a new framework for the regulation of these tariffs, which bans early termination fees and minimum commitment provisions.

[2] They often apply to contracts for post-paid, fixed-term mobile and broadband services, in particular when the contract involves subsidized equipment, like a headset subsidy. The FCC 2010 survey also found that 54 percent of consumers would have to pay early termination fees, 28 percent would not have to pay, and 18 percent did not know whether they would have to pay termination fees. Of those who knew the level of their termination fees, 56 percent reported that these fees exceeded \$200. See Horrigan and Satterwhite (2010). Also, see https://www.fcc.gov/encyclopedia/early-termination-fees for the replies of the service providers to the queries of the FCC.

[3] The Article 30 of the Directive 2009/136/EC sets rules facilitating switching service providers.

[4] See the investigation document DA 15-1194 (pp. 7–11) and decision document 16-54.

[5] See http://www.kansascity.com/news/business/article39487791.

[6] Percentage commitments seem to provide MFNs implicitly by activating early termination fees, but only in case buyers fail to purchase the committed amounts from the incumbent and not when switching to another plan within the same provider.

The main focus of our paper is to analyze under what conditions breakup fees used by an incumbent provider could be anticompetitive and to derive policy recommendations regarding breakup fees. Very little is known about the implications of breakup fees in markets with nonpivotal buyers: that is, when an individual buyer does not have a significant impact on the total demand of a seller (see our summary of the literature below), in particular when the firms are asymmetric in terms of their market power. Our focus gives a fairly good representation of the example above of major network owners acting as an incumbent and new network builders acting as entrants, where the customers of data services are mostly nonpivotal buyers.

To capture the facts of the markets above where we see long-term contracts with breakup fees, we consider a two-period model of entry under the following assumptions: buyers are nonpivotal and are willing to buy one unit of a good in each period, the incumbent can offer a long-term (two-period) contract before entry, but cannot commit to not offering a spot price in the future when competing against a more efficient entrant. The incumbent's long-term contract is a combination of a unit price for today, a unit price for tomorrow, and a breakup fee which is paid if a consumer who signed the long-term contract does not buy from the incumbent tomorrow. The incumbent can offer a most favored nation (MFN) clause as part of the long-term contract, which will enable the signed consumers to purchase at the incumbent's lowest price in period 2 without incurring any additional fees. A consumer who signed the incumbent's long-term contract in period 1 and switches to the entrant in period 2 incurs an intrinsic switching cost and pays the breakup fee to the incumbent. For unsigned consumers, the incumbent and the entrant are undifferentiated competitors in period 2.

To sign consumers into a long-term contract with a high breakup fee, the incumbent must compensate them for not having the option of purchasing from a more efficient entrant in the future (Chicago School argument). We show that the incumbent profitably and inefficiently forecloses the entrant for any level of the entrant's efficiency advantage. Intuitively, consumers' expected surplus from not signing the long-term contract is buying from the entrant in period 2. By setting a very high breakup fee, the incumbent makes consumers believe that the entrant cannot profitably attract anyone who signed the incumbent's contract, so will compete only for unsigned consumers who do not face a switching cost. The undifferentiated asymmetric competition between the incumbent and the entrant then results in the entrant setting the price at the incumbent's second-period spot price and selling to the unsigned consumers. The incumbent will not compete for the unattached consumers, since otherwise it would have to give a lower price to its signed consumers (due to MFNs). By setting its second-period price at the consumers' valuation from the good, the incumbent lowers consumers' expected outside option of signing the long-term contract to zero. In other words, by combining a high enough breakup fee with an MFN clause, the incumbent lowers the expected gains from not signing the long-term contract to zero and so it does not have to compensate consumers for signing its long-term contract. This makes foreclosure profitable regardless of the entrant's efficiency advantage. Banning breakup fees lowers the equilibrium prices and improves consumer welfare. A prohibition of breakup fees increases total welfare when the entrant's efficiency advantage is high relative to the switching costs, whereas, interestingly, the ban is welfare reducing when the efficiency difference between the firms is small, since without breakup fees too many consumers would switch to the entrant.

It is important in our framework that the incumbent cannot ~~induce~~ use breakup fees to benefit from the entrant's efficiency advantage.[7] This is because the incumbent has to compensate consumers for the expected amount of breakup fee payments by lowering the first unit price. As a result, the level of breakup fee does not affect the equilibrium outcome when the incumbent accommodates entry; only the difference between the incumbent's second-period price and the breakup fee matters. On the other hand, a high enough breakup fee is essential to implement full foreclosure. Without breakup fees, the incumbent cannot fully foreclose the entrant; consumers with low switching costs buy from the entrant in period 2.

It is critical for the results that the incumbent's contracting space is rich enough to allow a long-term contract to include both a breakup fee and an MFN clause. Offering a long-term contract converts a nondurable good (consumption today) into a durable good (consumption in both periods). Like in the durable goods literature (Coase 1972; Bulow 1982), the incumbent cannot commit to not competing against itself in the future. Using an MFN clause in the long-term contract enables the incumbent to solve this commitment problem and to implement the full foreclosure outcome.[8]

The results above are obtained when the firms are differentiated due to consumer heterogeneity in the cost of switching from the incumbent to the entrant. Buyers are uncertain about their switching costs before deciding whether to sign the incumbent's long-term contract. Switching costs might arise from consumers' intrinsic costs of calling the current provider to cancel the contract, waiting for the new provider to activate its services, or calling the bank to change the automatic bill payment details, etc. We assume no fixed costs of entry,[9] and so an entrant can be a firm that exists in another market and which is extending to a new market. Our results are robust to allowing the incumbent to renegotiate its long-term contract in period 2.

In the telecom industry, providers, in order to acquire customers, sometimes offer to pay the breakup fees of rivals' customers if they switch.[10] We formally extend our setup by allowing the entrant to use price discrimination based on history: whether the consumer purchased a unit from the incumbent in period 1 or not. In this extension we show that the incumbent profitably and inefficiently forecloses the entrant with a sufficiently high breakup fee if the entrant's cost efficiency is not very large compared to the highest switching cost. Otherwise, the entrant efficiently sells to all consumers in period 2. In an online Appendix, we also extend the setup to an alternative model, where there are no exogenous switching costs, but consumers

[7] The literature refers to this as rent shifting from the efficient entrant: see, for instance, Aghion and Bolton (1987).

[8] This is similar to how price matching guarantees are used to solve the durable good monopolist's commitment problem (Butz 1990).

[9] Allowing fixed entry costs would make our foreclosure results stronger.

[10] For example, in their web advertisements, T-Mobile states: "Switch now. You have nothing to lose but overage charges. We will cover your switching fees when you trade in your phone so you can break free from your old carrier with its costly overage charges and restrictive services. It is one reason why more people switched to T-Mobile in 2015 than to any other carrier" or "Trapped in a contract with early termination fees (ETFs)? No worries. Switch to T-Mobile and we'll pay off your ETFs via Prepaid MasterCard Card." We thank a referee who provided us with these examples, which motivated the extension of history-based price discrimination.

have a heterogeneous mismatch value of the entrant's product relative to the incumbent's, regardless of whether they signed the incumbent's long-term contract or not. In this extension we find qualitatively the same results as when the entrant can use history-based price discrimination.

Our main contribution is to the literature on entry deterrence by exclusionary clauses (Aghion and Bolton 1987; Spier and Whinston 1995; Rasmusen, Ramseyer, and Wiley Jr. 1991; Segal and Whinston 2000; Choné and Linnemer 2015). This literature considers markets with pivotal buyers, such as business-to-business markets where a buyer purchases a significant portion of the seller's production. It is well established that in such markets an incumbent might foreclose an efficient entrant by using breakup fees (liquidated damages) in its contract with the buyer before the entrant appears (Aghion and Bolton 1987; Choné and Linnemer 2015). The coalition of the incumbent and buyer shifts rent from the more efficient entrant via a breakup fee, which leads to entry deterrence when there is uncertainty over the consumer surplus from the entrant's product and there is some positive fixed cost of entry. Our analysis is complementary to this literature in the sense that we focus on markets with nonpivotal buyers, such as final product markets or business-to-business markets where a buyer's purchase has no significant effect on the seller's revenue. In our setting, breakup fees cannot be used as a tool to shift rent from the more efficient entrant; nevertheless, we identify a new mechanism of entry deterrence of a more efficient entrant by an incumbent using breakup fees and MFNs in its long-term contracts. Importantly, this mechanism does not rely on scale economies (attracting a sufficient amount of buyers to cover some fixed costs).

The paper proceeds as follows. In Section I, we summarize our key contributions to the literature. We present our main model and results in Sections II and III. We discuss the key mechanism and important assumptions for the main result in Section IV and present formal extensions in Section V. We conclude in the final section and all formal proofs are in the Appendix.[11]

I. The Related Literature

As noted above, the key difference compared to Aghion and Bolton (1987) and Choné and Linnemer (2015) is that they focus on contracting where transactions take place only after the entrant appears, whereas we focus on contracts where buyers can buy a unit in each period, so in period 1 the incumbent has to compensate consumers for the expected amount of breakup fee payments by lowering the first unit price. This is the main reason why in our setup breakup fees cannot be used as a tool to shift rent from the more efficient entrant to the incumbent. Another difference from the previous papers is that our results are robust to allowing the incumbent to renegotiate its long-term contract in period 2, while in Aghion and Bolton the incumbent would want to forgive some of the breakup fee to benefit from the entrant's offer if it was allowed to.[12] In our setup the incumbent cannot commit to

[11] In our online Appendix we extend the analysis to the case of mismatch value interpretation and demonstrate that the qualitative features of our equilibrium hold for more general distributions of the consumer heterogeneity parameter (mismatch value).

[12] Allowing for renegotiation, Spier and Whinston (1995) show that if the incumbent invests in cost-reducing technology before entry, it may still block entry by overinvesting in its technology improvement.

not lowering the second unit price of the long-term contract, but this lack of commitment is not critical for complete foreclosure, since the incumbent can perfectly control the second-period price via its long-term contract's second unit price. It is important to note that the long-term contract enables the incumbent to commit to the highest price.[13]

Choné and Linnemer (2015) extend Aghion and Bolton by allowing downward-sloping demand and analyzing the implications of nonlinear tariffs that might be conditional on the quantity purchased from the entrant. For consumers who signed the incumbent's long-term contract, we also have downward-sloping demand. However, allowing for nonlinear tariffs would not make any difference here, since each buyer can buy a unit in each period. Our main result in the mismatch value case foreshadows their finding ~~in~~ that when the net surplus from the entrant's product is low there is full foreclosure. However, in our paper, when the entrant is very efficient, it serves the entire market, whereas in their setup there is partial foreclosure. This is because they assume ex ante full commitment by the incumbent. Similar to Rasmusen, Ramseyer, and Wiley Jr. (1991) and Segal and Whinston (2000), we show that foreclosure arises in equilibrium when consumers fail to coordinate. In that literature, a buyer's decision exerts an externality on the other buyers' payoffs, generating coordination failure in equilibrium, while our coordination failure does not rely on an individual buyer being pivotal.

Very recently, Elhauge and Wickelgren (2015)[14] illustrate how loyalty discounts could be used as a tool to possibly foreclose efficient entry or dampen competition when accommodating entry. The main difference in our paper is that we focus on the policy implications of breakup fees offered to nonpivotal buyers, whereas they focus on how signing a buyer to a contract with loyalty discounts generates negative externalities between pivotal buyers, and so leads to an anticompetitive market outcome.[15] More importantly, our equilibrium results enable us to derive clear policy implications on breakup fees. Despite these differences, in both papers the incumbent can raise the expected second-period prices and so lower consumers' outside option using the first-period contract, which includes loyalty discounts and up-front payments in their case, whereas here it is the terms of the long-term contract: a second unit price, a breakup fee, and an MFN clause.

We also contribute to the literature and policy debate on MFNs. Much policy work discusses ~~the~~ possible negative consequences of MFNs used in vertical contracts between upstream firms (like suppliers) and downstream firms (like retailers). In these contexts, a seller uses an MFN clause mostly as a commitment device such that if it sells to a buyer at a lower price, it has to offer that price to the other buyers. These concerns include the possibility that MFNs raise final consumer prices by dampening seller competition, facilitating coordination between sellers, or raising a rival's costs (for example, see Baker and Chevalier 2013). We identify a new role

[13] Otherwise, the incumbent would have an incentive to exploit its locked-in consumers in period 2. We thank Felix Bierbrauer and Bruno Julien for pointing this out.

[14] We thank a referee who brought this paper to our attention.

[15] In Appendix Section C we extend the analysis to the case when there are large and finite number of buyers. Other differences include that buyers are homogeneous (both before and after entry) in their model, whereas we have ex post buyer heterogeneity for those consumers who signed the incumbent's contract. An implication is that in their homogeneous buyer model it is always efficient for the entrant to serve the entire market, whereas this is not the case in our model.

of MFNs in long-term contracts: MFNs make it free for consumers to switch from the incumbent's long-term contract to its spot price in period 2 and thereby enable the incumbent to commit to not undercutting the long-term contract's second-period price. This in turn makes the entrant less aggressive, raises the second-period prices, and thus makes full foreclosure profitable.

Finally, a key difference with the endogenous switching costs literature (Caminal and Matutes 1990; Chen 1997; Fudenberg and Tirole 2000)[16] is that we have ex ante asymmetric firms and allow the incumbent to increase switching costs endogenously with breakup fees.

II. Model

We consider a two-period model of entry. In the first period there is only one firm, the incumbent (I), and in the second period the incumbent faces one entrant (E). We assume that the entrant is more efficient than the incumbent in production. Let c_I and c_E denote the marginal cost of the incumbent and the entrant, respectively. The efficiency advantage of the entrant is denoted by $\Delta c \equiv c_I - c_E > 0$.

A mass 1 of consumers are willing to buy one unit in each period. The value of consuming the incumbent's good in each period is v and the value of consuming the entrant's good in period 2 is also v. To consider the interesting case we assume that $v > c_I$. The incumbent has the first-mover advantage in contracting: it can make a long-term contract (LT) offer to consumers before the entrant comes to the market (the terms of the LT contract are described below). A consumer who signed the incumbent's LT contract and switches to the entrant in period 2 incurs an exogenous switching cost s, which is uniformly distributed over $[0, \theta]$. Following Chen (1997), we assume that consumers learn their switching cost s at the beginning of period 2. Firms never observe s and know only its distribution. Switching costs make the incumbent's product differentiated from the entrant's for those consumers who signed the incumbent's LT contract. If a consumer did not sign the incumbent's LT contract, she does not have to pay a switching cost when she buys from the entrant in period 2, and so the incumbent's and the entrant's products are homogeneous from the viewpoint of the unsigned consumers.

The timing of the contracting is as follows.

Period 1.—The incumbent offers a long-term contract, $LT = \{p_{I1}, p_{I2}, d\}$, which specifies three prices: p_{I1} is the price for buying one unit in period 1, p_{I2} is the price for buying an additional unit from the incumbent in period 2, and d is the breakup fee to be paid by the buyer who signed the incumbent's LT contract and does not buy from it in period 2.[17] The incumbent also offers a most favored nation clause (MFN) making it free for consumers to switch from its LT contract to the spot contract in period 2.[18] Consumers decide whether to accept or reject the LT contract.

[16] See Klemperer (1995) and Farrell and Klemperer (2007) for excellent reviews of the switching costs literature.

[17] We do not allow a breakup fee to be contingent on whether consumers switch to the entrant, since such a provision is not typical in practice. This might be due to potential antitrust concerns and also it would be difficult to verify whether a consumer used another provider.

[18] In Section IVB we explain why the incumbent prefers to offer an MFN clause in equilibrium.

Those who accept the LT contract consume one unit at price p_{I1}. Those who reject it consume nothing in period 1.

Period 2.—Consumers learn their switching cost s. Simultaneously, the incumbent offers a spot price p_{I2}^S and the entrant offers a price p_E. Consumers decide whether to buy a unit from the incumbent, a unit from the entrant, or buy nothing.

We now formally define the firms' strategies. The strategy of the incumbent is a set of three nonnegative real numbers, $\{p_{I1}, p_{I2}, d\}$, and a function $p_{I2}^S(h)$ mapping each period 1 history h into a nonnegative real number. Period 1 history includes a set $\{p_{I1}, p_{I2}, d\}$ and the measure of consumers who purchased the incumbent's LT contract in period 1. The entrant's strategy is a function $p_E(h)$ mapping each period 1 history h into a nonnegative real number.

Now we describe ~~the~~ consumers' decisions. First, consider a consumer who signed the incumbent's LT contract. In period 2, if she buys a unit from the incumbent, she pays its lowest price (the minimum of p_{I2} and p_{I2}^S) due to the MFN clause of the LT contract. If she switches to the entrant, she pays p_E to the entrant, d to the incumbent, and incurs her switching cost. If she chooses not to buy anything in period 2, she still needs to pay the breakup fee d to the incumbent. Next, consider a consumer who did not sign the incumbent's LT contract. She chooses whether to purchase a unit from the incumbent at price p_{I2}^S, a unit from the entrant at price p_E, or nothing.

We assume without loss of generality that on the equilibrium path the incumbent's spot price is at least as high as the second unit price of the LT contract, $p_{I2}^S \geq p_{I2}$, since otherwise no consumer would buy the second unit at p_{I2} (due to the MFN) and there would be an equivalent equilibrium in which the incumbent chooses a second unit price that is equal to the spot price.

We look for a subgame perfect Nash equilibrium. To rule out noncredible equilibria, we assume that the firms do not play weakly dominated strategies.[19]

III. Equilibrium Analysis

We now demonstrate that in the unique equilibrium the incumbent forecloses the entrant and obtains a profit equal to twice its static monopoly profit: $2(v - c_I)$. To do this first we show that in any equilibrium the incumbent can get at least $2(v - c_I)$. Suppose the incumbent offers the contract $p_{I1} = v - \epsilon$, $p_{I2} = v$, and $d > v$. If all consumers reject, then a rejecting consumer expects to earn $v - c_I$ in the second period because undifferentiated competition between the incumbent and the entrant implies that $p_E^* = p_{I2}^{S*} = c_I$.[20] However, an individual accepting consumer gets $\epsilon + v - c_I$ because she gets ϵ from period 1 consumption and pays the lowest price of the incumbent in period 2 due to the MFN. Hence, it is not a continuation equilibrium for all to reject the LT contract. Suppose that all consumers accept the LT contract. In the continuation equilibrium the incumbent does not undercut p_{I2} and so sets $p_{I2}^S = v$, since if it set a lower price it would have to offer it to all consumers

[19] This assumption is also used in second-price auctions and undifferentiated asymmetric cost Bertrand models.
[20] This is the unique equilibrium of an undifferentiated Bertrand competition between firms with asymmetric costs when weakly dominated strategies are eliminated.

due to the MFN. This would be unprofitable as the incumbent would lose a margin from a measure 1 of consumers and would attract a measure 0 of consumers who did not sign the LT contract. The entrant's best response is to charge a price of v to attract any consumer who did not sign the LT contract. Thus, an individual consumer who rejects the LT gets zero surplus, whereas an individual consumer accepting the LT contract gets ϵ. Hence, there is an equilibrium in which all consumers accept the offered LT contract.

In Appendix A we show that for a given $\epsilon > 0$ if a positive measure of consumers did not sign the offered LT contract then there is no pure strategy continuation equilibrium. This is because unsigned consumers go to the firm with the lowest price and each firm has an incentive to slightly undercut its rival's price. When choosing its spot price, the incumbent trades off the gains from attracting the unsigned consumers and the losses from lowering its margin from the signed consumers. In equilibrium, the expected gains from lowering the spot price below v must be equal to the losses. In order to have a mixed strategy continuation equilibrium, consumers must be indifferent between signing the LT contract and not signing it. We demonstrate that for an equilibrium to exist as $\epsilon \to 0$ it must be the case that the measure of consumers who signed the LT contract goes to 1. Hence, this guarantees the incumbent at least a payoff of $2(v - c_I)$ in any equilibrium.

Finally, we show that the incumbent can obtain no more than $2(v - c_I)$ from any consumer and thus the maximum profit is the foreclosure profit. Let's consider the incumbent's profit from each consumer group individually. Consumers who did not sign the LT contract in period 1 can generate no more profit than $v - c_I$. The consumers that signed the LT contract and do not switch to the entrant can generate no more profit than $2(v - c_I)$; otherwise these consumers would obtain negative utility. The last group includes consumers who signed the LT contract and switch to the entrant in period 2. We argue that the incumbent can obtain no more than $2(v - c_I)$ from those consumers. Suppose this was the case, the argument has three steps. First, we must have

$$p_{I1} - c_I + d \geq 2(v - c_I), \tag{1}$$

where the left-hand side is what the incumbent makes on every switching consumer. Second, consumers must get at least their surplus of not signing the LT contract:

$$v - p_{I1} + v - d - p_E \geq v - p_E, \tag{2}$$

where the left-hand side is the most a consumer can earn from accepting the incumbent's LT contract and the right-hand side is what the consumer can get by not signing the LT contract in period 1 and by buying from the entrant in period 2. Notice that it is the same p_E on both sides of equation (2). This is because an individual consumer choosing whether to sign the LT contract or not has no effect on the period 2-equilibrium price, since the firms' second-period strategies depend only on the period 1 history, which includes the incumbent's LT contract terms and the measure of consumers who signed the LT contract, and each consumer is nonpivotal. The left-hand side of equation (2) is an upper bound on the payoff from the LT contract, since $v - p_{I1}$ is the first-period payoff and $v - d - p_E$ is the second-period payoff of a consumer who draws zero switching cost given that this consumer switches by hypothesis. The second-period payoff can only be (at least weakly) decreasing in θ and so we have an upper bound. Finally, these two inequalities, (1) and (2), cannot be satisfied simultaneously: the first rearranges to $p_{I1} + d \geq 2v - c_I = v + v - c_I$ and the second rearranges to $p_{I1} + d \leq v$, which is a contradiction. Thus, the incumbent's foreclosure profit is higher than in any candidate equilibrium where either some consumers do not sign the LT contract or they sign and then switch to the entrant in period 2. Existence of an equilibrium where all consumers sign the LT with $p_{I1} = p_{I2} = v$ and $d > v$ is straightforward, and so we establish our main result.

PROPOSITION 1: *In the unique equilibrium, all consumers sign the incumbent's long-term contract and the incumbent sells to all consumers in period* 2, *and so fully forecloses the more efficient entrant. The equilibrium prices*, *payoffs*, *and expected utilities are*

$$p_{I1}^* = p_{I2}^* = p_{I2}^{S*} = p_E^* = v,$$

$$\Pi_I^* = 2(v - c_I),\ \Pi_E^* = 0,\ \textit{and}\ EU^* = 0.$$

The results of Proposition 1 are surprising because the incumbent always forecloses the more efficient entrant and captures all the surplus under full foreclosure, *regardless of the efficiency advantage of the entrant* or the level of switching costs. This is due to two features of our framework: (i) Inability of consumers to coordinate; (ii) breakup fees cannot be used to shift rent from the entrant to the incumbent. Indeed, even if there are no switchings costs, the incumbent still forecloses the entrant as in Proposition 1.

If consumers could coordinate, they would gain by all rejecting the incumbent's LT contract, since then each would get $v - c_I$ rather than 0. To illustrate why this cannot happen in equilibrium, we discuss a provocative example from a referee. Suppose $v = 100$, $c_I = 98$, $c_E = 0$, and switching costs are negligible, $\theta \to 0$. Why can't the incumbent allow signed consumers to switch to the entrant and make higher profits than the foreclosure profit by collecting breakup fees from switchers, for instance, via setting $d = 90$ and $p_{I1} = 55$? We now argue why we cannot have the incumbent shifting some efficiency rent from the entrant in contrast to Aghion and Bolton (1987). To see why we only have the full foreclosure equilibrium, consider each subgame.

If all consumers reject the LT contract then in the second period there will be Bertrand competition between the two firms with cost 98 and cost 0. In the equilibrium of this subgame, all consumers would buy from the entrant at a price of 98. As a result, consumers would earn 2, the incumbent would earn 0, and the entrant would earn 98. This cannot be the equilibrium of the game. Consider an individual consumer's deviation by accepting the LT contract. In this case, she expects to get a second-period surplus of 2 $(= 100 - 98)$, given that the MFN clause enables the consumer to purchase at the incumbent's lowest price in period 2. Hence, the consumer is willing to accept the LT contract as long as she gets some nonnegative surplus from period 1 consumption: $v \geq p_{I1}$. Given that $100 > 55$, an individual consumer deviates by accepting the LT contract, even if she expects all the other consumers to reject it. So it cannot be an equilibrium that all consumers reject the LT contract.

Consider the subgame where all consumers signed the incumbent's LT contract. We first argue that after signing the LT contract, all consumers switch to the entrant in period 2, and so the incumbent's profits come from collecting the fee in the second period. Given that the entrant is very efficient ($\Delta c = 98 > 2\theta = 0$) and the incumbent does not choose weakly dominated strategies, the undifferentiated competition between the entrant and the incumbent (as switching costs are negligible) implies that the incumbent sets its equilibrium price at the *opportunity cost* of retaining consumers: $p_{I2} = c_I + d = 98 + 90 = 188$. This is the cost of serving a consumer plus the lost revenue if a consumer buys from the incumbent rather than switching to the entrant.[21] The only possible equilibrium is the one where the entrant charges a price at the incumbent's cost, $p_E = c_I = 98$, and attracts all consumers from the incumbent's LT contract.[22] But, consumers would incur a loss of 88 in period 2 if they signed the LT contract ($v - p_E - d = 100 - 98 - 90 = -88$). Note that a signed consumer has to pay the breakup fee to the incumbent if she does not purchase a unit in period 2.[23] The total surplus for a consumer who signed the LT contract would be -43: $v - p_{I1} + v - p_E - d = 100 - 55 + 100 - 98 - 90 = -43$. An individual consumer's outside option of not signing the LT contract is 2, her value (100) less the entrant's price (98). So an individual consumer has an incentive to reject the LT contract. This shows that it cannot be equilibrium that all consumers sign the LT contract with $d = 90$ and $p_{I1} = 55$.

To maintain the breakup fee at $d = 90$, the incumbent has to lower the first-period price from 55 to at most 10. But then the incumbent's profit is $p_{I1} - c_I + d = 10 - 98 + 90 = 2$. On the other hand, if the incumbent deters entry, it would make twice the static monopoly profit: $2(v - c_I) = 2(100 - 98) = 4$. Thus, the LT contract allowing entry with $d = 90$ and $p_{I1} = 10$ results in less profit for the incumbent than the profit from deterring entry. Hence, even when the entrant is much more efficient than the incumbent and the switching costs are negligible, as in the example, the incumbent prefers to block entry since it could not shift rent from the entrant if it accommodated entry.

Efficiency of the Equilibrium Outcome.—Ex post efficiency, that is, after all consumers signed the LT contract, requires that consumers with $s < \Delta c$ to switch to the entrant. Proposition 1 illustrates that the entrant is always fully foreclosed. Hence, the equilibrium allocations are ex post inefficient and the distortion from foreclosure rises in Δc. Furthermore, it might be efficient for consumers not to buy from the incumbent in period 1 and save the expected switching cost. If all

[21] Here, we presume that $v - p_E > 0$ (which will be the case in equilibrium), and so if a consumer signed the LT contract, not buying any unit in period 2 is dominated by switching to the entrant, since she has to pay the breakup fee in both cases (by assumption of our model), but gets some surplus from consumption ($v - p_E > 0$) if she switches to the entrant.

[22] If the entrant charged a price strictly below 98, it could increase its profits by raising its price to a level still below 98 and attracting all consumers. This is the same reasoning in an asymmetric cost undifferentiated Bertrand model, where firms charge the same price and consumers must choose the firm with the lowest cost in equilibrium.

[23] In practice, we do not see breakup fees being conditioned only on switching to a rival, probably because such a condition in the incumbent's contract would raise antitrust concerns and also it would be difficult to verify whether a consumer purchased from a rival. To reflect the practice, we assume that a consumer who signed the LT contract in period 1 and does not buy a unit from the incumbent in period 2 has to pay the breakup fee to the incumbent.

consumers buy from the incumbent in period 1 and those with $s < \Delta c$ switch to the entrant in period 2, the total surplus is

$$2(v - c_I) + \frac{(\Delta c)^2}{2\theta}. \tag{3}$$

If all consumers do not buy from the incumbent in period 1 and buy from the entrant in period 2, the total surplus is $v - c_E$. If

$$v - c_I > \frac{(2\theta - \Delta c)\Delta c}{2\theta}, \tag{4}$$

then it is ex ante efficient that all consumers to buy from the incumbent in period 1. Otherwise, the equilibrium has inefficient purchases both in periods 1 and 2.

IV. Critical Factors for Inefficient Foreclosure

Now we discuss the critical assumptions for the full foreclosure result: allowing the incumbent's LT contract to have breakup fees as well as a most favored nation (MFN) clause, nonpivotal buyers, all consumers being locked into the LT contract in period 2, entrant market power, and ex ante homogeneous consumers. We also provide some policy implications with respect to breakup fees.

A. *Breakup Fees*

When the incumbent is not allowed to use a breakup fee, it cannot fully foreclose entry. Even when all consumers sign its long-term contract, some positive measure of consumers (ones with low switching costs) will prefer to buy from the more efficient entrant in period 2. If all consumers signed the incumbent's LT contract, we assume that the consumers' valuation from the product is sufficiently high so that consumers will always buy a product in equilibrium of period 2.

ASSUMPTION 1: $v > \frac{2\theta + c_E + 2c_I}{3}$.

The assumption ensures that the market is covered when the incumbent accommodates the entrant. This assumption was not needed to prove Proposition 1, since no consumer switches to the entrant when the incumbent can use breakup fees. We now present the equilibrium without breakup fees (the proof is in Appendix B).

PROPOSITION 2: *If breakup fees are banned, in equilibrium all consumers sign the incumbent's long-term contract.*

(*i*) *If* $\Delta c > 2\theta$, *there is a unique equilibrium where all consumers switch to the entrant. The equilibrium payoffs and utility are*

$$\Pi_I^* = v - c_I - \frac{\theta}{2}, \Pi_E^* = \Delta c - \theta, \textit{and } EU^* = v - c_I.$$

(*ii*) *If* $\Delta c \leq 2\theta$, *there is a unique equilibrium where both firms sell in period* 2. *The equilibrium payoffs and utility are*

$$\Pi_I^* = v - c_I + \frac{\theta^2 - 4\Delta c\theta + \Delta c^2}{6\theta},$$

$$\Pi_E^* = \frac{(\Delta c + \theta)^2}{9\theta} \text{ and } EU^* = v - \frac{\theta + 2c_E + c_I}{3} \equiv \underline{U}.$$

When the entrant's efficiency advantage is large, the incumbent cannot profitably compete against it in period 2 and sets $p_{I2}^* = c_I$. The entrant sets $p_E^* = c_I - \theta$, attracting all consumers and compensating them for the highest switching cost, θ. Hence, the entrant gets its competitive advantage less the highest switching cost. The incumbent attracts all consumers to its long-term contract by charging $v - \frac{\theta}{2}$ up-front, which compensates consumers for their expected switching costs.

Ex post efficiency requires that consumers switch to the entrant if and only if $s < \Delta c$. Proposition 2 shows that when breakup fees are banned, all consumers efficiently buy from the entrant if its efficiency advantage is large: $\Delta c > 2\theta$. However, if $\Delta c \leq 2\theta$, we show in Appendix B that in equilibrium consumers of type $s < \frac{\theta + \Delta c}{3}$ buy from the entrant. At $\Delta c = \frac{\theta}{2}$, the marginal type is exactly the difference in cost and so we get an ex post efficient allocation in equilibrium. As Δc decreases from 2θ down to $\theta/2$, the price difference is less than the cost difference and hence too few people buy from the entrant. For values of Δc smaller than $\theta/2$, the price difference is larger than the cost difference and too many people buy from the entrant conditional on having signed the incumbent's LT contract.

To further understand the intuition behind the result first note that the difference between the incumbent's and the entrant's price in equilibrium, $p_{I2}^* - p_E^* = \frac{\theta + \Delta c}{3}$, determines the marginal consumer type in period 2, which is increasing in Δc. When the entrant becomes more efficient (Δc increases), the entrant's price decreases more than the incumbent's second unit price, so the marginal type increases. Alternatively, when the incumbent becomes more inefficient (Δc increases), the incumbent's second-period price increases more than the entrant's price, so the marginal type increases.

Policy Implications of Banning Breakup Fees.—To analyze the welfare implications of breakup fees, we focus on the case where it is ex ante efficient that all consumers sign the incumbent's LT contract, that is, inequality (4) holds. This is the relevant case because both in the equilibrium with breakup fees and without breakup fees all consumers sign the LT contract in period 1.

COROLLARY 1: *When breakup fees are banned*, *the consumer surplus is always higher*:

(*i*) *The ban increases the total welfare if* $\Delta c \geq \frac{\theta}{5}$;

(*ii*) *The ban reduces the total welfare if* $\Delta c < \frac{\theta}{5}$.

The first-period welfare is $v - c_I$ regardless of allowing breakup fees or not. The second-period welfare with breakup fees is $W_2^* = v - c_I$ (all consumers buy a unit from the incumbent). When $\Delta c > 2\theta$, the second-period welfare without breakup fees is $W^*_{2,d=0} = v - c_E - \frac{\theta}{2}$, since then all consumers switch to the entrant in period 2 and so the expected switching cost is $\theta/2$. Hence, in this case the second-period welfare is lower with breakup fees than without: $W^*_2 = v - c_I < W^*_{2,d=0} = v - c_E - \frac{\theta}{2}$ since $\Delta c > \theta/2$. On the other hand, when $\Delta c \leq 2\theta$, the second-period welfare without breakup fees is

$$(5)\quad W^*_{2,d=0} = v - \Pr\left(s < \frac{\theta + \Delta c}{3}\right)c_E - \Pr\left(s \geq \frac{\theta + \Delta c}{3}\right)c_I - \int_0^{\frac{\theta+\Delta c}{3}} \frac{s}{\theta}\, ds.$$

It is then straightforward to show that when $\frac{\theta}{5} \leq \Delta c \leq 2\theta$ the welfare without breakup fees is larger than the welfare when breakup fees are allowed. A prohibition of breakup fees changes the firms' pricing and thus the allocation of consumers in equilibrium. As a result, whether banning breakup fees improves welfare depends on the comparison between the entrant's efficiency advantage and switching costs. When the entrant's efficiency advantage is very low compared to the highest switching cost, $\Delta c < \frac{\theta}{5}$, banning breakup fees is detrimental to the allocative efficiency, since without breakup fees too many consumers would switch to the entrant and incur switching costs. In this case, it is more efficient for the incumbent to serve all consumers. However, when the entrant's efficiency advantage is high enough, $\Delta c \geq \frac{\theta}{5}$, then banning breakup fees is an efficient regulatory intervention. If it is possible for a regulator to control the level of breakup fees, for example, by placing a binding cap on the fees, then the regulator could, in principle, implement the efficient allocation. This would clearly require the regulator to have a great deal of knowledge on all relevant market features.

The only reason why breakup fees might be desirable for the total welfare is that they reduce allocative inefficiency by reducing excessive entry when the entrant's efficiency advantage is very small compared to switching costs. Note that banning breakup fees is always beneficial to consumers since in the full foreclosure equilibrium with breakup fees consumers get zero surplus, whereas in the equilibrium where breakup fees are banned they always get some positive surplus ($v - c_I$ if $\Delta c > 2\theta$ and $\underline{U} > 0$ if $\Delta c \leq 2\theta$; see Proposition 2).

B. *MFNs in the Long-Term Contract*

As stated in the introduction, offering a long-term contract converts a nondurable good (consumption today) to a durable good (consumption today and tomorrow). In the foreclosure scenario, the incumbent would have an incentive to undercut its LT contract's second unit price so as to compete for unsigned consumers (residual demand), similar to the durable good monopolist's commitment problem (Coase 1972). Such an incentive would lower profits from foreclosure since consumers would then expect to pay a lower price and get a higher surplus if they did not sign the LT contract. The incumbent overcomes this problem by using an MFN clause, which allows consumers to switch from the LT contract to its spot price for free, and so undercutting the LT price would imply margin losses from all consumers. Hence, the incumbent would use this commitment tool and make it free to switch from the LT contract to its spot contract if we allowed the incumbent to choose whether to do that.

Finally, one might ask whether the result is dependent on the incumbent not using history-based pricing. That is, suppose the incumbent can offer a lower price in period 2 to consumers who did not sign the LT contract. This would give the incumbent an incentive to price more aggressively in period 2 for any new customer. From the incumbent's point of view this is problematic, since it would raise the expected consumer surplus from not signing the LT contract due to the more intense competition in period 2. An MFN in the LT contract prevents this.

C. *Nonpivotal Buyers*

Having infinitesimal buyers that are nonpivotal (nonconsequential for the total demand) is important for the foreclosure result. Suppose that there was one buyer, instead of a continuum. The buyer's decision of whether to sign the LT contract would affect its expected surplus from not signing it. This is in contrast to the case with nonpivotal buyers. If the buyer did not sign the LT contract, the firms compete for this buyer in period 2, and so asymmetric Bertrand competition would determine the prices. But then the expected buyer surplus from not signing the LT contract would not depend on the terms of the LT contract. As a result, breakup fees clearly would not matter for the equilibrium allocation in period 2. On the other hand, in Appendix C, we show that when there are finitely many buyers, the second-period pricing game only has a mixed strategy equilibrium and the incumbent's price approaches its benchmark equilibrium price (v) when the number of buyers goes to infinity.[24]

D. *All Consumers Are Locked into the LT Contract*

We now consider situations where some consumers are not locked into the LT contract in period 2. This can happen when a new group of consumers enter in period 2 or some consumers mistakenly did not sign the LT contract in period 1. First, suppose a new set of consumers enter the market in period 2. In this case, there exists no pure strategy equilibrium in the period 2 subgame; if one firm were to capture the new consumers, the other firm would slightly undercut the price. When the incumbent chooses whether to lower the LT contract's second unit price in period 2, it trades off the margin lost from the locked-in consumers (due to the MFNs the signed consumers can purchase at the lower price) with the gains of attracting new consumers. We show in in Appendix D that as the measure of new consumers goes to 0, the incumbent's incentive to undercut the second unit price of the LT contract goes to 0 and the equilibrium outcome of the benchmark model holds. Second, if some $\epsilon > 0$ amount of people reject the LT contract in period 1 by mistake, the equilibrium analysis is mathematically equivalent as if ϵ new consumers entered the market in period 2. Thus, the original equilibrium outcome prevails when $\epsilon \to 0$.

[24] Elhauge and Wickelgren (2015, Proposition 1) show that when there are a finite number of buyers, there exists an equilibrium where the incumbent forecloses efficient entry using loyalty discounts and up-front transfers. Their result is similar to our full foreclosure result in a sense that when the number of buyers increases in their setup, the minimum loyalty discount that the incumbent has to pay falls.

E. *Entrant Market Power*

If there were many entrants such that none of them had market power and so price at the marginal cost, consumers' outside option to signing the incumbent's first contract, would be exogenous $(EU_{nosignI} = v - c_E)$. Using the up-front fee, p_{I1}, the incumbent could capture all expected consumer surplus ex ante after leaving consumers their outside option. The incumbent would therefore prefer to maximize this surplus by inducing efficient purchasing in period 2. This requires setting $p_{I2} - d$ at its marginal cost. Hence, in equilibrium, all consumers would sign the incumbent's LT contract and switch to the entrants if and only if $s < \Delta c$. Whether breakup fees are allowed or not would not be critical for this result, since the outside option could not be affected by the level of breakup fees. Finally, allowing the incumbent to offer a spot contract in period 2 would not be critical for the equilibrium, since the incumbent would not want to undercut its LT contract price, which was set to its marginal cost. In Aghion and Bolton (1987) the entrant's market power is also crucial for having inefficient foreclosure via breakup fees. In their setup a rent-shifting mechanism via breakup fees would not be effective if the entrant had no rent. This differs from why the entrant's market power is necessary for our foreclosure result.

V. Extensions

First note that the full foreclosure result does not require ex ante commitment to the lowest second-period price or to the breakup fee level since the incumbent is allowed to offer a spot price in period 2 and does not want to offer a lower breakup fee in period 2. We now discuss extensions of the benchmark model.

A. *History-Based Price Discrimination by the Entrant*

We now allow the entrant to price discriminate based on whether the consumer bought from the incumbent in period 1. Such price discrimination can be feasible to implement only if the entrant can acquire information on whether a consumer signed the incumbent's LT contract in the previous period. For instance, the entrant can offer to pay the incumbent's breakup fees if they switch to the entrant (like in the examples we discussed in footnote 10). Assume that the entrant can offer a price, p_E, to consumers who signed the incumbent's LT contract and a price, $\hat{p}_E$, to those who did not sign the LT contract.

As in the benchmark case, the incumbent can choose d high enough to obtain the twice static monopoly profit by foreclosing the entrant. We now argue when the entrant is very efficient, $\Delta c > 2\theta$, the incumbent induces consumers to switch to the entrant in period 2 to shift some efficiency rent from the entrant via breakup fees. Thus, the incumbent improves its payoff by allowing entry.

When $\Delta c > 2\theta$, the incumbent sets its price at the opportunity cost of retaining a consumer, $p_{I2}^* = c_I + d$. The entrant reacts by setting $p_E^* = c_I - \theta$, $\hat{p}_E^* = c_I + d$ and efficiently sells to all consumers in period 2. A consumer's expected surplus from signing the LT contract is the surplus of buying a unit from the incumbent in period 1 at p_{I1} and buying a unit from the entrant in period 2, where she expects to pay $p_E^* = c_I - \theta$ to the entrant, d to the incumbent, and incur the expected switching cost of $\frac{\theta}{2}$:

$$EU_{signI} = 2v - p_{I1} - c_I + \theta - d - \frac{\theta}{2}.$$

Unlike the benchmark, a consumer's expected surplus from not signing the LT contract is buying a unit from the entrant at price $\hat{p}_E^* = c_I + d$, so $EU_{nosignI} = v - c_I - d$. The incumbent maximizes its profit, $\Pi_I = p_{I1} - c_I + d$, subject to the consumers' participation constraint, $EU_{signI} \geq EU_{nosignI}$, as well as the constraint that consumers should get a nonnegative payoff in equilibrium: $v - c_I - d \geq 0$. At the optimal solution the incumbent sets $p_{I1}^* = v + \frac{\theta}{2}$ and $d^* = v - c_I$, so captures $\Pi^* = 2(v - c_I) + \frac{\theta}{2}$, which is more than the foreclosure profit. We thereby have Proposition 3 (see Appendix E for a detailed proof).

PROPOSITION 3: *When the entrant can do history-based price discrimination, in the unique equilibrium the incumbent fully forecloses the entrant if the entrant is not very efficient*, $\Delta c \leq 2\theta$. *Otherwise, the entrant efficiently sells to all consumers in period* 2.

Intuitively, if the incumbent does not block entry ($p_{I2} - d > c_E$), consumers are more willing to accept the incumbent's LT contract when the entrant uses history-based price discrimination, since they then expect to pay a higher price if they do not sign the LT contract. When the entrant is very efficient ($\Delta c > 2\theta$), this increases the incumbent's profit from accommodating entry above the foreclosure profit. The entrant's price for a consumer who did not sign the incumbent's LT contract is equal to the incumbent's second-period price, $\hat{p}_E^* = p_{I2}^* = c_I + d$, whereas the entrant's price for a consumer who signed the LT contract is lower and equal to the incumbent's marginal cost less the highest switching cost: $p_E^* = c_I - \theta$. If a consumer signs the LT contract, she expects to switch to the entrant by paying c_I to the entrant, paying d to the incumbent, and incurring $\frac{\theta}{2}$ of switching costs, while being compensated by the entrant for the highest switching cost θ. If a consumer does not sign the LT contract, she expects to buy a unit from the entrant at a higher price $c_I + d$. Hence, each consumer is willing to pay a price above her valuation for the first unit, $p_{I1}^* = v + \frac{\theta}{2}$, and sign the LT contract with $d^* = v - c_I$ and $p_{I2}^* = v$. By allowing entry, the incumbent is able to capture $\frac{\theta}{2}$ more surplus than twice the static monopoly profit. By using the fact that the entrant is willing to pay for the breakup fee, the incumbent can transfer rent from the entrant, as in Aghion and Bolton (1987).

B. *Mismatch Value Interpretation of the Preference Parameter*

In the online Appendix, we offer an alternative model to the switching cost model such that we interpret the preference parameter, s, as a consumer's mismatch value of the entrant's product relative to the incumbent's: the utility from consuming the incumbent's good is v as before, but the value from consuming the entrant's good is $v - s$. In the alternative model, firms are differentiated due to consumer heterogeneity in mismatch value: s is uniformly distributed over $[0, \theta]$. Buyers are uncertain about their mismatch value before the decision of whether to sign the incumbent's long-term contract. Consumers' heterogeneous beliefs about their mismatch value might be manifested by how good a match (or mismatch) an entrant's product is for a particular consumer or how willing she is to try a new product. This alternative interpretation (from the switching cost one) has implications for the consumers' outside option to not signing the incumbent's first-period contract. Now, each consumer values the entrant's good less than the incumbent's, even if she did not sign the LT contract. This implies that the entrant faces a downward-sloping demand of these unsigned consumers, instead of getting all or none of them in the switching cost model when they were identical. We find that in this case, in the unique equilibrium the incumbent forecloses the entrant only if the entrant's cost advantage is sufficiently smaller than the highest mismatch value, $\Delta c \leq 2\theta$. Otherwise, the incumbent sells nothing in period 2 and all consumers buy from the entrant. Intuitively, when the entrant becomes more efficient, the incumbent has to leave consumers more surplus to convince them to sign the long-term contract, since the entrant's equilibrium price decreases in its cost given that it faces a downward-sloping demand of unsigned buyers. We note that this is exactly the same prediction as when the entrant can use history-based pricing, but for different reasons.

C. *Ex Ante Homogeneous Consumers*

Suppose there were some ex ante consumer heterogeneity such that consumers' value of a unit is $v - t$ where t is independently distributed from s over $[0, \bar{t}]$ and consumers know their preference parameter t in period 1.[25] If $\bar{t}$ is sufficiently small then the incumbent would still choose to lock in all consumers into the LT contract with a high enough breakup fee in period 1. There are two reasons for this. First, when $v - c_I$ is large relative to $\bar{t}$, the incumbent prefers to sell to all consumers, like when a monopolist faces a downward-sloping demand of consumers with high valuations. Second, by locking in all consumers in period 1, the incumbent is not tempted to compete fiercely in period 2 and so the consumers' gain from switching to the entrant can be lowered to zero, as in the benchmark. This makes full foreclosure profitable. When $\bar{t}$ is large relative to $v - c_I$, attracting all consumers in period 1 is costly in both periods. If the incumbent does not lock in all consumers in period 1, the entrant will price aggressively to attract unsigned consumers. When the entrant is very efficient, that is, when Δc is large, the incumbent cannot compete for unsigned consumers in period 2. In that case, the incumbent would prefer to accommodate the entrant and so breakup fees would be inconsequential, similar to the previous extensions.

VI. Conclusions

We investigate the welfare consequences of breakup fees of long-term contracts used by an incumbent facing a more efficient entrant in the future. We show that the

[25] We thank a referee for suggesting that we consider the case of ex ante heterogeneous buyers.

incumbent uses a high enough breakup fee to deter entry, regardless of the entrant's cost advantage or level of switching costs. Unlike Aghion and Bolton, this result does not depend on the ability of the incumbent to shift rents from the more efficient rival, since breakup fees cannot be used as a rent-shifting tool in our framework. Our result instead hinges on the ability of the incumbent using the terms of its long-term contract, in particular breakup fees and MFNs, to alter the consumers' outside option of not signing it. This makes foreclosure profitable. Hence, we identify a new mechanism of entry deterrence of a more efficient entrant by an incumbent via the profitable use of breakup fees in long-term contracts. In illustrating how this new entry deterrence mechanism can be profitable, we also identify a new role of widely used MFNs in long-term contracts: by making it free for consumers to switch from the incumbent's long-term contract to its spot price in period 2, MFNs enable the incumbent to commit to not undercutting the long-term contract's second-period price in the spot market, and so inducing the entrant to set a higher price.

Our results provide some policy implications regarding breakup fees of long-term contracts. A ban of breakup fees increases consumer welfare. The ban increases total welfare when the entrant's efficiency advantage is relatively high, but reduces the welfare when the incumbent and entrant have similar levels of efficiency, since without breakup fees there would be too much switching to the entrant. We extend our benchmark formally: by allowing the entrant to use history-based prices and allowing for the preference parameter to be consumers' mismatch value from the entrant's product relative to the incumbent's. In both cases, we illustrate that the incumbent forecloses the more efficient entrant only if the entrant's cost advantage is sufficiently small relative to the highest switching cost or mismatch value. Otherwise, the entrant efficiently serves all consumers in period 2. We also discuss the extensions when there are pivotal (finitely many) buyers, when some consumers mistakenly did not sign the long-term contract in period 1, when some new consumers enter the market in period 2, and when there is some ex ante consumer heterogeneity.

Finally, we argue that our predictions are consistent with the facts of the current FCC investigation on incumbent providers' lock-in provisions of long-term contracts for business data services (the case discussed in the introduction). We predict that the incumbent using a long-term contract with a breakup fee sets a higher second-period price than the entrant. The FCC investigation notes that AT&T's (incumbent) contracts are longer term (usually five to nine years) and charge higher tariffs than the competitor (entrant), which offer short-term (one-year) contracts. Furthermore, our theory predicts that early termination fees will be high enough to be effective in blocking an efficient entrant. The complaints in the FCC case argue that "these fees bear no relationship to the service costs incurred by the incumbent. For example, Sprint asserts that these fees may be as much as ten times the monthly rate under the pricing plan." Finally, the investigation points out the possibility that lock-up provisions of the incumbents' long-term contracts to "prevent competitors from achieving viable scale, preventing challenges to the nonaddressable portion of the market," so hindering investment in new technologies (fiber networks). Our framework considers the best entry condition by assuming a zero fixed cost of entry. Clearly, allowing for fixed entry costs would make entry deterrence more likely in equilibrium.

Appendix

A. *The Incumbent's Minimum Equilibrium Profit*

Suppose that the incumbent sets the LT contract $(p_{I1}, p_{I2}) = (v - \epsilon, v)$ and $d > v$. We now characterize the conditions for a mixed strategy equilibrium to exist in period 2 given that $0 < \alpha < 1$ amount of consumers signed the LT contract.

The lowest spot price of the incumbent is $p_{I2}^{S} = (1 - \alpha)\, c_I + \alpha v \equiv \underline{p}$, since the incumbent can always choose a spot price at v and get $\alpha(v - c_I)$. This is also the lowest price that the entrant charges in period 2, since there is undifferentiated competition between the entrant and the incumbent for those consumers who did not sign the LT contract. The highest price for both firms is v.

The equilibrium price distribution of the entrant's price, $F_E(\cdot)$, satisfies

$$F_E(p)\alpha(p - c_I) + (1 - F_E(p))(p - c_I) = \alpha(v - c_I). \tag{A1}$$

The left-hand side is the incumbent's expected profit from undercutting its LT contract's second-period price in a mixed strategy equilibrium, in which case the incumbent sells only to its locked-in consumers if the entrant's price is less than the incumbent's spot price (with $\Pr(p_E < p)$) and sells to all consumers otherwise. The right-hand side is the incumbent's profit from setting its spot price at v, in which case the incumbent sells only to its locked-in consumers, since the entrant attracts the unsigned consumers. Simplifying equation (A1) gives

$$F_E(p) = \frac{p - \alpha v - (1 - \alpha)c_I}{(1 - \alpha)(p - c_I)} = 1 - \frac{\alpha(v - p)}{(1 - \alpha)(p - c_I)},$$

and taking the derivative of the cumulative distribution gives the probability density of the entrant's price:

$$f_E(p) = \frac{\alpha(v - c_I)}{(1 - \alpha)(p - c_I)^2}.$$

The equilibrium price distribution of the incumbent's price, $F_I(\cdot)$, satisfies

AQ1

$$(1 - \alpha)(1 - F_I(p))(p - c_E)\cancel{)} = (1 - \alpha)(\underline{p} - c_E). \tag{A2}$$

The left-hand side is the entrant's expected profit in a mixed strategy equilibrium, in which case the entrant sells to the unsigned consumers if the incumbent's spot price is greater than the entrant's price (with $\Pr(p_{I2}^{S} > p)$) and sells nothing otherwise. The right-hand side is the entrant's profit when it sets the lowest price to attract all unsigned consumers. Simplifying equation (A2) gives

$$F_I(p) = \frac{p - \underline{p}}{p - c_E} = 1 - \frac{\underline{p} - c_E}{p - c_E},$$

and taking the derivative of the cumulative distribution gives the probability density of the incumbent's spot price:

$$f_I(p) = \frac{\underline{p} - c_E}{(p - c_E)^2}.$$

Note that there is a mass point of $F_I(\cdot)$ at v.

The expected surplus of a consumer who signs the incumbent's LT contract in period 1 is

$$EU_{signI} = \epsilon + v - \int_{\underline{p}}^{v} p f_I(p)\, dp.$$

The expected surplus of a consumer who does not sign the LT contract is

$$EU_{nosignI} = v - \int_{\underline{p}}^{v} p f_E(p)(1 - F_I(p))\, dp - \int_{\underline{p}}^{v} p f_I(p)(1 - F_E(p))\, dp.$$

The expected gains from signing the LT contract equal to

$$\text{(A3)}\quad EU_{signI} - EU_{nosignI} = \epsilon + \int_{\underline{p}}^{v} p f_E(p)[1 - F_I(p)]\, dp - \int_{\underline{p}}^{v} p F_E(p) f_I(p)\, dp.$$

The sum of the last two integral terms represents the price difference in period 2. Applying integration by parts to the second integral term, we simplify equation (A3) to

$$EU_{signI} - EU_{nosignI} = \epsilon + \int_{\underline{p}}^{v} p f_E(p)\, dp - v + \int_{\underline{p}}^{v} F_E(p) F_I(p)\, dp.$$

Applying integration by parts to the first integral term, we simplify the equation to

$$\text{(A4)}\quad EU_{signI} - EU_{nosignI} = \epsilon - \int_{\underline{p}}^{v} [1 - F_I(p)] F_E(p)\, dp.$$

In a mixed strategy equilibrium each consumer must be indifferent between accepting and rejecting the LT contract: $EU_{signI} - EU_{nosignI} = 0$. It means for each ϵ we need to find α such that $EU_{signI} - EU_{nosignI} = 0$. After plugging the distributions into equation (A4) (and setting $c_E = 0$ without loss of generality) we have

$$EU_{signI} - EU_{nosignI} = \epsilon - \int_{\underline{p}}^{v} \frac{\underline{p}}{p}\left[1 - \frac{\alpha(v - p)}{(1 - \alpha)(p - c_I)}\right] dp.$$

Calculating the latter integral and rearranging the terms by using the definition of $\underline{p} = (1 - \alpha) c_I + \alpha v$, we have $EU_{signI} - EU_{nosignI}$:

$$\text{(A5)}\quad \epsilon - \frac{\underline{p}}{(1 - \alpha) c_I}\left[\underline{p}(\ln v - \ln \underline{p}) - \alpha(v - c_I)\big(\ln(v - c_I) - \ln(\underline{p} - c_I)\big)\right].$$

Given that $\frac{\underline{p}}{(1-\alpha)c_I} > 0$, for a mixed strategy equilibrium we need the term inside the brackets to be 0 when $\epsilon \to 0$. First, observe that if $\alpha \to 0$, we have $\underline{p} \to c_I$, and so when $\epsilon \to 0$, the bracket term goes to $c_I(\ln v - \ln c_I)$.[26] This implies that the expected utility of not signing the LT contract is greater than the expected utility of signing it by $c_I(\ln v - \ln c_I)$:

$$\lim_{\alpha\to 0,\, \epsilon\to 0} (EU_{signI} - EU_{nosignI}) = -c_I(\ln v - \ln c_I).$$

Second, if $\alpha \to 1$, we have $\underline{p} \to v$, and so when $\epsilon \to 0$, the bracket term in (A5) goes to 0. As the denominator of equation (A5) also goes to 0 we apply l'Hôpital's rule to show that the expected utility difference goes to 0: $\lim_{\alpha\to 1,\, \epsilon\to 0}(EU_{signI} - EU_{nosignI})$ equals

$$\lim_{\alpha\to 1} \frac{\underline{p}(v-c_I)}{c_I}\left[-1 + \ln v - \ln \underline{p} - \big(\ln(v-c_I) - \ln(\underline{p}-c_I)\big) + \frac{\alpha(v-c_I)}{\underline{p}-c_I}\right] = 0.$$

Finally, the bracket term in (A5) is monotonically decreasing in α:

$$\begin{aligned}\frac{d[\cdot]}{d\alpha} &= (v-c_I)\left[\ln v - \ln \underline{p} - 1 - \big(\ln(v-c_I) - \ln(\underline{p}-c_I)\big) + \frac{\alpha(v-c_I)}{\underline{p}-c_I}\right]\\ &= (v-c_I)\big[\ln v - \ln \underline{p} - \big(\ln(v-c_I) - \ln(\underline{p}-c_I)\big)\big] < 0\end{aligned}$$

where the second equality holds because $\underline{p} - c_I = \alpha(v-c_I)$ using the definition of $\underline{p}$ and the inequality holds due to the concavity of the natural logarithm function. Hence, when $\epsilon \to 0$, the expected utility difference, (A5), goes to 0 only when $\alpha \to 1$.

We conclude that if $0 < \alpha < 1$ amount of consumers signed the LT contract with $(p_{I1}, p_{I2}) = (v-\epsilon, v)$ and $d > v$, for a mixed strategy equilibrium to exist when $\epsilon \to 0$, it must be the case that $\alpha \to 1$. Hence, as $\epsilon \to 0$ the incumbent gets twice the static monopoly profit, $2(v - c_I)$.

B. *Proof of Proposition 2*

When the incumbent's long-term contract cannot have a breakup fee, the entrant can always sell to some consumers in period 2. Recall that without loss of generality, $p_{I2}^S \geq p_{I2}$. To determine the constraint on p_{I2}, which arises from the spot market competition, consider an out-of-equilibrium path where $p_{I2}^S < p_{I2}$. Consumers then choose to pay the incumbent's spot price since the LT contract's second unit price is higher and under an MFN clause they can switch from the LT contract to the incumbent's spot offer at no cost. Consumers with switching costs lower than the difference between the incumbent's spot price and the cost of buying from the entrant, $s < p_{I2}^S - p_E$, switch to the entrant and the rest buy a unit from the incumbent at its

[26] We use L'Hôpital's rule to calculate $\lim_{\alpha\to 0} \frac{\ln(\underline{p}-c_I)}{1/\alpha} = 0$.

spot price. The entrant's demand is then $D_E = \frac{p_{I2}^S - p_E}{\theta}$ and the incumbent's demand is $D_{I2} = \frac{\theta - p_{I2}^S + p_E}{\theta}$ in period 2.

The incumbent sets p_{I2}^S by maximizing its second-period profit

$$\Pi_{I2} = (p_{I2}^S - c_I)\frac{\theta - p_{I2}^S + p_E}{\theta}.$$

The best-reply of the incumbent to the entrant's price is $p_{I2}^{S*}(p_E) = \frac{\theta + p_E + c_I}{2}$ if at that price it has some positive demand: $p_{I2}^{S*}(p_E) - p_E < \theta$. Otherwise, the incumbent cannot compete against the entrant and sets a price equal to the cost: $p_{I2}^{S*} = c_I$. Note that for the incumbent setting a spot price below c_I is weakly dominated: see our footnote 20.

The entrant sets p_E by maximizing its profit

$$\Pi_E = (p_E - c_E)\,\frac{p_{I2}^S - p_E}{\theta}.$$

The best-reply of the entrant to the incumbent's spot price is $p_E^*(p_{I2}^S) = \frac{p_{I2}^S + c_E}{2}$ if at this price the entrant does not attract all consumers: $p_{I2}^S - p_E^*(p_{I2}^S) < \theta$. Otherwise, the entrant sets $p_E^*(p_{I2}^S) = p_{I2}^S - \theta$ and sells to all consumers.

The simultaneous solution to the best-replies determines the spot market equilibrium prices and demands (in this subgame where $p_{I2}^S < p_{I2}$):

If $\Delta c \leq 2\theta$,

$$p_{I2}^{S*} = \frac{2\theta + c_E + 2c_I}{3}, \quad p_E^* = \frac{\theta + 2c_E + c_I}{3}, \tag{A6}$$

$$D_{I2}^* = \frac{2\theta - \Delta c}{3\theta}, \qquad D_E^* = \frac{\theta + \Delta c}{3\theta}.$$

If $\Delta c > 2\theta$,

$$p_{I2}^{S*} = c_I, \quad p_E^* = c_I - \theta, \tag{A7}$$

$$D_{I2}^* = 0, \quad D_E^* = 1.$$

In equilibrium, we have $p_{I2} \leq p_{I2}^{S*}$, since otherwise p_{I2} would not be paid by any consumer. Given $p_{I2} \leq p_{I2}^{S*}$, the entrant's best-reply is $p_E^* = \frac{p_{I2} + c_E}{2}$ when $\Delta c \leq 2\theta$, in which case both firms sell to some consumers in period 2. The entrant's best-reply is $p_E^* = p_{I2} - \theta$ when $\Delta c > 2\theta$, in which case the entrant sells to all consumers in period 2. Note that $p_E^* \leq p_{I2}^{S*}$.

Step 1 (Existence): We first show that there exists an equilibrium where each consumer signs the incumbent's LT contract and then show that this is the unique equilibrium. Suppose that each consumer believes that every other consumer signs the incumbent's LT contract.

A consumer's surplus from not signing the incumbent's LT contract is the net surplus of buying from the entrant in period 2:

$$EU_{nosignI} = v - p_E^*, \tag{A8}$$

where the entrant's price is $p_E^* = \frac{p_{I2} + c_E}{2}$ if $\Delta c \leq 2\theta$ and $p_E^* = p_{I2} - \theta$ when $\Delta c > 2\theta$.

A consumer's expected utility if she signs the LT contract is

$$EU_{signI} = 2v - p_{I1} - p_{I2}\Pr(s \geq p_{I2} - p_E^*) - \int_0^{p_{I2}-p_E^*} (s + p_E^*)\,\frac{1}{\theta}\,ds,$$

which is the net surplus from period 1 consumption plus the expected surplus from period 2 consumption, where the consumer buys a unit from the incumbent if her switching cost is above the difference between the prices of the incumbent and the entrant, that is, if $s \geq p_{I2} - p_E^*$, otherwise she buys a unit from the entrant and incurs her switching cost.

The incumbent maximizes its profit subject to the consumers' participation constraint, $EU_{signI} \geq EU_{nosignI}$, and the second-period price equilibrium, $p_{I2} \leq p_{I2}^{S*}$:

$$\max_{p_{I1},p_{I2}} \Pi_I = [p_{I1} - c_I + (p_{I2} - c_I)\Pr(s \geq p_{I2} - p_E^*) + d\Pr(s < p_{I2} - p_E^*)]$$

subject to

(i) $EU_{signI} \geq EU_{nosignI}$,

(ii) $p_{I2} \leq p_{I2}^{S*}$.

At the optimal solution the incumbent sets the highest p_{I1} satisfying the participation constraint, (i):

$$p_{I1}^*(p_{I2}) = v + (p_E^* - p_{I2})\,\frac{\theta - p_{I2} + p_E^*}{\theta} - \int_0^{p_{I2}-p_E^*} s\,\frac{1}{\theta}\,ds.$$

Replacing the latter in the incumbent's profit we rewrite its problem:

$$\max_{p_{I2}} \Pi_I = v - c_I + (p_E^* - c_I)\left(1 - \frac{p_{I2} - p_E^*}{\theta}\right) - \int_0^{p_{I2}-p_E^*} s\,\frac{1}{\theta}\,ds$$

subject to (ii). If $\Delta c \leq 2\theta$, the first-order conditions of the incumbent's problem give us the equilibrium prices

$$p_{I2}^* = \frac{2\theta + c_E + 2c_I}{3}, \quad p_E^* = \frac{\theta + 2c_E + c_I}{3}.$$

Observe that constraint (ii) is also satisfied since $p_{I2}^{*} = p_{I2}^{S*}$. Hence, when $\Delta c \leq 2\theta$, in equilibrium the incumbent's profit, the entrant's profit, and the consumer surplus are, respectively,

$$\Pi_I^{*} = v - c_I + \frac{\theta^2 - 4\Delta c\theta + \Delta c^2}{6\theta},\ \Pi_E^{*} = \frac{(\Delta c + \theta)^2}{9\theta},$$

$$EU^{*} = v - \frac{\theta + 2c_E + c_I}{3} \equiv \underline{U}.$$

On the other hand, if $\Delta c > 2\theta$, the incumbent cannot compete against the entrant and so sets $p_{I2}^{*} = p_{I2}^{S*} = c_I$.[27] The entrant reacts by setting $p_E^{*} = c_I - \theta$. In this case, the entrant sells all consumers in period 2 (this is efficient) and the incumbent captures its static monopoly profit, $\Pi_I^{*} = v - c_I$, by collecting $p_{I1}^{*} = v - d^{*}$ up-front, the entrant gets its competitive advantage after compensating consumers for the highest switching cost: $\Pi_E^{*} = \Delta c - \theta$, and the consumer surplus is $EU^{*} = v - c_I$.

Step 2 (Uniqueness): If all consumers reject the incumbent's LT contract, there will be undifferentiated Bertrand competition with no switching costs resulting in a price equal to the incumbent's cost. Hence, consumers expect to receive $v - c_I$ if they all reject (or all other consumers reject) the LT contract. To obtain uniqueness, we see whether consumers have a credible outside option to reject the LT contract if the incumbent does not offer them at least $v - c_I$.

When $\Delta c > 2\theta$, $v - c_I$ is what a consumer's expected utility is in the equilibrium we derived above (when all consumers expect each other to accept the incumbent's LT contract). When $\Delta c \leq 2\theta$ a consumer's expected equilibrium payoff, which we computed in step 1, was

$$\underline{U} = v - \frac{\theta + 2c_E + c_I}{3}.$$

If this value is greater than $v - c_I$, then consumers do not have a credible threat to reject the incumbent's offer of $\underline{U}$ from step 1. Hence, we have a unique equilibrium for $\Delta c > \theta/2$.

We now argue that the equilibrium is unique for $\Delta c \leq \theta/2$. The difference between the argument for this case and for when $\Delta c > \theta/2$, is that $\underline{U} < v - c_I$ in this case. The distinction is that now the consumers' outside option if they all say no to the incumbent's offer is higher than the equilibrium utility that the incumbent offered when all consumers believed that all other consumers would accept the offer.

So, we need to check whether consumers can credibly reject an offer that gives them more than $\underline{U}$ up to $v - c_I$. Suppose that consumers coordinate to reject any offer from the incumbent in period 1 that gives them a lower expected utility than $\overline{U} \in (\underline{U}, v - c_I]$. Suppose that the incumbent makes the offer of $\underline{U}$, which will include a price of $p_{I1}^{*} < v$. It cannot be an equilibrium that all consumers

[27] Observe that for the incumbent setting a price below its marginal cost is weakly dominated by setting $p_{I2}^{S*} = c_I$.

reject the offer. A consumer could accept the offer and improve her payoff, since $v - p_{I1}^{*} + v - c_I > v - c_I$, given that the consumer pays the same price in period 2 due to the MFNs. Since all consumers will have this incentive, their threat of rejecting $\underline{U}$ is not credible.

Finally, can an equilibrium where only some consumers accept the incumbent's LT contract exist? If a measure α consumers accept the LT contract, then for the spot prices that give the incumbent positive second-period sales, the incumbent's and the entrant's prices are

$$p_{I2}^{S*} = \frac{\theta(1+\alpha)/\alpha + c_E + 2c_I}{3}, \; p_E^{*} = \frac{\theta(2-\alpha)/\alpha + 2c_E + c_I}{3}.$$

We should note that for small α none of the consumers will buy from the incumbent in period 2.[28] The consumers who reject the LT contract have a utility of

$$U(\alpha) = v - \frac{\theta(2-\alpha)/\alpha + 2c_E + c_I}{3}.$$

It is straightforward to show that $U(\alpha) < \underline{U}$ for any $\alpha < 1$. But, this contradicts the fact that consumers will reject any offer that gives them some utility $U \in (\underline{U}, v - c_I]$. ∎

C. *Nonpivotal Buyers*

We now demonstrate that our equilibrium for a continuum of consumers is the limit equilibrium with a finite number of consumers. Suppose that there are N consumers with $N - 1$ consumers having signed the incumbent's LT contract in period 1 and d is set such that none of these consumers would buy the entrant's good in period 2.

There is no pure strategy equilibrium in period 2 where the incumbent chooses a spot price and the entrant chooses its price. Suppose that there were. It must be the case that the entrant wins the remaining buyer, since it is willing to price down to $c_E < c_I$ to attract the buyer and the incumbent would never price below c_I. If the entrant won the buyer then one of the sellers would prefer to change its offer. If $p_E < p_{I2}^{S} \leq v$ then the entrant could profitably raise its price and still attract the remaining buyer. If $p_E = p_{I2}^{S} < v$ then the incumbent prefers to raise its price and not lose the margin on its $N - 1$ buyers. If $p_E = p_{I2}^{S} = v$ then the incumbent would lower its price slightly.

There is a mixed strategy equilibrium. The lowest price that the incumbent would choose in the equilibrium is a price $\underline{p}_I$ that satisfies

$$(N-1)(v - c_I) = N(\underline{p}_I - c_I).$$

[28] In this case, the equilibrium prices will be $p_{I2}^{S*} = c_I$ and $p_E^{*} = c_I - \theta$. This case corresponds to the equilibrium outcome when $\Delta c > 2\theta$ and so consumers do not have an incentive to deviate from this equilibrium given that they get $v - c_I$.

At $\underline{p}_I$, the incumbent is indifferent between selling to all consumers and only to its captive consumers at a price of v. Thus, $\underline{p}_I = \left[(N-1)v + c_I\right]/N$. Clearly, this will be the lowest price that the entrant would be willing to choose. Any price lower than $\underline{p}_I$ will not be made by the incumbent and if the lower bound were higher then each seller would have an incentive to price slightly lower and guarantee a profit with probability 1. The highest price in both sellers' equilibrium support is v. The incumbent's profit is $(N-1)(v-c_I)$ while the entrant's is $\underline{p}_I - c_E$. The distribution of prices for the incumbent and entrant are

$$F_I(p) = \frac{p-\underline{p}_I}{p-c_E} \quad \text{and} \quad F_E(p) = \frac{N(p-c_I)-(N-1)(v-c_I)}{N(p-c_I)}.$$

Notice that there is a mass point for the incumbent's price distribution at v. As $N \to \infty$, $\underline{p}_I \to v$, which is the upper bound of the support then the incumbent's profit goes to the static monopoly profit. The incumbent can induce all consumers to buy its LT contract by offering a first-period price of $v-\varepsilon$ such that ε is larger than the expected difference between the incumbent and entrant prices, which clearly goes to 0 as $N \to \infty$.

D. *Entry of New Buyers*

Finally, we examine the case when there is an exogenous entry of new buyers ϵ into the market. As in the case with a finite number of buyers, there is no pure strategy equilibrium in prices in period 2. If there was, at least one of the sellers could profitably deviate. In the mixed strategy equilibrium, the entrant's price distribution is $F_E(p)$. By setting d sufficiently high, the incumbent can always make sure that it will keep all the consumers who signed the LT contract. Thus, the lowest price that the incumbent would choose in order to attract new consumers is $\underline{p}$, which satisfies

$$(v-c_I) = (1+\epsilon)(\underline{p}_I - c_I).$$

Or $\underline{p}_I = \frac{v+\epsilon c_I}{1+\epsilon}$. As $\epsilon \to 0$, $\underline{p}_I$ goes to v, which is the period 2 equilibrium price in the LT. The entrant then cannot sell to any signed consumers because of the high d. The incumbent's equilibrium pricing distribution makes the entrant indifferent between charging $\underline{p}_I$ and getting new consumers with probability 1, and charging a higher price and maybe not making any sales.

E. *Proof of Proposition 3*

Suppose that the entrant can do history-based price discrimination. Let p_E denote the entrant's price to consumers who signed the incumbent's LT contract and $\hat{p}_E$ denote the entrant's price to consumers who did not sign the LT contract (if there are any of these consumers). Using a similar argument as in the benchmark model the incumbent can always guarantee its foreclosure profit, $2(v-c_I)$. We analyze whether the incumbent can earn more than this if it accommodates entry.

Consider the subgame where the incumbent sets $p_{I2} - d \geq c_E$, which allows the entrant to have some sales in period 2. To determine the constraint on p_{I2}, which arises from the spot market competition, consider an out-of-equilibrium path where $p_{I2}^S < p_{I2}$. Consumers then choose to pay the incumbent's spot price since the LT contract's second unit price is higher and under an MFN clause they can switch from the LT contract to the incumbent's spot offer at no cost. Consumers with switching costs lower than the difference between the incumbent's spot price and the cost of buying from the entrant, $s < p_{I2}^S - d - p_E$, switch to the entrant and the rest buy a unit from the incumbent at its spot price. The entrant's demand is then $D_E = \frac{p_{I2}^S - d - p_E}{\theta}$ and the incumbent's demand is $D_{I2} = \frac{\theta - p_{I2}^S + d + p_E}{\theta}$ in period 2.

The incumbent sets p_{I2}^S by maximizing its second-period profit

$$\Pi_{I2} = \left(p_{I2}^S - c_I\right) \frac{\theta - p_{I2}^S + d + p_E}{\theta} + d\, \frac{p_{I2}^S - d - p_E}{\theta},$$

which is the sum of the profit from sales and the revenue from breakup fee payments made by consumers who switch to the entrant. The best-reply of the incumbent to the entrant's price is $p_{I2}^{S*}(p_E) = d + \frac{\theta + p_E + c_I}{2}$ if at that price it has some positive demand: $p_{I2}^{S*}(p_E) - d - p_E < \theta$. Otherwise, the incumbent cannot compete against the entrant and sets a price equal to the opportunity cost of attracting one buyer in period 2: $p_{I2}^{S*} = d + c_I$, that is, the cost of serving one buyer, c_I, plus the forgone revenue from the lost breakup fee, d, when a consumer buys from the incumbent rather than switching to the entrant. Note that for the incumbent setting a spot price below $c_I + d$ is weakly dominated: see our footnote 20.

The entrant sets p_E by maximizing its profit

$$\Pi_E = (p_E - c_E)\, \frac{p_{I2}^S - p_E - d}{\theta}.$$

The best-reply of the entrant to the incumbent's spot price is $p_E^*(p_{I2}^S) = \frac{p_{I2}^S - d + c_E}{2}$ if at this price the entrant does not attract all consumers: $p_{I2}^S - d - p_E^*(p_{I2}^S) < \theta$. Otherwise, the entrant sets $p_E^*(p_{I2}^S) = p_{I2}^S - d - \theta$ and sells to all consumers.

The simultaneous solution to the best-replies determine the spot market equilibrium prices and demands (in this subgame where $p_{I2}^S < p_{I2}$):

If $\Delta c \leq 2\theta$,

$$\text{(A9)} \qquad p_{I2}^{S*} = d + \frac{2\theta + c_E + 2c_I}{3}, \quad p_E^* = \frac{\theta + 2c_E + c_I}{3},$$

$$D_{I2}^* = \frac{2\theta - \Delta c}{3\theta}, \qquad D_E^* = \frac{\theta + \Delta c}{3\theta}.$$

If $\Delta c > 2\theta$,

$$\text{(A10)} \qquad p_{I2}^{S*} = d + c_I, \quad p_E^* = c_I - \theta,$$

$$D_{I2}^* = 0, \qquad D_E^* = 1.$$

In equilibrium, we have $p_{I2} \leq p_{I2}^{S*}$, since otherwise p_{I2} would not be paid by any consumer. Given $p_{I2} \leq p_{I2}^{S*}$ and $p_{I2} - d \geq c_E$, the entrant's best-reply is $p_E^* = \frac{p_{I2} - d + c_E}{2}$ when $\Delta c \leq 2\theta$, in which case both firms sell to some consumers in period 2. The entrant's best-reply is $p_E^* = p_{I2} - d - \theta$ when $\Delta c > 2\theta$, in which case the entrant sells to all consumers in period 2. In contrast to the benchmark analysis, the entrant could compete for those consumers that did not sign the LT contract by undercutting the incumbent's second-period price and offering $\hat{p}_E^* = p_{I2}$ to these consumers.

If a consumer does not sign the LT contract, she expects to buy a unit from the entrant at price $\hat{p}_E^* = p_{I2}$ and so the expected surplus from not signing the LT contract is (note that the consumers' outside option is different from the benchmark)

$$EU_{nosignI} = v - p_{I2}.$$

The expected surplus from signing the LT contract and the incumbent's problem are, respectively,

$$EU_{signI} = v - p_{I1} + v - p_{I2}\Pr(s \geq p_{I2} - p_E^* - d)$$
$$- \int_0^{p_{I2}-p_E^*-d} (s + p_E^* + d)\,\frac{1}{\theta}\,ds,$$

and

$$\max_{p_{I1}, p_{I2}, d} \Pi_I$$
$$= [p_{I1} - c_I + (p_{I2} - c_I)\Pr(s \geq p_{I2} - p_E^* - d) + d\Pr(s < p_{I2} - p_E^* - d)],$$

subject to

(i) $EU_{signI} \geq EU_{nosignI}$,

(ii) $p_{I2} \leq p_{I2}^{S*}$,

(iii) $p_{I2} - d \geq c_E$.

At the optimal solution the incumbent sets the highest p_{I1} satisfying the participation constraint, (i)

$$p_{I1}^* = v - \int_0^{p_{I2}-p_E^*-d} (s + p_E^* - p_{I2} + d)\,\frac{1}{\theta}\,ds.$$

Replacing the latter into the incumbent's profit we rewrite its problem:

$$\max_{p_{I2}, d} \Pi_I = v - c_I + p_{I2} - c_I\left(1 - \frac{p_{I2} - p_E^* - d}{\theta}\right) - \int_0^{p_{I2}-p_E^*-d} (s + p_E^*)\,\frac{1}{\theta}\,ds.$$

subject to (ii) and (iii). The incumbent can capture the ex ante expected consumer surplus via the first-period price and this washes out the breakup revenues and period 2 sales revenues from the incumbent's profit function. As a result, the incumbent's profit depends on $p_{I2} - d$ via its effect on the second-period consumption decisions, but also depends on the individual level p_{I2}.

If $\Delta c \leq 2\theta$, the first-order condition of the incumbent's problem with respect to p_{I2} gives us the unconstrained second-period optimal price:

$$p_{I2}^{unc} = d + \frac{4\theta + c_E + 2c_I}{3} > p_{I2}^{S*},$$

so constraint (ii) is binding in equilibrium, $p_{I2}^* = p_{I2}^{S*}$:

$$p_{I2}^* = d + \frac{2\theta + c_E + 2c_I}{3}, \quad p_E^* = \frac{\theta + 2c_E + c_I}{3},$$

given that at these prices constraint (iii) is also satisfied. The incumbent's equilibrium profit

$$\Pi_I^* = v - c_I + \frac{\theta^2 - 4\Delta c\theta + \Delta c^2}{6\theta}$$

is less than the foreclosure profit.

In the case of $\Delta c > 2\theta$, the incumbent sets $p_{I2}^{S*} = p_{I2}^* = c_I + d$, the entrant sets $p_E^* = c_I - \theta$ and $\hat{p}_E^* = c_I + d$, and sells to all consumers in period 2 (this is efficient). A consumer's expected surplus from signing the LT contract is the surplus of buying a unit from the incumbent in period 1 at p_{I1} and buying a unit from the entrant in period 2, where she expects to pay $p_E^* = c_I - \theta$ to the entrant, d to the incumbent, and incurs an expected switching cost of $\frac{\theta}{2}$:

$$EU_{signI} = 2v - p_{I1} - \frac{\theta}{2} - d - c_I + \theta.$$

The incumbent's problem is

$$\max_{p_{I1}, d} \Pi_I = p_{I1} - c_I + d,$$

subject to

(i) $EU_{signI} \geq EU_{nosignI}$,

(ii) $v - c_I - d \geq 0$,

where constraint (i) is the consumers' participation constraint and is different from the benchmark since buying a unit from the entrant at price $\hat{p}_E^* = c_I + d$ is now the outside option:

$$EU_{nosignI} = v - c_I - d.$$

Constraint (ii) ensures that the consumers who did not sign the LT contract would get nonnegative surplus in period 2: $v - c_I - d \geq 0$. At the optimal solution the incumbent sets $p_{I1}^* = v + \frac{\theta}{2}$ and $d^* = v - c_I$ and so captures $\Pi^* = 2(v - c_I) + \frac{\theta}{2}$, which is more than the foreclosure profit. ∎

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AQ#	Question	Response
1.	Please check for extra paren in equation (A2).	
2.	For European Commission (2013) and Horrigan and Satterwhite (2010), please provide URL and date accessed, or additional information such as publisher or city of publication.	