Coordination and Lock-In:
Competition with Switching Costs and Network Effects

Part I of IV Table of Contents, Abstract and Introduction

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ABSTRACT

Switching costs and network effects bind customers to vendors if products are incompatible, locking customers or even markets in to early choices. Lock-in hinders customers from changing suppliers in response to (predictable or unpredictable) changes in efficiency, and gives vendors lucrative ex post market power---over the same buyer in the case of switching costs (or brand loyalty), or over others with network effects.

Firms compete ex ante for this ex post power, using penetration pricing, introductory offers, and price wars. Such "competition for the market" or "life-cycle competition" can adequately replace ordinary compatible competition, and can even be fiercer than compatible competition by weakening differentiation, as in mix-and-match duopoly.

More often, however, incompatible competition not only involves direct efficiency losses but also softens competition and magnifies incumbency advantages. With network effects, established firms have little incentive to offer better deals when buyers' and complementors' expectations hinge on non-efficiency factors (especially history such as past market shares), and although competition between incompatible networks is initially unstable and sensitive to competitive offers and random events, it later "tips" to monopoly, after which entry is hard, often even too hard given incompatibility. And while switching costs can encourage small-scale entry, they discourage sellers from raiding one another's existing customers, and so also discourage more aggressive entry.

Because of these competitive effects, even inefficient incompatible competition is often more profitable than compatible competition, especially for dominant firms with installed-base or expectational advantages. Thus firms probably seek incompatibility too often. We therefore favor thoughtfully pro-compatibility public policy.

Introduction

The economics of switching costs and network effects have received a great deal of popular, as well as professional, attention in the last two decades. They are central to the "new economy" information technology industries. But these new topics are closely linked to traditional concepts of contract incompleteness, complementarity, and economies of scale and scope.

Both switching costs and proprietary network effects arise when consumers value forms of *compatibility* that require otherwise separate purchases to be made from the same firm. Switching costs arise if a consumer wants a group, or especially a series, of his own purchases to be compatible with one another: this creates economies of scope among his purchases from a single firm. Network effects arise when a user wants compatibility with *other* users (or complementors), so that he can interact or trade with them, or use the same complements; this creates economies of scope between *different* users' purchases.

These economies of scope make it unhelpful to isolate a transaction: a buyer's best action depends on other, complementary transactions. When those transactions are in the future, or made simultaneously by others, his *expectations* about them are crucial. When they are in the past, they are *history* that matters to him. History also matters to a firm because established *market share* is a valuable asset: in the case of switching costs, it represents a stock of individually locked-in buyers, while in the case of network effects an installed base directly lets the firm offer more network benefits and may also boost expectations about future sales.

Vying for valuable share, firms may compete hard for early adoptions, notably with penetration pricing but perhaps also in less efficient ways. Early sales induce lucrative follow-on sales, which we often call locked-in, although lock-in is seldom absolute. Both switching costs and proprietary network effects thus shift the locus of competition from smaller to larger units of sales, as economies of scope, tying, and bundling do, but usually in a different contracting game.

When switching costs are high, buyers and sellers actually trade streams of products or services, but their contracts often cover only the present. Similarly, network

effects push large groups of users toward doing the same thing as one another, but contracts usually cover only a bilateral transaction between a seller and one user. If users choose sequentially, early choices constrain later buyers and create "collective switching costs;" if users choose simultaneously, they face a coordination problem. Clever contracts can solve these problems, but ordinary contracts generally do not.

Because firms compete to capture buyers, those problems are more subtle than the mere fact that buyers are locked in ex post. For example, in the simplest switching-cost models, initial sales contracts do not specify future prices, yet competition for the stream of purchases is efficient. Similarly, in some simple network models, users efficiently coordinate and network effects cause no trouble. As such models illustrate, conventional competition "in the market" *can be* replaced by well-functioning competition "for the market"---for a buyer's lifecycle requirements in the case of switching costs, or for the business of many buyers when there are network effects. Early adoptions are often pivotal and competition focuses on them; later, locked-in buyers pay more and create ex post rents; but ex ante competition passes those rents through to the pivotal buyers. This can be efficient, though it raises distributional issues unless (as in simple switching cost markets) locked-in buyers were themselves previously pivotal.

But these simplest models are misleading: things do not usually work so well. Despite ex ante competition for the market, incompatibilities often reduce efficiency and harm consumers in a number of ways:

Direct costs are incurred if consumers actually switch or actually adopt incompatible products.[1] Consumers may avoid those costs by not switching, or by buying from the same firm, but that ties together transactions and thus often obstructs efficient buyer-seller matching. Variety may be more sustainable if niche products don't force users to sacrifice network effects or incur switching costs by being incompatible with mainstream products. Entrants lack installed bases and consumers' expectations may naturally focus on established firms, so entry with network effects, and large-scale entry with switching costs, are hard. These entry hurdles may be broadly efficient *given* incompatibility, but they nevertheless represent a social cost of incompatibility.

[1] In some cases, firms may also dissipate resources creating and defending incompatibility --- by contract, product design, or (as in "aftermarket" cases such as Kodak) business practice.

Ex ante competition often fails to compete away ex post rents: switching costs typically raise oligopoly profits and proprietary network effects often do, especially if expectations fail to track relative surplus. And even when ex ante competition dissipates ex post rents, it may do so in unproductive ways such as through socially inefficient marketing; at best it induces “bargain-then-ripoff” pricing (low to attract business, high to extract surplus) that normally distorts buyers' quantity choices, gives consumers wrong signals about whether to switch, and (in the case of network effects) provides artificial incentives to be or appear pivotal.

Thus while incompatibility does not necessarily damage competition, it often does.

Switching Costs

A product has classic switching costs if a buyer will purchase it repeatedly and will find it costly to switch from one seller to another. Switching costs also arise if a buyer will purchase follow-on products such as service and repair, and will find it costly to switch from the supplier of the original product.

Large switching costs lock in a buyer once he makes an initial purchase, so he is effectively buying a series of goods, just as (more generally) with strong enough relationship-specific economies of scope, sellers compete on bundles of goods rather than single goods. Sometimes sellers offer complete ("life-cycle") contracts that specify all prices. But often contracts do not specify all the future prices, so that a long-term relationship is governed by short-term contracts. This pattern creates ex post monopoly, for which firms compete ex ante.[2]

Some of the same issues arise if contracts are incomplete for other reasons. For instance, shops often advertise some, but not all, of their prices: the consumer learns others only once he is in the shop and will find it costly to go elsewhere. Just as with dynamic switching costs, this tends to produce ripoffs on un-advertised (small print) prices and correspondingly bargains on advertised (loss leader) prices.

The same consumer-specific economies of scope are present in “shopping-cost” markets where consumers face costs of using different suppliers for different goods in a

[2] Williamson (1985) stressed the "fundamental transformation, in which the initial winner of a bidding competition thereafter enjoys an advantage over rival suppliers because of its ownership of or control over transaction specific assets."

single period and with all prices advertised, but neither time nor commitment problems arise. Such shopping costs encourage firms to offer a full (perhaps too broad) product line – and so help explain multi-product firms – but can lead firms to offer similar products to each other so that there may be too little variety in the market as a whole. We argue below that the shopping-cost framework is the best way to understand the otherwise hard-to-categorize “mix and match” literature.

Switching costs shift competition away from what we normally think of as the default (a single consumer's needs in a single period) to something broader---a single consumer's needs over time. Even when that long-term relationship is governed by short-term contracts, this shift need not cause competitive problems: competing on first-period terms can be an adequate proxy for competition with complete contracts. Likewise, the theory of bilateral contracts with hold-up shows that when parties cannot readily contract on future variables and there are switching costs, it can be efficient to accept that hold-up will occur and to compensate the prospective victim up front. But this only works if the parties can efficiently transfer rents across periods; often, instead, “hold up” or “bargain-then-ripoff” pricing distorts quantity choices, incentives to switch suppliers, and entry incentives.

The bargain-then-ripoff structure is clearest when new and locked-in customers are clearly distinguished and can be charged separate bargain and ripoff prices respectively. This will be the case when prices are individually negotiated (and existing customers are known); it will also be the case when locked-in buyers buy separate “follow-on” products such as parts and service, rather than repeatedly buying the same good.

If, however, each firm has to set a single price to old (locked-in) and new customers, then its trade with a locked-in customer affects its trade with a new customer and the problem is no longer bilateral. A form of bargain-then-ripoff pricing sometimes survives, with firms engaging in repeated "sales", but prices will often instead be a compromise between high prices to exploit locked-in buyers and lower prices to build a locked-in customer base

Whether we see bargain-then-ripoff dynamics, or whether we see a single compromise price, switching costs may either raise or lower average oligopoly prices.

The outcome depends heavily on how consumers form expectations about future prices, but on balance switching costs seem more often to increase prices. Furthermore, switching costs can segment an otherwise undifferentiated market as firms focus on their established customers and do not compete aggressively for their rivals' buyers, letting oligopolists extract positive profits.

Switching costs also affect entry conditions, in two opposing ways. They hamper forms of entry that must persuade customers to pay those costs. So in a classic switching-cost market they hamper large-scale entry that seeks to attract existing customers (for instance to achieve minimum viable scale, if the market is not growing quickly). Likewise, shopping costs make single-product entry hard.

On the other hand, if incumbents must set a single price to old and new buyers, switching costs create a fat-cat effect: a firm with a larger customer base puts relatively more weight on harvesting this base than on winning new customers. This fat-cat effect actually encourages entry that focuses purely on new customers. It also makes competition stable: large shares tend to shrink and small shares to grow. More generally, the tradeoff between harvesting and investing depends on interest rates, the state of the business cycle, expectations about exchange-rates, etc, with implications for macroeconomics and international trade.

Network Effects

A good exhibits *direct* network effects if adoption by different users is complementary, so that each user's adoption payoff, and his incentive to adopt, increases as more others adopt. Thus users of a communications network or speakers of a language gain directly when others adopt it, because they have more opportunities for (beneficial) interactions with peers.

Indirect network effects arise through improved opportunities to trade with the other side of a market. Although buyers typically dislike being joined by other buyers because it worsens terms of trade, they also like it because it attracts more sellers. If thicker markets are more efficient, then buyers' indirect gain from the re-equilibrating entry by sellers can outweigh the terms-of-trade loss for buyers, and vice versa; if so, there is an indirect network effect.

From a cooperative game theory perspective, network effects are just economies of scale: the per-buyer surplus available to a coalition of buyers and a seller increases with the size of the coalition.[3] But the contracting and coordination issues seem much harder.

Unless adoption prices fully internalize the network effect (which is difficult), there is a positive externality from adoption, and a single network product tends to be under-adopted at the margin. But when one network competes with another, adopting one network means not adopting another; this dilutes or overturns that externality.

More interestingly, network effects create incentives to "herd" with others. Self-fulfilling expectations create multiple equilibria and cause chicken-and-egg or critical-mass behavior with positive feedback or "tipping": a network that looks like succeeding will *as a result* do so.

How adopters form expectations and coordinate their choices dramatically affects the performance of competition among networks. If adopters smoothly coordinate on the best deal, vendors face strong pressure to offer such deals. Indeed, competition may be unusually fierce because all-or-nothing competition neutralizes horizontal differentiation --- since adopters focus not on matching a product to their own tastes but on joining the expected winner.

Smooth coordination is hard, especially when different adopters would prefer different coordinated outcomes (as in the Battle of the Sexes), perhaps because each has a history with a different network and faces individual switching costs; but some institutions can help. In particular, consensus standard setting (informally or through standards organizations) can help avert "splintering"; contingent contracts seem theoretically promising but little used; and---most important---adoption is very often sequential. If one trusts long chains of backward induction, fully sequential adoption eliminates the starkest coordination traps, in which an alternative equilibrium would be strictly better for all.

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[3] The analogy becomes weaker if network effects are less anonymous. Likewise, switching costs correspond to economies of scope on the production side in a single-consumer context, but the analogy is imperfect with many consumers because individual customer-supplier matches matter in switching-cost markets.

However, sequential adoption may not help overall efficiency in the Battle-of-the-Sexes case. Sequential adoption translates multiple static (simultaneous-adoption) equilibria into the adoption dynamics characteristic of network markets: *early instability and later lock-in*. In particular, sequential adoption implements tradeoffs between early and late efficiencies that are not generally efficient. Because early adoptions affect later ones, long-term behavior is driven by early events, whether accidental or strategic. Thus early adopters' preferences count for more than later adopters': "excess early power." These adoption dynamics are the essence of competition among unsponsored networks, and the playing field for competition among firms sponsoring incompatible products.

Sponsors compete ex ante, in particular with penetration pricing, and perhaps also using other tactics such as preannouncements, to appeal to the pivotal early adopters, since the ex post lock-in creates ex post dominance and profits. This competition for the market neutralizes (and can even overturn) excess early power if sponsors' anticipated later relative efficiency feeds through into their early willingness to set low penetration prices. But where that feed-through is obstructed or asymmetric, networks that appeal to early pivotal customers thrive, while late developers have a hard time. More importantly, while much has been written on whether there is "excess inertia," that is, whether incompatible transitions are even harder than they should be, given ex-post incompatibility, this may not be the main question: even with "excess momentum" (the reverse of ex post excess inertia) long-term choices still hinge mainly on early preferences and early information. In section 3.2 below, we illustrate these themes in the famous case of the QWERTY keyboard.

If such incompatible competition does not tip all the way to one network, it sacrifices network benefits and may segment the market; if it does tip, it sacrifices matching of products to customers or to time periods and loses the option value from the possibility that a currently inferior technology might become superior. Moreover, if adopters don't coordinate well, or coordinate using cues —for instance, history— other than the surpluses firms offer, the direct loss in performance is exacerbated by vendors' weaker incentive to offer good deals. For example, if one firm clearly has the *ability* to offer the highest quality, so buyers know it could profitably recapture the market even after losing any one cohort's business, they may quite rationally all buy from it even if it

never actually produces high quality or offers a low price. Finally, the excess power of early adopters biases outcomes towards networks that are more efficient early on, when unsponsored networks compete; biases outcomes in favor of sponsored over unsponsored alternatives; and often biases the outcome even when both alternatives are sponsored.

If firms choose to compete with compatible products, then consumers obtain full network benefits even when they don't all buy from the same firm. This raises consumers' willingness to pay, which can persuade firms to make their products compatible. But, as with switching costs, compatibility often sharpens competition and neutralizes the competitive advantage of a large installed base; furthermore, while switching costs tend to soften competition, hindering attempts to lure customers from rivals (though they may facilitate small-scale entry, they also encourage entry to stay small), proprietary network effects tend to make competition all-or-nothing, with risks of exclusion. Thus large firms and those who are good at steering adopters' expectations may prefer their products to be incompatible with rivals'. If others favor compatibility, this can lead to complex maneuvering, but intellectual property can help firms insist on incompatibility.

Strategy and Policy

Switching costs and proprietary network effects imply cross-transaction complementarities that in turn make success selling in one period or to one customer an advantage in another. This central fact has important implications for competitive strategy and for public policy.

For a firm, it makes market share a valuable asset (in a way absent from much economic theory), and encourages a competitive focus on affecting expectations and on signing up pivotal (notably early) customers, which is reflected in strategies such as penetration pricing; competition is shifted from textbook competition in the market to a form of Schumpeterian competition for the market in which firms struggle for dominance.

For a consumer, it may make early choices tantamount to long-term commitments—necessitating great care and raising the value of accurate information at that stage; it may make those choices a coordination problem with other adopters, or it

may mean that there is no real choice because of what others have done or are expected to do.

And for policy, these facts collectively have broad repercussions. Because early choices are crucial, consumer protection (against deception, etc.) and information can be key; because coordination is often important and difficult, institutions such as standards organizations matter. Finally, because competition for the market differs greatly from competition in the market, competition policy gets involved in issues of compatibility, as well as in the analysis of mergers, monopolization, intellectual property, and predation, all of which behave differently in the presence of switching costs and network effects.[4]

[4] Switching costs have featured in a range of significant antitrust cases, including IBM and Kodak; the network effect by which popular operating systems attract applications software supply was central in the US Microsoft case; and both network effects and switching costs are important in the European Microsoft case.