Asian Journal of Innovation and Policy (2018) 7.1:207-234
DOI: http//dx.doi.org/10.7545/ajip.2018.7.1.207

Dual Monopolies of New Durables and Their Ancillaries: Exclusive Supply Contracts

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Abstract A manufacturer of a durable good typically purchases supplies, including parts for assembly — that are also useful for repairs — from independent "original equipment suppliers" with which it contracts. The manufacturer is a branded monopolist of its final assembled product. To put into effect also a monopoly of the replacement parts, it must stipulate in its arrangements with independent suppliers of the parts that they not supply such patented parts to any other buyer. Durable good owners would then only be able to obtain their requirements of replacement parts from the same company that supplied the durable. This would amount to a tie-in of replacement parts to the direct purchase of new durables. And that describes the apparently widespread practice of automobile manufacturers in India, as exposed in a recent case before the Competition Commission of India (Samsher Kataria v Honda Siel Cars India Limited and others). Here, I will argue that such tie-in enabled automotive manufacturers to more fully appropriate consumer surplus, which induced them to lower the price of new cars, sell more cars and also sell more repair parts. The tie-in expanded the auto parts industry and promoted new entry. The main restraint on expansion of India's automotive manufacturing is not monopoly. It is government protection in the form of tariffs on automobiles and auto parts.

Keywords Aftermarkets, durable goods markets, monopoly pricing

I. Introduction

The burden of this essay is to explore how presumed complementarity in demand between durable and ancillaries affects the management of manufacturing supply chains, with particular attention to automobile manufacturer contracts with independent suppliers of automotive parts. I will also have some comments on how all of this affects the climate for start-ups and new-firm entry in the auto parts industries of India, Japan, and elsewhere.

Submitted, August 14, 2017; 1st Revised, December 9, 2017; Accepted, March 23, 2018
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A durable good and its "ancillaries"— meaning repair parts, maintenance services, and non-durable supplies used with the durable good — are inter-related in demand. This is because the ancillaries enable more prolonged and intense use of the durable good. The interrelation in demand between a durable good and its ancillaries manifests subtle inter-temporal effects, which are the subject of a companion paper to this one. In that paper, Flath (2017), I argue that although it is possible that durable and ancillaries could be substitutes in demand (because a higher price of ancillaries could induce more frequent replacement of used durables with new ones), the usual case is that they are complements in demand. Higher prices of ancillaries render the durables less valuable to their users, which decreases the stock demand for the durables, and probably also decreases the flow demand for new durables[1], which would mean that durable and ancillaries are complements in demand. Accordingly, the monopolist of a durable that tied in ancillaries, and raised the price of ancillaries, would likely also lower the price of the durable.

The motivation for exploring the economic effects of dual monopoly of a durable and ancillaries is the presumption that the supplier of a durable good would necessarily be able to monopolize the ancillaries used with the durable. The direct purchasers of the durable represent an "installed base" that is "locked-in" to the purchase of ancillaries compatible with the durable. Even in the absence of market power in the durable, the firm could have market power in the supply of ancillaries used with its durable, because of its holding of patents and copyrights for parts, software, and service manuals. But if consumers were forward-looking and rational, a monopoly of ancillaries for use with the durable would be profitable for the supplier of the durable only if it holds market power in the durable. A dual monopoly, on the other hand, is indeed valuable, but is likely to harm social welfare only if the durable and ancillaries are substitutes in demand. A dual monopoly of durable and ancillaries that are complements in demand is likely to improve social welfare-compared to independent monopolies, and even compared to the case of monopoly of the durable and competitive supply of the ancillaries. This last point is because the tie-in of otherwise competitively supplied ancillaries enables a durable good monopolist to extract consumer surplus arising from purchase of the durable, which better aligns the monopoly profit with social welfare. This has particular relevance for the supply of automobiles and auto parts in India, as I will explain with reference to a recent case before the

[1] With higher price of ancillaries, the durable goods are repaired less frequently, but are used less intensely and so may be replaced less frequently, not more. And even if they are replaced more frequently, the smaller equilibrium stock demand induced by higher price of ancillaries could mean that the flow demand for new durables is still less than before even in spite of more frequent replacement.

Competition Commission of India (Samsher Kataria vs Honda Siel Cars India Limited and others). That case has some similarities to an earlier US case (Eastman Kodak Co. vs. Image Technical Services, Inc.).

II. The Kodak Doctrine

Recent antitrust attention to markets for durables and their ancillaries stems from the Kodak[2] case-decided 26 years ago in 1992. There, the U.S. Supreme Court found that even though Kodak had a trivially small share in the market for copy machines, it nevertheless had obtained an illegal monopoly of the supply of ancillaries used with its machines by tying the ancillaries to the machines. That is, Kodak only sold repair parts needed in servicing the machines to direct purchasers of the machines. Independent service organizations therefore could not obtain the parts needed to service Kodak machines not from Kodak, nor from the firms supplying such parts to Kodak, because Kodak had entered exclusive agreements with the parts suppliers precluding their sale of such parts to anyone other than it. The independent service organizations sued Kodak for having violated U.S. antitrust law, and won on appeal at the Supreme Court.

At the time the Kodak decision was announced, it seemed to antitrust experts that the Court had stepped away from University of Chicago price-theory doctrines in favor of notions that, unless law intervenes, unscrupulous and rapacious business firms are apt to prey on ill-informed and gullible consumers. In other words, if customers had been aware of the high prices of repairs and servicing of Kodak machines, then as argued by Shapiro (1995), Kodak would have had to lower its prices of machines and would have been substantially deterred from tying repair parts to the machines. But the customers were not so aware, decreed the Supreme Court. The Supreme Court seemed to embrace the notion that the customers of Kodak were ignorant of their own self-interest or had been deceived by Kodak. They purchased the Kodak copy machines while uninformed of the price of ancillaries, and then found themselves locked-in to the purchase of ancillaries at exorbitant prices.

In the years since the Kodak decision, there actually has not been a succession of similar cases in the US. When cases are adjudicated in which the defendant firm, like Kodak, has tied ancillaries to a durable good and faces substantial competition in the market for the durable, there is no summary

[2] Eastman Kodak Co. vs. Image Technical Services, Inc., 112 S. Ct. 2072 (1992) The Wikipedia page discussing the case is particularly informative on the case itself and on the important scholarly essays dealing with economic aspects of the case.

judgment in favor of the plaintiff. To win such a case requires the plaintiff to show that the tie-in has resulted in a large and unanticipated increase in the prices of the ancillaries, and that seems rarely to have happened (Goldfine and Vorrasi, 2004). Neither has the Kodak case much influenced European Union antitrust policy. As described by Lang (2011), in the EU, there has never been a finding of illegal monopolization of an aftermarket by a firm that lacked dominance in the primary market. The same cannot be said of India.

In Samsher Kataria v Honda Siel Cars India Limited and others[3], the Competition Commission of India found that fourteen automobile companies had illegally tied auto repair parts to the direct purchase of automobiles, by enforcing exclusive agreements with the parts suppliers preventing their sale of such parts to anyone other than the auto companies themselves or dealers authorized by those auto companies to perform warranty servicing of the vehicles. The fourteen include virtually all the companies that assemble cars in India, of which most have market shares of the passenger car market less than three percent, as shown in Table 1.

Table 1 Passenger car market share in India in FY 2015 by manufacturer

	Market Share
Maruti Suzuki	46.50%
Hyundai	17.16%
Mahindra & Mahindra	7.38%
Honda	7.29%
Toyota	5.04%
Tata Motors	4.95%
Ford India	2.80%
Renault	1.94%
Volkswagen	1.55%
Nissan	1.47%
GM	1.31%
Skoda	0.55%

Source: https://www.statista.com/statistics/316850/indian-passenger-car-market-share/

The original complaint by Mr. Kataria was against Honda Siel Cars India Ltd., Volkswagen India Pvt. Ltd. and Fiat India Automobiles Ltd., manufacturers of the three cars that he owned, but was expanded by the Competition Commission to include the other fourteen companies based on discovery that the offending practices were widespread in the industry. Including even

[3] Samsher Kataria v Honda Siel Cars India Limited and others, Case no: 03/2011.CCI.

companies with small market shares in the complaint - Ford India (2.80%), Renault (1.94%), Volkswagen (1.55%), Nissan (1.47%), GM (1.31%) and Skoda (0.55%) - is a straight application of the Kodak doctrine. By the way, the industry is highly concentrated. The top three have a combined market share of 71 percent: Maruti Suzuki (46.50%), Hyundai (17.16%), and Mahindra & Mahindra (7.38%). In any case, even the firms with small shares in the Indian market should be regarded as monopolists in the economic sense of facing less than infinitely elastic demand. Their products are differentiated in ways that are valued by some demanders.

The Competition Commission of India found that all of the auto manufacturers effectively tied repair parts to the direct purchase of automobiles. They did this by enforcing exclusive supply agreements with the independent suppliers of replacement parts. These are the companies called "original equipment suppliers"(OES) that supply components for assembly of new vehicles. The same components are also useful as repair parts. By disallowing direct sale of such replacement parts in the aftermarket, and by withholding or blocking the direct sale of diagnostic tools and technical manuals in the aftermarket, the auto manufacturers ("original equipment manufacturers"—OEM) effectively tied OES replacement parts to direct sale of the automobiles. Contracts with new car purchasers included warranties that would be invalidated if prior services had been performed by unauthorized dealers using unauthorized parts. These stipulations amounted to a tie-in of repair parts to new car sales, but fell short of effective dual monopoly of cars and repair parts. Usable parts from independent sources are widely available and much in use for off-warranty repairs. The scope and impact of the tie-in is difficult to determine from the written decision of the Competition Commission of India.

A short piece by Philip in The Economic Times ("Why carmakers are joining hands against CCI charge," October 23, 2014) has some useful data attributed to anonymous company insiders. I will use these data as a basis to speculate about the likely effects of the tie-in of repair parts to the purchase of new cars. It is first necessary to review some economics of tie-in sales.

III. Tie-In Sales

A tie-in sale can be either in the form of a requirements contract, or bundling. A requirements contract disallows purchase of the tied good from anyone other than ones authorized by the supplier of the tying good. Bundling means that the tied good and tying good are both supplied together, as a package, in a fixed ratio; the tying good may not be purchased without some specific

quantity of the tied good also being purchased from the same supplier. The tie-in of auto parts to direct purchase of automobiles is an example of a requirements contract.

1. Requirements Contracts

A frequent example of requirements contract is when the supplier of a patented durable leases and does not sell it, and conditions the lease on purchase from it of all requirements of some non-durable good used in conjunction with the durable. Many US antitrust cases over the years involve such tie-ins. These cases include Motion Picture Patents (projectors+film)[4], IBM (posting machines+ledger cards)[5], International Salt (Brine-making machines+salt)[6], American Can (can-closing machines+cans)[7], United Shoe Machinery (shoe machinery+eyelets)[8], and Kodak (cameras+film)[9]. This is not an exhaustive list.

The first thing to recognize is that such requirements contracts represent a way of pricing the patented durable; they often do not entail monopoly production of the tied non-durable. Motion Picture Patents is a good illustration. The 1916 case involved a company whose sole assets consisted of patents on parts essential to projection equipment. The company licensed others to manufacture the equipment and required that stipulations be affixed to each projector indicating that only films approved by Motion Picture Patents Co. were allowed to be used in conjunction with them. They then charged movie producers for such approval. Motion Picture Patents Co. obtained no monopoly in the production of movies. Nevertheless the tie-in was profitable for it. For by making the payment of an "excise tax" on movies (paid to itself) a condition of purchase of the projector, the company in effect imposed a two-part price on the projector. And what is more, the two-part price collected more revenue from those who used the projectors more intensely and who presumably more valued the projector. The Appendix A develops a simple algebraic example of a metering tie-in that captures the salient elements.

It is thus quite intelligible that non-durables used with the patented durable should be the preferred tied good. But there are a couple of broader points. First, the complementary nondurable might be a preferred tied good, but in principle the tying of requirements of any other good, whether or not related in

[4] Motion Picture Patents Co. v. Universal Film Co., 243 U.S. 502 (1917).
[5] International Business Machines Corp. v. United States, 298 U.S. 131 (1936).
[6] International Salt Co., Inc. v. United States, 332 U.S. 392, 395-96 (1947).
[7] United States v. American Can, 87 F. Supp. 18 (N.D. Cal. 1949).
[8] United States v. United Shoe Machinery Corp., 110 F. Supp. 295 (D. Mass. 1953).
[9] Berkey Photo, Inc. v. Eastman Kodak Co., 603 F.2d 263, 287 (2d Cir. 1979).

demand to the monopolized good, would enhance profit compared to ordinary monopoly pricing. The "taxes" collected on the tied goods; in general, confer the property of two-part pricing on the tying good. Second, as with excise taxes generally, the burden of the tax is larger than the revenue collected because of the distortion of relative prices. And just as an excise tax that covers all goods exhibits minimal relative price distortion and minimal deadweight losses, so a requirements contract that ties in virtually every other good would (apart from the costs of administration!) be the most profitable for a monopolist. (This point is due to Burstein, 1960). If only one good could be tied, then selection of a nondurable complementary in use with the monopolized durable is a good choice. But if the costs of administration are small then many goods would be tied including ones unrelated in demand. A monopsony example: The company store. Workers at a plant in a small, isolated town are required to live in company housing and receive their wages in the form of "chits" accepted in exchange for merchandise at the company store. As viewed by the employer, better than a simple monopsony wage! But are the workers worse off? Possibly not if the participation constraint is just binding.

A final point. Requirements contracts and bundling often have nothing to do with monopoly pricing. There are technological reasons for bundling: Who wants to buy a new car with no tires? Also, requirements contracts can promote efficient risk bearing as in the American Can case (Flath, 1980). Vegetable packers leased can-closing machines before learning the sizes of the harvests they had contracted for at planting. By agreeing to buy all cans from the suppliers of the machines they based the rental payment on the crop-size, shifting some of the risk of a bad harvest to the can-closing machine lessors.

2. Pricing of Durable and Ancillaries

Whatever the motivation for a requirements-contract-type tie-in sale, the pricing of the tying and tied good (for example durable and ancillaries), would be analytically the same as the prices set by a multiproduct monopolist for whom demanders of the one good (the tied good-the ancillaries) consist only of purchasers of the other (the tying good-the durable). In this formulation, because the demand for the tied good is conditional on purchase of the tying good, the demand for the tied good is not the ordinary Marshallian demand function based on utility theory, but with that caveat, the results are the same as for pricing by a multiproduct monopolist. The simple analytics of pricing by a multiproduct monopolist—which have been well understood for many years—are set out in Appendix B.

Here stipulate that a durable and its ancillaries are complements in demand. We understand that a monopolist that could tie-in but one good would choose a good the quantity demanded of which is correlated with demanders' willingness to pay for the monopolized good. This is the metering argument: Quantity demanded of ancillaries meters the willingness to pay for the durable. As shown in Appendix B, in the constant-unit-cost, constant-demand-elasticity case, the dual monopolist of durable and ancillaries would set the price of one of them below the price that would be set by an independent monopoly. And if both prices are above unit cost, it would set both prices below the levels that would be set by independent monopolies. The exclusionary supply contracts and other measures by which durable good monopolists seek to establish effective tie-ins of ancillaries all presume that the ancillaries are priced above unit cost. One implication is that to the extent the monopolist of a durable succeeds in tying-in ancillaries, it will lower the price it sets on the durable good itself, which would increase the demand for ancillaries. In other words, as a result of the tie-in, the price of the ancillaries is raised above unit cost but the demand for ancillaries is also increased.

It is possible that more ancillaries will be sold with a tie-in and a price increase than if the price of ancillaries with no tie-in were forced by competition to equal marginal cost. The monopolist chooses which ancillaries to tie-in to the purchase of the durable based on profitability, and that favors the tying of ancillaries for which the demand is relatively own-price inelastic and for which quantity demanded of each individual is highly correlated with willingness to pay for the durable. Tying in such an ancillary would enable the monopolist to more completely appropriate the demanders' willingness to pay, which would also have the felicitous effect of better aligning the monopolist's own profit with social welfare. I am describing a situation resembling the metering tie-in example of Appendix A. To interpret the India auto parts case, I will model a metering tie-in that, unlike the example of Appendix A, enables only partial appropriation of consumers' surplus.

IV. Appropriation of Consumer Surplus

Suppose that by tying, the monopoly supplier of a durable good is enabled to appropriate some fraction λ of the consumer surplus that is entailed by setting a price for the durable, p_d. Suppose that the unit cost of supplying the durable is k. The marginal revenue facing the monopoly becomes

$$MR \equiv \frac{\partial(p_d Q)}{\partial \mathrm{Q}} = p_d + Q\frac{\partial p_d}{\partial Q} - \lambda Q\frac{\partial p_d}{\partial Q}$$

$$MR = p_d\left(1 - \frac{(1-\lambda)}{\xi}\right)$$

The term

$$-\lambda Q\frac{\partial p_d}{\partial Q}$$

represents the marginal contribution to revenue from appropriation of the fraction λ of the consumer surplus generated by expanding output of the durable good. Solving for the profit-maximizing price yields the Lerner index.

$$\frac{p_d - k}{p_d} = \frac{1}{\xi}(1-\lambda)$$

Appropriation of consumer surplus lowers the price-cost margin of the profit-maximizing monopolist—in fact, lowers it all the way to zero in the case of full appropriation, $\lambda = 1$. That is the case described in Appendix A.

The article by Philip in The Economic Times ("Why carmakers are joining hands against CCI charge," October 23, 2014) has some data that is useful here. According to Philip, the auto manufacturers in India seem to gain about 10 percent of their revenue from spare parts, rather than from new car sales,

$$\frac{p_2 Q_2}{p_1 Q_1} = 0.11.$$

The dealer margin on spare parts is 16 to 17 percent, and the auto manufacturer margin on the spare parts is about four times as great as the dealer margin, or 64 to 68 percent. If we treat the auto companies and their dealers as a single entity, controlled by the auto companies, then the combined margin on replacement parts is roughly 75 percent, say,

$$\frac{p_2 - c_2}{p_2} = 0.75.$$

The dealer margin on new car sales in India is 3 to 4 percent. If the auto manufacturer margin on new cars is four times as great as the dealer margin, as it is alleged to be for spare parts, than the manufacturer margin on new cars would be 12 to 16 percent, and the combined margin is then 15 to 20 percent, say,

$$\frac{p_1 - c_1}{p_1} = 0.17.$$

These figures are crude but plausible. Putting it all together, the profit from repair parts is roughly half as great as the profit from new cars. [Parts profit as a fraction of total revenue (parts plus new cars) $= (0.1)(0.75) = 0.075$, and new vehicles profit as a fraction of total revenue $= (0.9)(0.17) = 0.153$].

Some of the apparently large profit from repair parts arises from appropriating the consumer surplus in cars by tying parts to direct ownership of the cars. There are two questions to answer. First, how large is the profit from selling parts in relation to the consumer surplus from selling cars? Also, how great is λ, the fraction of consumer surplus appropriated by the tie-in? Let us presume constant elasticity of demand for cars ξ_1, (so, $Q_1 = Ap_1^{-\xi_1}$). Then consumer surplus is

$$\text{CS} = \int_{p_1}^{\infty} Ap_1^{-\xi_1} dp_1 = \frac{p_1 Q_1}{\xi_1 - 1}$$

If elasticity of demand for cars is 5 — a reasonable presumption given the 0.17 price-cost margin for new cars-then consumer surplus is ¼ as great as revenue from sale of cars. From the earlier result,

$$\frac{p_d - k}{p_d} = \frac{1}{\xi}(1 - \lambda),$$

and assuming

$$\frac{p_d - k}{p_d} = 0.17$$

and $\xi = 5$, then $\lambda = 0.15$. Roughly 15 percent of the consumer surplus from cars is appropriated by tying-in replacement parts.

If, as conjectured above, profit from repair parts is equal to 8.3 percent of the revenue from sale of cars ($0.075 \div 0.9 = 0.083$), then that profit is equal to 33.2 percent of the consumer surplus from selling cars $(0.332 = 4 \times 0.083)$. This would mean that 45.2 percent of the profit from parts $(0.452 = 0.15 \div 0.332 = \lambda \div 0.332)$ is appropriation of consumer surplus on cars, and the remainder is the normal profit. Breaking the tie-in would raise the price-cost margin on cars from 0.17 to 0.2, and would lower the price-cost margin on repair parts sold by OEMs and their dealers from 0.75 to $0.41 = 0.75 \times (1 - 0.452)$. The change in profit and in consumer surplus from breaking the tie-in would be as follows: The increase in price of new cars of 3.75 percent, implies a 15 $(= 3.75 \times (\xi - 1) = 3.75 \times 4)$ percent decrease in revenue from new cars, and 3.75 (=15÷4) percent decrease in direct consumer surplus (from the rise in price of new cars). But offsetting this is the increase in consumer

surplus attending the decrease in price of replacement parts equal to λ=15 percent of the consumer surplus originally attaining from the purchase of new cars. Altogether this would mean a net increase in consumer surplus of 11.25 percent ($15 - 3.75$). So consumers are better off without the tie-in.

What about the OEMs? What is the effect on their profit of ending the tie-in? Their 15 percent decrease in revenue from selling cars, and increased price-cost margin on new cars from 0.17 to 0.2, would leave their profit from selling cars unchanged—expressed as a percentage of the original revenue from selling cars, the net change in profit is $0 = (1 - 0.15) \times 0.2 - 0.17$). But this would be accompanied by loss in profit from using the parts tie-in and parts pricing to appropriate consumer surplus, roughly comprising 14.9 percent of their original profit ($0.149 = \big(0.075 \div (0.153 + 0.75)\big) \times 0.452$). This is a fairly sizable loss and larger than the increase in consumer surplus from ending the tie-in.

To summarize, if the tie-in is ended, the original profit equaling 22.8 percent of total revenue (including cars and parts) is reduced by 14.9 percent, and original consumer surplus equaling 19.1 percent ($0.191 = 0.85 \times 0.9 \times 0.25 = (1 - \lambda) \times 0.9 \times 0.25$) of total revenue increases by 11.25 percent. Profit falls by 3.40 percent of original total revenue and consumer surplus rises by 2.15 percent of original total revenue. The net decrease in social welfare is 1.25 percent of the original revenue of the OEMs. The results of the various calculations just describe are shown in Table 2.

The calculations just related and shown in Table 2 are presented as percentages of (retail) revenue. It may also be useful to suggest corresponding monetary amounts. A blogger (named 'jpcoolguy') at Team-BHP.com has estimated the approximate revenue of each automaker from the sale of passenger cars in India in the one month, December 2016[10]. His method is, for each model, to multiply the ex-showroom price[11] minus excise tax (which is from 15% to 30% of the price, depending on the model) times the number of each model sold, and sum over all models of each company. Based on this estimate, the average retail price (net of excise tax) per car sold in December 2016, was Rs.666,667, approximately USD10,000, at the current exchange rate. In the calendar year 2016, Indian carmakers sold approximately 2,921,913 new passenger cars, implying (at the price-per-car just reported) total retail sales revenue net of excise tax of Rs.194,794 Crore[12] (approximately USD29.2-

[10] Http://www.team-bhp.com/forum/indian-car-scene/180766-revenue-calculation-cars-sold-india-how-many-each-model-brings-its-maker.html

[11] The 'ex-showroom price' is the manufacturer-listed price including excise tax, which jpcoolguy has extracted from carwale.com (https://www.carwale.com/). It is an estimate of the approximate retail price of each car.

[12] One crore is defined as ten-million (10^7) Rupees.

billion). From the results shown in Table 2, we can use these new figures to impute monetary amounts to the various effects of the tie-in of replacement parts to the sale of new passenger cars. This is summarized in Table 3.

Table 2 Effects of the tie-in of auto parts to direct purchase of automobiles

	Without Tie-in		With Tie-in				
	Percent Change	Change as Percent of Original Total Revenue	Total Revenue	Revenue from Cars	Revenue from Parts	Gross CS Cars	Profit from Parts
Price of Car	3.75%						
Total Revenue			100.00%				
Revenue from Cars	–15.00%		90.00%	100.0%			
Revenue from Parts			10.00%		100.0%		
Gross CS	–3.75%	–3.75%	22.50%	25.0%		100.0%	
Net CS	11.25%	2.15%	19.10%				
Profit from cars	0.00%	0.00%	15.30%	17.0%			
Profit from parts	–14.90%	–3.40%	7.50%	8.3%	75.0%	33.2%	100.0%
Appropriation of cons surplus	-100.00%	–13.50%	3.39%		34.0%	15.0%	45.2%
Normal profit	0.00%	0.00%	4.11%		41.0%	18.2%	54.8%
Total Profit	–14.90%	–3.40%	22.80%				
Social Welfare		–1.25%	41.90%				

Note. These calculations assume the following: With tie-in: price-cost margin of car =0.17, price-cost margin of parts 0.75, with 90 percent of OEM revenue from cars and 10 percent from parts, and constant unit cost of each. Elasticity of demand for cars =5. From these assumptions, I deduce that gross consumer surplus from cars is ¼ of revenue from cars and 15 percent of that gross consumer surplus is appropriated by the OEM through the tie-in of parts to cars.

As shown in Table 3, if the tie-in were disallowed, producers would increase the retail price of the cars by an average of USD375 per vehicle (approximately Rs.25,000). The tie-in is enabling producers to appropriate USD377 per vehicle (Rs.25,111). Given the total number of passenger cars sold in 2016 of 2.92 million vehicles, this amounts to a total appropriation of consumer surplus by the industry of about USD1.1 billion per year (Rs.7,337 Cr.). Ending the tie-in would increase total consumer surplus by about USD0.7 billion per year (Rs.4,653 Cr.), but would lower automaker profit by USD1.1 billion per year (Rs.7,359 Cr.), resulting in a net loss of social welfare of USD0.4 billion per year (Rs.2,705 Cr.).

Table 3 Monetary amounts corresponding to effects of the tie-in

	With tie-in				Change if tie-in disallowed			
	per car sold		total per year for the industry		per car sold		total per year for the industry	
	USD per car	Rs. per car	USD-billions	In. Cr.	USD per car	Rs. per car	USD-billions	In. Cr.
Price of Car	10,000	666,667			375	25,000		
Total Revenue	11,111	740,733	32.465	216,436				
Revenue from Cars	10,000	666,667	29.219	194,794			4.383	29,219
Revenue from Parts	1,111	74,074	3.247	21,644				
Gross CS	2,500	166,667	7.305	48,699			-1.217	-8,116
Net CS	2,122	141,481	6.201	41,340			0.698	4,653
Profit from cars	1,700	113,333	4.967	33,115				
Profit from parts	833	55,556	2.435	16,233			-1.104	-7,359
Appropriation of cons surplus	377	25,111	1.101	7,337			-4.383	-29,219
Normal profit	457	30,444	1.334	8,896				
Total Profit	2,533	168,889	7.402	49,348			-1.104	-7,359
Social Welfare	4,656	310,370	13.603	90,688			-0.406	-2,705

Note. These calculations are based on Table 2 and assume that the total number of passenger cars sold with the tie-in is 2,921,913, as reported for 2017, at an average retail price of USD 10,000 per vehicle.

The 14 OEMs found to have illegally tied repair parts to direct purchase of cars were ordered to desist from practices that supported the tie-in and were each fined 2 percent of total (wholesale) revenue, averaged over three fiscal years, 2009-2011 Rs. 2,544.65 Cr. (USD 381.7 million)[13]. By the calculation above, this is about half as great as the reduction in consumer surplus caused by the tie-in, in just one year, and about one-third as great as the annual addition to automaker profit resulting from the tie-in. The order to desist from the tie-in is likely to have a much greater adverse effect on OEM profit than the fine itself.

Before moving on to consider the implications of this analysis, let me note the highly conjectural nature of these calculations. All of it is based on very crude estimates of the price-cost margins in new cars and in aftermarket parts, and on the bald assumption that price elasticity of demand for automobiles is 5.

[13] Ford, Toyota and Nissan appealed to the Competition Appellate Tribunal, which on December 9, 2016, upheld the original CCI order of August 25, 2014, but reduced the penalty from 2 percent of the annual sales revenue of the companies (averaged over the three previous fiscal years) to 2 percent of the annual revenue from the sale of replacement parts. The other 11 companies subject to the CCI order have appealed to the New Delhi High Court, questioning the constitutionality of the 2002 Competition Act itself.

More accurate figures would be of interest. That said, the calculations are my best estimates of the likely effects of the tie-in, given the data at hand.

V. Implications of the Tie-In for Automotive Parts Supply Chains

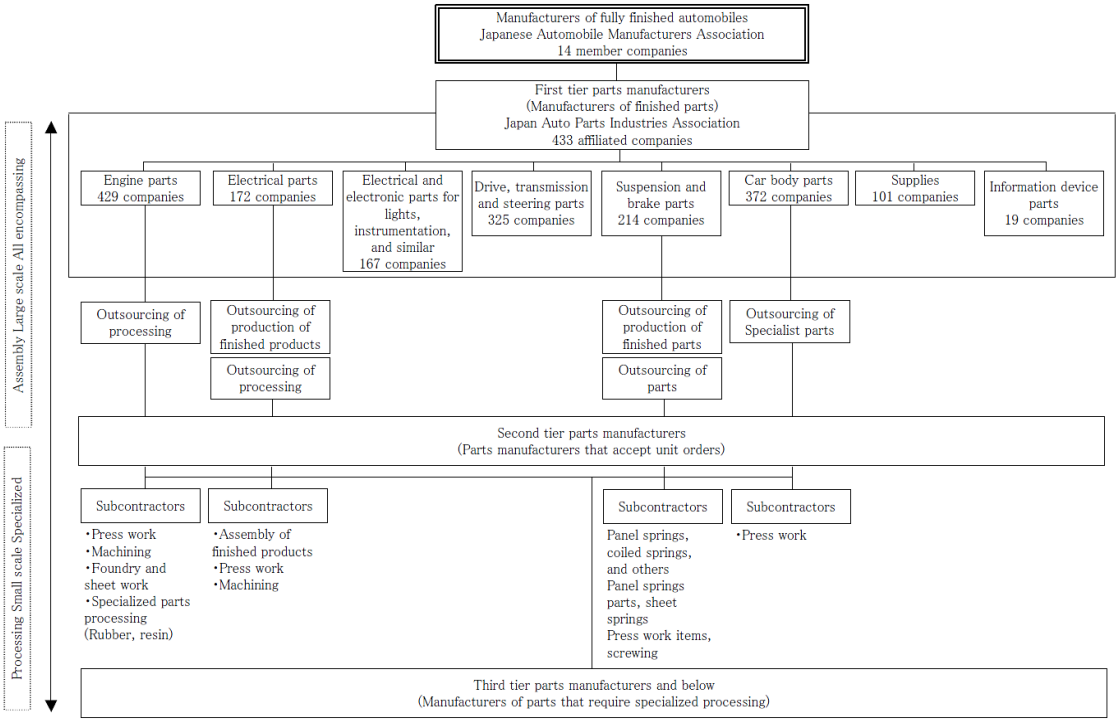
It appears from my calculations in the previous section, that the auto manufacturers in India had been gaining 10 percent of their revenue but 33 percent of their profit from the sale of replacement parts. I have argued that they achieved this by (illegally) tying parts to the direct purchase of automobiles as a device to appropriate consumer surplus on the automobiles. If, as seems likely, the Competition Commission ruling prohibiting the tie-in is upheld on appeal, will the OEMs find another way of appropriating consumer surplus? What are the implications for the OES companies that sell the parts to the OEMs? And what are the implications for start-up and entry in the OES sector?

1. Auto Parts Suppliers

Automobiles these days each have roughly 20,000 to 30,000 separate parts. The automobile manufacturers are at the apex of a pyramid with several layers of independent firms supplying component parts for assembly of vehicles. This is true of the auto industry in every country. Let us focus first on Japan, the country with the most highly developed automotive manufacturing sector, then come back to India.

1.1 Auto Parts Supply Chains in Japan

As shown in Figure 1, in Japan, the first layer (top tier) of the auto parts supply chain consists of 400 or so primary contractors that supply major components that are themselves assembled from smaller parts. The second and third layers (the lower tiers) comprise the secondary and tertiary contractors. Many of the primary contractors are themselves sizeable companies that supply components to more than one automobile company, and in some cases to all automobile companies. For example, in Japan there are three companies that supply piston rings: Riken with 50 percent market share, Teikoku Piston Rings with 30 percent and Nihon Piston Rings with 20 percent. All three of them sell to all of the auto companies in Japan. This is similar to the case of other major components in Japan-for each of them, three suppliers account for most of the production. All of the figures below are from JETRO (2005).



Source: JETRO (2005), p.26

Figure 1 Distribution structure for auto parts in Japan

Piston rings - Riken with 50 percent market share, Teikoku Piston Rings with 30 percent and Nihon Piston Rings with 20 percent.

Radiators - Denso (affiliate of Toyota) with 50 percent share, Calsonic Kansei (Nissan affiliate) and Toyo Radiator, together account for 90 percent market share).

Wiring harnesses - Electrical wires and their pins and connectors-Yazaki with 40 percent share) and Sumitomo Electric with 35 percent share.

Headlights - Koito Mfg (a Toyota subsidiary), Stanley Electric and Ichiko Inds with a combined 90 percent market share.

Transmissions - Aisin (Toyota affiliate) and Jatco together account for 40 percent and OEMs themselves produce another 40 percent in-house.

Steel wheels - Topy Inds. with 35 percent, Chuo Precision Inds. 30 percent and Ring Techs with 25 percent.

Shock absorbers - Kayaba, Hitachi, and Showa (Honda affiliate) with combined 80 percent share.

Brake disc pads - Akebono Brake Ind, Advics, and Hisshinbo Inds with combined 85 percent share.

Seat belts - Takata 45 percent share, Tokai Rika 25 percent, and Autolive with 20 percent.

The primary contractors work closely with the OEMs in designing components they supply. Most of the components fit particular specifications for one make and model of car only. They are not interchangeable parts. And they are protected by patents and copyrights, most of which are held by the OEMs. Nishitateno (2015) analyzes the transactions between the automobile companies of Japan and their primary contractors, 1990-2010, and finds that each OEM on average purchases each type of component from two contractors.

Of the more than 9,000 suppliers of auto parts in Japan, two-thirds are firms with fewer than 20 employees, and one-third have fewer than five employees. Most of these small firms are secondary and tertiary contractors (JETRO, 2005, figure 21, p.27). They do not themselves deal directly with the OEMs. In the US, there were in 2011 roughly 5,000 auto-parts suppliers, about half as many as in 2000 (International Trade Administration, 2011). A much higher percentage of the auto parts by-value are produced in-house by the three US auto companies and by EU auto companies than is true of their Japanese counterparts—for the US, 60 percent in-house, and for the EU, 40 percent, compared to Japan, 30 percent (JETRO, 2002, Appendix, p.9).

The same suppliers of parts for assembly of new vehicles, and others, produce auto parts to replace ones that have worn out or been damaged. Some of these replacement parts are classified as "original equipment parts." These are the parts that are supplied to the OEMs for use in their own service networks, or to dealers authorized by the OEMs. These are the sorts of parts that were the subject of the India tie-in case. For Japan, replacement parts are from 10 percent to 25 percent of the auto parts supplied (JETRO, 2002, Appendix, p.1). In the US, one-third to one-fourth of the auto parts supplied-by value-are for replacement rather than for assembly of new vehicles (according to International Trade Administration, 2011).

In Japan, most replacement parts are either OE parts supplied through OEMs and the networks controlled by them, or, since 1972, parts offered by the OE suppliers directly in the aftermarket and certified as "superior parts" by the

Japan Automobile Parts Association (JETRO, 2002, p.44-45). Tying of parts to direct purchase of vehicles seems not as evident as in the India case. Perhaps this is because the demand for replacement parts is less in Japan, given the stock of vehicles.

Replacement parts can be for parts that wear out through normal use or for ones that have been damaged. In Japan, more than 75 percent of the expenditure for replacement of worn-out parts is for tires, followed by another 8 percent for batteries. Spark plugs, filters, mufflers, and so on account for the rest (JETRO, 2002, p.ii). Probably more of the parts to repair damage to vehicles are parts of the vehicle body, body frame and engine. These parts are more likely to be OE parts. The fundamental basis for tie-in of parts to direct purchase of the vehicle is that many of the parts are specifically designed for use with a particular make and model of vehicle. So, for instance, in Japan there are about 3,000 different part number specifications for brake disks and covers (JETRO, 2002, p.13, fn 68). Even tires are specifically designed for compatibility with wheels that vary depending on the make and model of vehicle. Unless and until parts are fully standardized, tying will be practically assured for many parts. In the US, there is an awareness that patent protection of replacement parts secures de facto monopoly in OE parts, and there is a bill before congress to drastically shorten the patent life for collision-repair auto parts to 30 months (The Promoting Automotive Repair, Trade and Sales (PARTS) Act, proposed by California Representatives Zoe Lofgren and Darrell Issa, and senators Sheldon Whitehouse and Orrin Hatch).

The elaborate three-tier subcontracting network of the Japanese auto manufacturing industry has evolved in tandem with the development and diffusion of the Toyota production management system, sometimes called the "just-in-time" system of inventory control. As I briefly described in Flath (2014, p.383-4), efficient implementation of the just-in-time system has required frequent and timely delivery of parts produced to fine tolerances and with a minimum of defects. This has required the development of a system in which each contractor's expectations are communicated in detail to subcontractors and made to be in the self-interest of the subcontractors to fulfill. Furthermore, the arrangements with subcontractors—to the extent warranted by the subcontractors' capacities to absorb risk—are gauged to preserve incentives for seeking cost-reducing innovation. In practice, this has meant that the larger first-tier contractors have shared in the profit that their own cost-reducing innovation has generated. The smaller second and third-tier subcontractors have been less rewarded for innovation; they make parts to order at prices deemed to cover cost and have little prospect of themselves generating cost-reducing innovation. The just-in-time system, and the Japanese auto parts supply chain that it has fostered, has become like the automobile

itself, a "machine that has changed the world" (Womack, Jones, and Roos, 1991). It is a model at which others have marveled and strived to imitate.

1.2 Auto Parts Supply Chains in India

Automobile manufacturing and assembly in India has always reflected extreme government manipulation of market incentives. Agustin and Schröder (2014) provide a useful chronology of Indian government measures to nurture a locally-based and domestically-owned automobile industry. Such measures go back to the colonial era in the 1920s and continue to this day. They include a ban of imports of completely built units until 1949, then local content requirements for semi-knocked down units from 1953 until 1995, and heavy regulation of automotive product design under the Industrial Licensing Act from 1951 until the 1970s (the "Licensing Raj").

The manufacture of passenger cars in India in significant numbers only began in the 1980s with the Maruti-Suzuki public-private joint venture. Its forerunner, Maruti Udyog was founded in 1971 (headed by Sanjay Gandhi, son of then Prime Minister Indira Gandhi). The company, although never profitable, was a favored recipient of government largesse—award of an exclusive license to produce a "people's car." Ultimately, the company was nationalized before it had produced a single vehicle. After much back-and-forth with potential joint venture partners, the government in 1981 finally approved a tie-up with the Japanese automaker Suzuki. The new company, Maruti-Suzuki, 24 percent owned by Suzuki and 76 percent owned by the government of India, began operations in 1983. At first, virtually all of the Maruti-Suzuki component parts other than tires and batteries were imported from Japan. But this was partially eclipsed by the advent of joint ventures between Indian firms and Japanese tier-one contractors. After the liberalization of India's foreign trade and investment regime in 1991, a number of other foreign automobile manufacturers set up operations in India-Daewoo, Daimler, Fiat, Honda, Hyundai, Mitsubishi, Peugeot, Toyota, Ford, and GM—but were constrained by the regulations that remained—local content requirements, and minimum investment conditions for wholly-owned subsidiaries, which were waived in the case of joint ventures with Indian partners.

The auto manufacturing industry in India is still stamped by the conditions of its origin as just described. Maruti-Suzuki was privatized in May 2007 (and Suzuki now holds a majority of the equity). Currently, Maruti-Suzuki has around a 50 percent market share of the annual new automobile sales in India, and its nearest rival is Hyundai with a 15 percent share. India-based companies Tata Motors and Mahindra & Mahindra each have about 5 to 7 percent market shares and the other ten firms with 1 percent or greater market shares are all foreign OEMs with plants in India.

Table 4 India ad valorem applied tariff rates, motor vehicles and motor vehicles parts

	Motor cars and other motor vehicles principally designed for the transport of persons	Parts and accessories of the motor vehicles
1996	52	52
1997	45	45
1998	45	45
1999	40	40
2000	39	39
2001	105	35
2002	105	30
2003	105	25
2004	105	20
2005	100	15
2006	100	13
2007	100	10
2008	55	10
2009	100	10
2010	60	10
2011	100	10
2012	100	10
2013	100	10
2014	100	10
2015	60	10
2016	60	10

Source: WTO tariff download facility.

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The main impetus for foreign direct investment in the Indian auto manufacturing industry has been government trade policy. To put it bluntly, the base motivation for the FDI was, and still is, tariff jumping. After 1991, India liberalized its foreign trade and investment, greatly reducing its average

effective tariff rate. But, as shown in Table 4, the tariff rate on passenger automobiles is still 60 percent (in 2016) and as recently as 2004 was 105 percent. The tariff rate on auto parts has been steadily lowered and is now 10 percent. By assembling passenger cars in India, the foreign OEMs avoid the 60 percent tariff rate, and by obtaining parts locally they can avoid the 10 percent tariff on imported parts.

It is well documented that OEMs, if allowed to do so, would import "semi-knocked-down units" for local assembly simply to avoid a 60 percent tariff. The Indian company Mahindra & Mahindra itself took preliminary steps (without follow through to fruition) to set-up a similar operation in South Carolina in the US to avoid the 25 percent US tariff rate on imports of light trucks — the so-called "chicken tax" instituted by President Lyndon Johnson in 1963 in retaliation for European barriers to the import of US chicken meat, still remaining in effect more than six decades later (See "Chicken Tax," Wikipedia). An OEM that set up a tariff-jumping assembly operation, to the extent possible, would want to avoid the costs of establishing local sources of component parts. This inclination is apt to brush against government constraints. In the 1980s, the Indian government imposed local content requirements as preconditions for granting permission to establish automotive assembly plants on a case-by-case basis. Local content requirements as conditions for FDI have since 1995 been disallowed (but with temporary exceptions for developing countries), in accordance with the Uruguay round of multilateral agreements (1986-1993) that established the WTO. The India tariff on auto parts (now 10 percent) is the main regulation still affecting local sourcing of auto parts by OEMs in India.

The various OEMs in the India automotive sector have adopted different strategies in developing their auto part supply chains. Hyundai has had its primary contractors based in Korea establish facilities in India. Maruti-Suzuki has induced the Japan-based contractors of Suzuki to invest in India as joint ventures with local firms. Toyota has exploited its network of contractors in Thailand, Indonesia and Malaysia to supply parts to its plants in India.

Tata Motors, starting from a strong base as the leading manufacturer of commercial vehicles (heavy trucks) and buses in India, diversified into production of SUVs in 1991 and minicars in 1998. To expand its product line and develop its supplier network, it has undertaken a series of foreign acquisitions including the commercial vehicle division of the Korean conglomerate Daewoo in 2002, the Spanish bus and coach cabin maker Hispano Carrocera in 2009, and Jaguar-Land Rover in 2008. It entered into a 50:50 joint venture with Fiat in 2008. Tata Motors' largest foray into passenger cars was its introduction of the Nano in 2008, heralded as the world's cheapest car.

There are far more two-wheel transport vehicles produced in India than four-wheel ones. The indigenous two-wheeler OEMs and their networks of component suppliers constitute the main pool of potential partners for foreign investors seeking to establish joint ventures for assembling passenger vehicles or supplying component parts for such assembly. Furthermore, the now extensive network of foreign auto parts companies with facilities in India are diversifying their sales beyond the particular OEMs that originally induced them to set up in India in the first place. Uchikawa (2011) describes some of the steps leading to the current situation of India automotive subcontractor networks.

The 750 or so members of the Automotive Component Manufacturers Association of India (ACMA) — many of which are subsidiaries of foreign companies — include the India-based prime contractors of components for passenger vehicles, commercial vehicles, tractors, and two-wheelers. These are the top tier of an industry that employs 6-million persons (Confederation of Indian Industry, 2016, p.17). This is 1.1 percent of the total labor force in India, 511 million persons in 2016 according to the World Bank. By way of comparison, auto parts manufacturing in Japan employs 637,000, roughly 1 percent of the Japanese labor force of 65 million persons (Japan Motor Vehicle Association, 2015, p.1).

VI. Conclusion

Management consultants stress the benefit of aftermarket services for continued profitability of direct sale of new durables. For example, Cohen, Agrawal and Agrawal (2006), writing in the Harvard Business Review, document the many challenges of meeting the uncertain and idiosyncratic demand for repair parts, but also note the potential profit from providing repair parts and ancillary servicing in a timely and reliable way. Customers value ancillaries and will pay more for the new durables if the ancillaries can be counted on. In other words, durable and ancillaries are complements in demand. The aim of companies supplying durable goods is wide availability of the aftermarket ancillaries used with the durable goods. Durable and ancillaries are part of the same general package of services.

The tying of repair parts to direct purchase of new cars, as apparently has been the practice in India, in a roundabout way fits these same notions. Although the prices of repair parts were elevated as a result of the tie-in, the prices of new cars were lowered. The overall effect was to expand the sale of repair parts by expanding the sale of cars.

The Competition Commission found the widespread tie-in of replacement parts to direct purchase of automobiles constituted a "foreclosure of competition" in the OES sector of the auto replacement parts industry (Case No. 03/2011, Date: 25/08/2014, In re: Shri Shamsher Kataria Informant and fourteen opposite parties, p.27). But, if my analysis of the tie-in is correct, then it expanded the flow of replacement parts, because it was accompanied by a lower price of new cars and greater equilibrium stock of cars, with implied greater demand for replacement parts. Rather than constituting a barrier to entry, the tie-in would have invited entry.

Ending the tie-in may nevertheless have little noticeable effect on entry in the OES sector. Even if the OES firms have unrestricted access to the aftermarket, the OEMs may still hold an effective monopoly of replacement parts by virtue of the copyrights and patents for the design and production of those parts, which they—the OEMs—hold. By virtue of those patent and copyrights, OEMs in India will continue to enjoy significant market power in replacement parts used with the vehicles they have sold. The analysis of the previous section leads me to think that might actually be good, not only for the auto manufacturers but also for global social welfare (though possibly not for the citizens of India because much of the profit of automotive OEMs in India accrues to the foreign shareholders of those OEMs).

Finally, as the economy of India continues to expand, the demand for motor vehicles will inevitably expand with it. The prospects for profitable investment in the manufacture of automobiles must be very bright. But India's continuing high tariff rates on the import of automobiles and automotive parts constrain such investment and distort the market incentive to exploit the nation's comparative advantage to the fullest extent possible. The automotive component sector in India has reached a sufficient state of maturity that tariff protection has become more of an inhibition to further technological advance than a spur to investment and entry.

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Appendix A: Metering Tie-In of Ancillaries to Durable

Posit a monopoly supplier of a durable good with unit cost k, and suppose that using the durable entails consumption of a non-durable ancillary that has unit cost c. Suppose that each demander i's maximum willingness to pay for the services of the durable good is proportionate to his consumption of the ancillary, x_i. In other words, use of the ancillary meters the willingness to pay for the durable. Denote i's willingness to pay for the durable as vx_i, where v is a parameter common to all demanders, and usage of the durable x_i is distributed uniformly over the population $x_i \sim U(0, \bar{x})$. If the ancillary is supplied by a competitive industry at price $p_x = c$, then the inverse demand for the durable would be

$$p_d = (v - p_x)\bar{x}\left(1 - \frac{x}{\bar{x}}\right),$$

where $\frac{x}{\bar{x}}$ is the fraction of the population that purchases the durable. As shown in Figure A1, with $p_x = c$, the monopoly price of the durable becomes

$$p_d^* = \frac{k + (v - c)\bar{x}}{2}.$$

In general, with given price of ancillaries, p_x, the fraction of the population served is

$$\frac{x^*}{\bar{x}} = 1 - \frac{p_d^*}{(v - p_x)\bar{x}} = 1 - \frac{k + (v - p_x)\bar{x}}{2(v - p_x)\bar{x}} = \frac{(v - p_x)\bar{x} - k}{2(v - p_x)\bar{x}}$$

The monopoly profit is

$$\pi^* = (p_d^* - k)\frac{x^*}{\bar{x}} = \frac{\left((v - p_x)\bar{x}\right)^2 - k^2}{4(v - p_x)\bar{x}}$$

Consumer surplus is $\frac{\pi^*}{2}$.

The monopolist can fully and maximally appropriate consumer surplus by tying the ancillary to the durable and setting prices

$$p_d = k \quad \text{and}$$

$$p_x = \begin{cases} 0, & x < \dfrac{k}{v} \\ v, & x \geq \dfrac{k}{v} \end{cases}$$

and earn profit $2\pi^*$ while serving twice as many customers as before. Those customers still not served value the good less than its social cost.

In this example, tying harms consumer surplus, compared to simple monopoly pricing of the durable, but attains maximum social welfare.

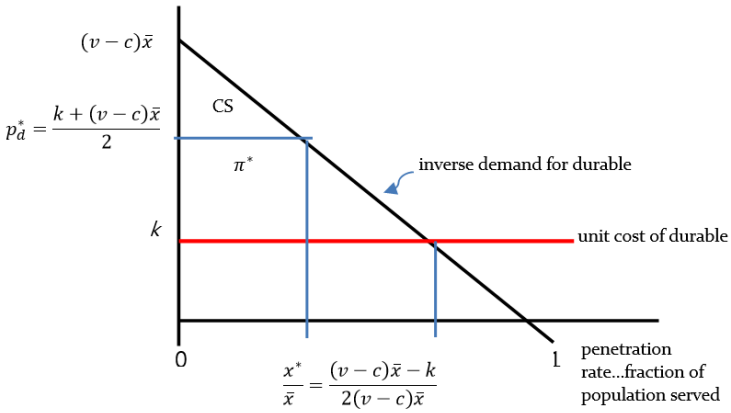

Figure A1 Monopoly pricing of durable good with ancillaries supplied by a competitive industry.

Willingness to pay for durable is proportionate to use of ancillaries and distributed uniformly in the population. By tying ancillaries to durable, the monopolist can fully appropriate consumer surplus and so would aim to maximize appropriable consumer surplus by reducing the price of the durable to unit cost, k.

Appendix B: Multiproduct Monopoly

The prices set by a multiproduct monopoly have been well-understood for many years—see for example Tirole, 1988, p.70. Suppose that the constant-elasticity demands for two goods are such that they are either substitutes in demand or complements and that the same firm is the sole supplier of each:

$$Q_1 = Ap_1^{-\xi_1}p_2^{\xi_{12}}$$
$$Q_2 = Bp_2^{-\xi_2}p_1^{\xi_{21}}$$

To keep matters simple let us assume that there are constant unit costs c_1 and c_2 of supplying each good. The monopolist chooses prices of both goods to maximize total profit:

$$\max_{p_1,p_2} \pi(p_1,p_2) = p_1Q_1 + p_2Q_2 - c_1Q_1 - c_1Q_1$$

The necessary conditions for maximum profit are the following:

$$\frac{\partial \pi_1}{\partial p_1} = Q_1 + p_1\frac{\partial Q_1}{\partial p_1} - c_1\frac{\partial Q_1}{\partial p_1} + (p_2 - c_2)\frac{\partial Q_2}{\partial p_1} = 0 \ ,$$

and

$$\frac{\partial \pi_2}{\partial p_2} = Q_2 + p_2\frac{\partial Q_2}{\partial p_2} - c_2\frac{\partial Q_2}{\partial p_2} + (p_1 - c_1)\frac{\partial Q_1}{\partial p_2} = 0 \ ,$$

which reduce to the following

$$\frac{p_1-c_1}{p_1} = \frac{Q_1}{-p_1\frac{\partial Q_1}{\partial p_1}} + \frac{(p_2-c_2)\frac{\partial Q_2}{\partial p_1}}{-p_1\frac{\partial Q_1}{\partial p_1}}$$

$$= \frac{1}{\xi_1} + \frac{\xi_{21}}{\xi_1}\frac{p_2Q_2}{p_1Q_1}\left(\frac{p_2-c_2}{p_2}\right)$$

and

$$\frac{p_2-c_2}{p_2} = \frac{1}{\xi_2} + \frac{\xi_{12}}{\xi_2}\frac{p_1Q_1}{p_2Q_2}\left(\frac{p_1-c_1}{p_1}\right)$$

If the two goods are complements in demand, $\xi_{12} < 0$ and $\xi_{21} < 0$, then the multiproduct monopolist will set the price of at least one of them below the level that would be set by a single product monopolist.

Proof. Profit must be positive so $p_2 > c_2$ or $p_1 > c_1$, or both. Suppose that $p_2 > c_2$. Then, according to the above, $\frac{p_1-c_1}{p_1} < \frac{1}{\xi_1}$. And if, to the contrary,

$p_2 < c_2$, then $p_2 < c_2\left(1 - \frac{1}{\xi_2}\right)^{-1}$ and $\frac{p_1 - c_1}{p_1} > \frac{1}{\xi_1}$. So at least one of the prices is below the level that would be set by a single-product monopoly. If both $p_1 > c_1$ and $p_2 > c_2$ then both prices must lie below the levels that would be set by single product monopolies.

If the two goods are substitutes in demand (and again presuming constant elasticities), $\xi_{12} > 0$ and $\xi_{21} > 0$, then the multiproduct monopolist will set the price of each above the price that would be set by a single product monopoly.

> *Proof.* According to the necessary conditions for profit maximum for the multiproduct monopolist if one of the prices is set below unit cost then both are...but then profit would be negative. So both prices must be positive. But according to the same conditions, if $p_2 > c_2$, then $\frac{p_1 - c_1}{p_1} > \frac{1}{\xi_1}$. And if $p_1 > c_1$, then $\frac{p_1 - c_2}{p_2} > \frac{1}{\xi_2}$. Both prices lie above the levels that would be set by single-product monopolies.

The case of two products that are perfect substitutes in demand might be a limiting case of the one just considered. Pricing by independent monopolists in that case is a Bertrand duopoly with price equal to unit cost at the Nash equilibrium, compared to the simple monopoly price above marginal cost that would be set by a dual monopolist of two perfect substitutes.