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Consumer-surplus-enhancing collusion and trade

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That collusion among sellers hurts buyers is a central tenet in economics. We provide an oligopoly model in which collusion can raise consumer surplus. A differentiated-product duopoly operates in two geographically separated markets. Each market is home to a single firm, but can import, at a cost, from the foreign firm. Under some circumstances, a perfect cartel, relative to duopolistic competition, raises the price of the imported good and lowers the price of the home good. This raises welfare for most consumers and increases aggregate consumer surplus. A similar possibility result applies to autarky. Our analysis applies beyond the spatial setting.

1. Introduction

■ Economists generally consider collusion among sellers to be detrimental to buyers. Yet conversations with executives in a certain spatial industry that stands accused of explicit collusion—Brazilian cement[1]—have revealed to us a purported belief that some forms of

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[1] More specifically, we refer to contacts with an executive interviewed at the Brazilian cement trade association's offices in 2001, and with three executives who casually turned up at an academic seminar at the Fundação Getulio Vargas in 2005, on the industry's collusiveness. In 2007, a wide-reaching antitrust case was brought against the industry, on allegations that included "industry executives meeting at hotels to divide regional markets," according to the then-head of the Secretariat for Economic Defense (Agência Estado, 2007). The case (administrative proceeding no. 08012.011142/2006-79) remains open in 2011.

coordination that curtail "cross-hauling," by not wasting resources, can benefit society. In this article, we set out to investigate this possibility result. Using only standard ingredients, we provide a simple duopoly model in which, relative to (imperfect) competition, collusion not only turns out to enhance aggregate welfare but, even less conventionally, *may be beneficial for consumers*. We argue that our analysis extends more generally to contexts other than spatial ones where goods are provided at different cost levels.

Colluding firms typically coordinate on several dimensions other than fixing price, such as assigning geographic regions, customers, or product segments to each other (Kaplow and Shapiro, 2007).[2] Motta (2004) and Harrington (2006) document that an element common to the market-sharing scheme of a number of real-world cartels is the adoption of a "home-market principle," by which each cartel member is given preference in supplying its home market—a region, say, where its production facilities are located, or in which consumers might exhibit a "home bias" in its favor—at the expense of supplying other regional markets. The incentive to reduce the volume of cross-hauling may be particularly acute in spatial industries, where transport (or more generally trade) costs are high relative to product value. Similarly, in a context of systems competition, where an adaptation cost must be incurred whenever the owner of a system sells a complementary component to a user of a rival system, systems-components providers might coordinate to reduce the penetration of each provider's component in rival platforms.

We choose to cast our model in a trade setting, at the intersection of the trade and industrial organization literatures. There are two geographically separated markets, 1 and 2, each market being home to one firm: firm A is located in market 1 and firm B is located in market 2. To supply consumers in the other market, a firm incurs a trade cost t per unit shipped. Within each market, consumers vary in their preferences over a differentiated good, each market being modelled as a uniform mass of consumers distributed over a unidimensional space of product characteristics; that is, we embed Hotelling's unit interval in each market. Each of the two firms produces a single variety: firm A's offering lies at the left endpoint of the unit interval and firm B's at the right endpoint. A consumer's disutility from consuming a variety other than her ideal variety is linear in the distance along this interval. We parameterize the model such that each consumer purchases one of the two goods, thus abstracting away from aggregate demand effects (which are already well understood; see below) and focusing on strategic market-share effects. As remarked by a referee, because the two markets are not linked, the model can be rewritten in more general terms, emphasizing the applicability of our findings beyond trade (or multiple markets), albeit at the cost of increased complexity.[3]

We derive equilibrium outcomes under two alternative market-based behavioral benchmarks: (i) a Nash equilibrium in prices—the "(imperfectly) competitive regime," and (ii) the joint-profit-maximizing cartel—the "(fully) collusive regime" (which, due to the symmetry across markets, is equivalent to a merger to monopoly). Relative to the collusive regime, the competitive regime is characterized by more trade across geographic markets,[4] as each competitive firm vies to sell to consumers whose tastes are closer to their product offering than that of the rival firm yet lower social welfare. From a social viewpoint, competition leads to "excessive trade"—in which the "variety effect" is dominated by costly cross-hauling—and collusion serves as a mechanism

[2] Multidimensional cartel agreements were a feature of some early cartels (e.g., see Deltas, Serfes, and Sicotte, 1999).

[3] That is, two differentiated firms would compete in a *single* market, firm A at the left endpoint enjoying a marginal cost t lower than firm B at the right endpoint. Our chosen trade setting, although indeed more specific, appears salient both in the literature and in practice (the geographic configuration of many cartels), originally motivating us to write the article. It also allows for relatively clean modelling (by preserving overall symmetry of firms across markets, one can solve for the first-best collusive agreement without resorting to side payments—an unappealing assumption—or imposing a model of bargaining).

[4] Unlike Pinto's (1986) homogeneous-goods setting, the perfect cartel still cross-hauls a positive quantity. We do not require constrained cartels (i.e., deviation incentives, as in Bond and Syropoulos, 2008) for cross-hauling to obtain.

to (partially) address this distortion.[5] The more striking possibility result is that *collusion can increase consumer surplus* relative to competition, with some of the welfare gain generated through collusion being captured by consumers.[6]

The intuition for this result follows from noting that a necessary condition for collusion to raise consumer surplus is that, on shifting from duopoly to monopoly, the price of the home good falls (more generally, the price of the efficiently produced variety falls; see footnote 3). In each market, the "foreign" firm has a cost disadvantage, as it incurs a trade cost, and a lower market share in equilibrium than the "home" firm: the high-cost competitor prices aggressively, given the smaller revenue losses from sales to inframarginal consumers. On shifting from the competitive regime to the collusive one, the cartel raises the price of the imported good (more generally, the inefficiently produced variety). Now consider parameter values such that an interval of consumers in the competitive regime do not enjoy too high a surplus (relative to the outside good) and who, if faced with an isolated increase in the price of the imported good, would no longer buy an inside good. We show that an import-price-raising cartel finds it optimal to keep this margin of consumers, and thus lowers the price of the home good. The drop in the price of the home good, which raises welfare for most consumers, can dominate the loss experienced both from the higher import price and from inducing some consumers to switch away from their favored imported variety. Similar intuition applies to a second possibility result, that *autarky* (banning cross-hauling or, more generally, banning the inefficiently produced variety) *can increase consumer surplus* relative to trade under monopoly (collusion) or duopoly (competition).

Recent empirical work on spatial (international or subnational) cartels suggests that the home-market principle is not a mere theoretical curiosity (e.g., Strand, 2002 on EU sugar markets; Röller and Steen, 2006 and Salvo, 2010 on Norwegian/European and Brazilian cement markets, respectively).[7] Harrington (2006) describes several global cartels, arguing that in the methionine case "the home-market principle was, in fact, the instigating factor for cartel formation" (also see Levenstein and Suslow, 2004). Other settings motivate the analysis. In a context where retailers can mail coupons to households based on address (e.g., Bester and Petrakis, 1996), the two markets could correspond to different neighborhoods, each neighborhood being home to a mass of shoppers (residents) and hosting a single differentiated retail outlet, owned by a separate firm. Retailers A and B compete by providing rebates to attract ("poach") physically distant shoppers, some of whom are induced to travel, at cost t, to their favored-format store. In analogy to spatial markets, imagine the two markets corresponding to some form of systems competition: firms A and B make both systems and complementary components (e.g., a differentiated peripheral or service to be used on a platform). Firm A's "home" market is the market for the complementary component used on firm A's system; firm A's "foreign" market is the market for the complementary component used on firm B's system. To be used on a "foreign" system, a component needs to be adapted at cost t (with autarky corresponding to perfect incompatibility of a system with components of the other).

We make two qualifications. First, we are not arguing that conventional wisdom on the impact of collusion on buyers is misguided; our purpose is to point out, through a workhorse model, that a "perverse" possibility result may arise in *some* plausible market settings. Other research

[5] In a homogeneous-goods international Cournot oligopoly, Brander and Krugman (1983) show that the pro-competitive effect of trade, stemming from lower prices (rather than closer-to-ideal varieties, as in our model), can be dominated by costly cross-hauling when the trade cost is high enough. But, unlike in our model, collusion in their homogeneous-goods model—which would be akin to autarky—always hurts consumers. The result that trade can have an adverse effect on aggregate welfare has been extended (in varying contexts) by Newbery and Stiglitz (1984), Clarke and Collie (2003), Eden (2007), and Friberg and Ganslandt (2008).

[6] In the single-market model (see footnote 3), the competitive regime is characterized by excessive sales of the inefficiently produced variety, with monopoly serving as a mechanism to partially address this distortion.

[7] Lommerud and Sørgard (2001) cite a scheme uncovered in 1994 to limit intra-EU trade of cement (as well as the prosecution in the 1970s of Japanese and European synthetic fiber producers for agreeing to restrain exports to each other's markets). Of note, although cement (and sugar and chemicals) are often considered fairly homogeneous, sellers might differentiate their offerings through service or some form of state dependence (past dealings).

points to unconventional results of this nature. In a different (and empirically oriented) setup from ours, Fershtman and Pakes (2000) show that collusion can increase both the number and the quality of product offerings, offsetting the effect of higher prices and increasing consumer welfare (also see Draganska, Mazzeo, and Seim, 2009). Collusion can raise consumer surplus in markets with large fixed costs, because—some—consumers gain access to their more-preferred product (in contrast to our model, where collusion can benefit consumers despite—some—consumers receiving their less-desired product). Related literature examines higher prices stemming from competition lowering residual demand elasticities by enhancing choice (Chen and Riordan, 2008; Zacharias, 2009) or from a greater number of competitors inducing less search (Stiglitz, 1987).[8]

The second qualification is that our model, following the standard Hotelling framework, abstracts away from aggregate demand effects, because our intent is to focus on the possibility result, as argued not least by certain firms themselves (and allocative effects are present through variety). Our conclusions should be continuous as one introduces aggregate volume effects, to be balanced against the strategic effects at work in our model (i.e., the price aggressiveness of a high-cost or a low-quality firm in imperfect competition). However, near-zero aggregate volume effects do not seem to be an unreasonable assumption in spatial industries such as cement and sugar, or in markets for certain household appliances in mature economies.[9]

2. The model

■ We consider a geographically segmented industry where goods are horizontally differentiated. To capture the geographic component, we model two local markets, 1 and 2. Shipping product from one market to another—cross-hauling—incurs a unit trade cost $t > 0$ (and zero fixed cost). To capture the taste component, we model each local market as a continuum of consumers distributed uniformly over a unidimensional space of product characteristics, defined by the interval [0, 1]. The disutility from consuming a variety other than one's ideal variety is linear in the distance along this Hotelling interval, with slope $\theta > 0$. There are two firms, A and B, each firm producing one variety. In geographic space, firm A's plant is located in market 1, whereas firm B's plant is located in market 2. In product space, firm A's product is located at the left endpoint of the unit interval, whereas firm B's product is located at the right endpoint. (We assume barriers to entry are high enough in both geographic and product spaces so that neither firm will build a second plant or introduce a second product.[10]) The two firms have the same constant marginal cost of production $c \geq 0$.

Consumers make discrete choices, purchasing one unit or none. Let consumer type $x \in [0, 1]$ denote the distance from the left endpoint of the unit interval. A firm's price can vary across the two markets, although not across consumers within a market. Consider either one of the local markets, and denote the vector of prices by $p = (p_A, p_B)$; for simplicity, we momentarily omit market subscripts. Denoting the reservation price for one's ideal product (relative to the

[8] Whinston (2006) speculates that in certain settings, cartels may benefit society, but (like us) he is not advocating a rule-of-reason approach to the prosecution of cartels. Joe Farrell has pointed out to us that a similar line of "defense" is heard in merger cases, where merger proponents argue that unilateral effects will be outweighed by cost efficiencies. As pointed out by a referee, the standard natural monopoly argument also comes to mind, whereby the reduction in unit cost through better coordination of resources (including internalization of informational externalities) may be so pronounced as to lower prices. For contributions to the "empty core" literature, in which a competitive equilibrium can fail to exist, see Telser (1996), Sjostrom (1989, 2004), and Pirrong (1992). Our result is reminiscent of, though conceptually distinct from, suggestions that in some industries competitive markets can lead to "destructive competition" and that cartels can help stabilize them; for more discussion, see Deltas, Sicotte, and Tomczak (2008).

[9] A more general specification would be to embed a downward-sloping demand at each point of the Hotelling interval. We believe this would add notational clutter without providing intuition beyond what is already given here.

[10] We ignore the possibility that a firm's location in product space is endogenous, assuming instead that product attributes are fixed (e.g., brand identity or consumer perceptions, in which case locating the varieties at the endpoints constitutes a normalization). More generally, collusive firms may choose different locations from competing duopolists. We defer for future consideration whether endogenous differentiation would magnify or countervail the strategic market-share effects that we highlight.

outside good) by v, consumer type x chooses good A when $U_A(p_A; x) := v - \theta x - p_A \geq \min(U_B(p_B; x), 0)$, where $U_B(p_B; x) := v - \theta(1 - x) - p_B$, and chooses good B when $U_B(p_B; x) > \min(U_A(p_A; x), 0)$.[11] The location of the "marginal consumer" $\tilde{x}$, defined as the consumer who is indifferent between goods A and B, follows from solving $U_A(p_A; \tilde{x}) = U_B(p_B; \tilde{x})$, that is, $\tilde{x}(p) = 1/2 + (p_B - p_A)/(2\theta)$.

We examine equilibrium outcomes under price competition and full collusion. Our focus is the case where, in these alternative regimes, in equilibrium both firms sell in both markets and all consumers purchase an inside good. We thus restrict the space of parameters as follows.

Assumption 1. (Cross-hauling under collusion) $t < 2\theta$. Restricting the cost of cross-hauling between markets to be sufficiently low (relative to the degree of product differentiation) implies that cross-hauling occurs even in the fully collusive regime.[12]

Assumption 2. (Full market coverage) $2(v - c) > t + 3\theta$. Restricting the reservation price for one's ideal product to be sufficiently high (relative to product differentiation and costs) implies that in both regimes all consumers prefer either good to the outside option.[13]

Quantity shares for firms A and B are then given by $\tilde{x}(p)$ and $1 - \tilde{x}(p)$, respectively.

□ **Price competition.** As marginal cost is flat in output, the problem is separable (and analogous) across the two local markets. We consider market 1. In a competitive equilibrium, prices solve

$$\begin{cases} \max\limits_{p_A}(p_A - c)\tilde{x}(p) \\ \max\limits_{p_B}(p_B - c - t)(1 - \tilde{x}(p)), \end{cases}$$

yielding $(p_{1A}^C, p_{1B}^C) = (c + \frac{1}{3}t + \theta, c + \frac{2}{3}t + \theta)$ (now adding market subscripts). In this equilibrium, profits are $(\Pi_{1A}^C, \Pi_{1B}^C) = ((3\theta + t)^2/(18\theta), (3\theta - t)^2/(18\theta))$, and the location of the marginal consumer (equivalently, the home firm's quantity share) is $\tilde{x}_1^C = 1/2 + t/(6\theta)$. Assumption 1 implies that $\tilde{x}_1^C < 1$ and cross-hauling occurs. (See Figure 1 for a summary.) Equilibrium outcomes in market 2 are obtained from interchanging the market-firm subscripts (and $\tilde{x}_2^C = 1 - \tilde{x}_1^C$). One can verify that a firm's total profit $\Pi_{1A}^C + \Pi_{2A}^C$ is increasing in both the trade cost t and (given Assumption 1) the degree of product differentiation θ; intuitively, increasing t or θ relaxes price competition.

□ **Full collusion.** We derive the fully collusive outcome assuming that the discount factor is sufficiently close to one so that firms' incentive compatibility constraints do not bind.[14] In our setup, collusion is equivalent to a merger to monopoly, although for clarity of exposition we refer to joint-profit maximization (denoted by the superscript *JM*) as arising from collusion. In the joint-profit maximum, prices set by the firms fully extract the marginal consumer's surplus. (Were

[11] Our analysis is robust to the introduction of home bias, that is, specifying $v_{1A} = v_{2B} > v_{1B} = v_{2A}$. Home bias reduces cross-hauling, but by less under competition than it does under collusion. Deltas, Salvo, and Vasconcelos (2012) derive this result (in addition to aggregate welfare properties in the market environment considered here).

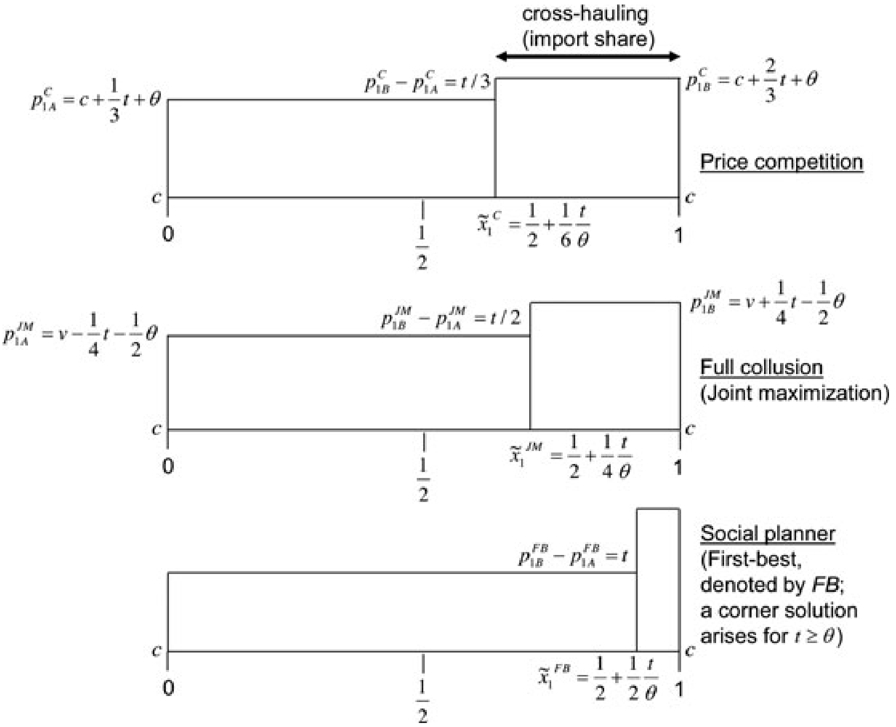
[12] To keep expressions brief, we chose Assumption 1 over the weaker restriction $t < 3\theta$ (cross-hauling under competition), although our possibility result can similarly arise when (only) the collusive market allocation is a corner solution.

[13] The restriction is equivalent to $(U_B(p_B^C; \tilde{x}^C) =) U_A(p_A^C; \tilde{x}^C) > 0$ (where C denotes the imperfectly competitive outcome). The market will remain covered for a region of parameters beyond this inequality. For these parameter values, the nature of competition will no longer be duopolistic but rather the kinked equilibrium of Salop (1979).

[14] When the number of (symmetric) firms is fixed, then any degree of cooperation, including the joint-profit maximum, can be supported as a subgame-perfect equilibrium outcome of an infinitely repeated game with perfect monitoring if the discount factor is high enough (e.g., Fudenberg and Maskin, 1986). An appendix examining the perfect cartel's incentive constraint, when firms adopt grim trigger strategies that account for the multimarket nature of their contact, is available upon request.

FIGURE 1

QUANTITY SHARES AND PRICES FOR THE HOME GOOD AND THE FOREIGN GOOD



In market 1, for different trade regimes (in the restricted space of parameters): price competition (top) and full collusion (middle). (The bottom panel illustrates an element of the set of first-best outcomes, denoted by the superscript *FB*.) Market 2 is symmetric. Drawn to scale for parameter values $v = 1$, $c = .42$, $t = .25$, $\theta = .3$. (Vertical measures start at c; relative to the vertical scale, the horizontal scale is scaled up by a factor of 2.)

the marginal consumer to have positive surplus, joint profits could increase by slightly raising prices, and we have assumed that v is large enough that it is optimal to serve all consumers; see below.) Thus, fully collusive prices satisfy $U_A(p_A; \tilde{x}(p)) = 0$, which substituting for $\tilde{x}(p)$ yields the price locus $2v - \theta - p_A - p_B = 0$. The perfect cartel's problem is

$$\max_{p_A, p_B} (p_A - c)\tilde{x}(p) + (p_B - c - t)(1 - \tilde{x}(p)) \quad \text{subject to } U_A(p_A; \tilde{x}(p)) \geq 0,$$

which collapses to the univariate problem $\max_{p_A} (p_A - c)(v - p_A)/\theta + (2v - \theta - p_A - c - t)(1 - (v - p_A)/\theta)$, immediately yielding the solution $(p^{JM}_{1A}, p^{JM}_{1B}) = (v - \frac{1}{4}t - \frac{1}{2}\theta, v + \frac{1}{4}t - \frac{1}{2}\theta)$. Equilibrium profits are now $(\Pi^{JM}_{1A}, \Pi^{JM}_{1B}) = ((2\theta + t)(4(v - c) - t - 2\theta)/(16\theta), (2\theta - t)(4(v - c) - 3t - 2\theta)/(16\theta))$ and the location of the marginal consumer is $\tilde{x}^{JM}_1 = 1/2 + t/(4\theta)$ which, under Assumption 1, is less than 1; that is, cross-hauling also occurs.[15,16] (Again, see Figure 1 for a summary, and interchange the market-firm subscripts for market 2 outcomes, with

[15] To see why the cartel wishes to sell to the entire market, consider a deviation $\Delta p > 0$ from p^{JM}_{1A}, which would result in $\Delta p/\theta$ of the market no longer being covered. Compute the gain on inframarginal consumers, $\Delta p(\tilde{x}^{JM}_1 - \Delta p/\theta) = \Delta p(\frac{1}{2} + t/(4\theta) - \Delta p/\theta)$, and the loss on marginal consumers, $(p^{JM}_{1A} - c)\Delta p/\theta = (v - \frac{1}{4}t - \frac{1}{2}\theta - c)\Delta p/\theta$. The marginal loss of this deviation would exceed the inframarginal gain when $\Delta p > -(v - c - \frac{1}{2}t - \theta)$, a condition that is satisfied under Assumption 2. Similar steps follow for a deviation $\Delta p > 0$ from p^{JM}_{1B}. (Under competition, full market coverage also follows from Assumption 2; recall footnote 13.)

[16] As we discuss below, the collusive margin on imports, although lower than the collusive margin on the home good, exceeds the competitive margin on imports; that is, the cartel raises the price of the imported variety relative to the competitive importer.

$\tilde{x}_2^{JM} = 1 - \tilde{x}_1^{JM}$.) One can show that in the collusive outcome a firm's total profit $\Pi_{1A}^{JM} + \Pi_{2A}^{JM}$ decreases in both the trade cost t (given Assumption 1) and the degree of product differentiation θ. Intuitively, the competitive mechanism is now absent, and a higher t raises the cost of bringing a variety to market, whereas a higher θ raises the disutility from not consuming one's ideal variety.[17]

□ **Comparing the two regimes: import shares and aggregate welfare.** Although less than one, the quantity share of the home good in the joint-profit-maximizing outcome is higher than under competition, $\tilde{x}_1^{JM} > \tilde{x}_1^{C}$. The perfect cartel trades less product across geographic markets, or "swaps geographic markets" relative to the competitive duopoly. In terms of social welfare—the sum of consumer surplus and producer surplus—it turns out that producers and consumers are jointly better off under full collusion than in the imperfectly competitive equilibrium outcome. This can easily be verified. Given our focus on the case where the market is fully covered, the comparison of welfare across the two regimes can be decomposed into (i) the different total cost of cross-hauling product between geographic markets (i.e., $t(1 - \tilde{x}_1^{C})$ against a less costly $t(1 - \tilde{x}_1^{JM})$, with market 2 being analogous); and (ii) the different total disutility from consuming a variety other than one's ideal (i.e., $\int_0^{\tilde{x}_1^C} \theta x dx + \int_{\tilde{x}_1^C}^1 \theta(1 - x)dx$ against a more costly $\int_0^{\tilde{x}_1^{JM}} \theta x dx + \int_{\tilde{x}_1^{JM}}^1 \theta(1 - x)dx$, as the good each consumer chooses under competition is (weakly) closer to her ideal variety relative to her choice under collusion). Effect (i) dominates effect (ii), with the (per-market) social welfare gain from collusion equating to $W^{JM} - W^{C} = 7t^2/(144\theta) > 0$, which is positive even for low t, is increasing in t, and is decreasing in θ.

In both competitive and collusive regimes, firms " price discriminate" against their home-market consumers (or, equivalently, in favor of their geographically distant consumers), but it is under competition that this price discrimination is more pronounced, in that $p_{2A}^{C} - p_{1A}^{C} = p_{1B}^{C} - p_{1A}^{C} = \frac{1}{3}t < p_{2A}^{JM} - p_{1A}^{JM} = p_{1B}^{JM} - p_{1A}^{JM} = \frac{1}{2}t < t$ (this is reminiscent of Thisse and Vives, 1988).[18] From a social point of view, the oligopolistically competitive equilibrium is characterized by "excessive trade," with collusion serving as a mechanism to correct this failure, if only as a partial mechanism.

A social planner would set the price difference between the home good and the imported good equal to the trade cost (with price levels determining the division of surplus between producers and consumers in this first-best world), further reducing the import share (also illustrated in Figure 1, denoted by the superscript FB, with the marginal consumer located at $\tilde{x}_1^{FB} = \min(1/2 + t/(2\theta), 1)$). As one might expect, this first-best market allocation $\tilde{x}_1^{FB}$ would also obtain in both competitive and collusive regimes, were firms able to price discriminate *within* markets[19]; although social welfare would be the same (and maximal) across the two regimes under perfect price discrimination, collusion would naturally make consumers worse off.

[17] As $\partial(\Pi_{1A}^{JM} + \Pi_{2A}^{JM})/\partial t < 0$ and (as noted) $\partial(\Pi_{1A}^{C} + \Pi_{2A}^{C})/\partial t > 0$, the (positive) private gains from collusion decrease in the trade cost: $\partial(\Pi_{1A}^{JM} + \Pi_{2A}^{JM} - \Pi_{1A}^{C} - \Pi_{2A}^{C})/\partial t < 0$. This may seem counterintuitive, as the cartel cross-hauls less than competing duopolists ($1 - \tilde{x}_1^{JM} < 1 - \tilde{x}_1^{C}$), but recall that raising t softens price competition.

[18] Under imperfect competition, there is more "dumping" (in the Brander and Krugman, 1983 sense) or, borrowing other terms from the trade and spatial literatures, there is a greater degree of "pricing to market" or "freight absorption" (again in the sense that the imported good's price upcharge falls short of the trade cost). Such freight absorption (in either regime) forestalls the possibility of buyer arbitrage.

[19] To see this, note that (i) for every consumer x, a monopolist would compare $v - \theta x$ (the price it would charge for the home good and extract all the consumer's surplus) against $v - \theta(1 - x) - t$ (the price on the imported good that extracts all the consumer's surplus, minus the trade cost it incurs); equating the two expressions yields $\tilde{x}_1^{FB}$; and (ii) in the competitive duopoly, with firms disputing every consumer separately (i.e., no consumer is inframarginal), the home firm would win consumers $x < \tilde{x}_1^{FB}$ whereas the importer would win consumers $x > \tilde{x}_1^{FB}$ (both firms would be equally placed to win the consumer at $\tilde{x}_1^{FB}$ because the relative taste disutility from consuming the home good, $2(t/(2\theta))\theta$, would equal the home good's relative price discount t, with marginal cost pricing at this location—the effects of product differentiation and cost asymmetry offsetting one another).

3. Consumer welfare and collusion: a possibility result

■ The finding that coordination (or monopoly) can raise aggregate welfare, although unconventional, arises in different models that have been studied in the literature. More striking in our model is the finding that, relative to duopolistic competition, collusion can be good even for *consumers*. As the following proposition states, the condition for the consumer-surplus-enhancing result to hold (i) translates into the marginal consumer's surplus under competition not being too high, and (ii) requires that, on shifting from duopoly competition to collusion, the price of the home good (the efficiently produced variety) *declines*.

Proposition 1. Full collusion raises consumer surplus relative to price competition when the unit trade cost t is sufficiently high (relative to the reservation price for one's ideal product v), that is, when $5t^2/(72\theta) > 2(v - c) - (t + 3\theta)$. A necessary condition for this to hold is that the price of the home good under collusion declines relative to competition, which (under Assumption 2) implies that $v - c$ falls in an interval of width $\frac{1}{12}t$, and in particular $\frac{7}{12}t + \frac{3}{2}\theta > v - c > \frac{6}{12}t + \frac{3}{2}\theta$.

Proof. Begin by calculating consumer surplus in each regime (this is equivalent to the area of two trapezoids under competition, which collapses to the area of two triangles under collusion, as the marginal consumer then has zero surplus):

$$\begin{aligned} CS^C &= \int_0^{\tilde{x}_1^C} \left(v - \theta x - p_{1A}^C\right) dx + \int_{\tilde{x}_1^C}^1 \left(v - \theta(1-x) - p_{1B}^C\right) dx \\ &= v - \frac{1}{2}\left(p_{1A}^C + p_{1B}^C\right) - \frac{1}{2}\tilde{x}_1^C\left(p_{1A}^C - p_{1B}^C + \theta\right) \\ &= (36v\theta - 36c\theta - 18t\theta - 45\theta^2 + t^2)/(36\theta), \quad \text{and} \\ CS^{JM} &= v - \frac{1}{2}\left(p_{1A}^{JM} + p_{1B}^{JM}\right) - \frac{1}{2}\tilde{x}_1^{JM}\left(p_{1A}^{JM} - p_{1B}^{JM} + \theta\right) \\ &= (4\theta^2 + t^2)/(16\theta). \end{aligned}$$

Rearrange the difference $CS^{JM} - CS^C = \frac{1}{2}(5t^2/(72\theta) - 2(v-c) + (t+3\theta))$, so $CS^{JM} > CS^C \Leftrightarrow 5t^2/(72\theta) > 2(v - c) - (t + 3\theta)$. The left-hand side of the inequality is positive and increasing in t, whereas the right-hand side is, under Assumption 2, also positive but decreasing in t. The condition holds when t is high enough and Assumption 2 is not too slack; more formally, $CS^{JM} > CS^C$ iff Assumption 2 is within $5t^2/(72\theta)$ of binding. Now consider

$$\begin{aligned} p_{1A}^{JM} - p_{1A}^C &= \left(v - \frac{1}{4}t - \frac{1}{2}\theta\right) - \left(c + \frac{1}{3}t + \theta\right) \\ &= \frac{1}{2}\left(2(v-c) - (t+3\theta) - \frac{1}{6}t\right), \end{aligned}$$

so $p_{1A}^{JM} < p_{1A}^C \Leftrightarrow \frac{1}{6}t > 2(v-c) - (t+3\theta)$. As, under Assumption 1, $\frac{1}{6}t > 5t^2/(72\theta)$, it follows that $CS^{JM} > CS^C \Rightarrow p_{1A}^{JM} < p_{1A}^C$; that is, whenever Assumption 2 is within $5t^2/(72\theta)$ of binding, it is necessarily within $\frac{1}{6}t$ of binding. Finally, the condition $p_{1A}^{JM} < p_{1A}^C$ is equivalent to $\frac{7}{12}t + \frac{3}{2}\theta > v - c$, and the right-hand side of the stated condition on $v - c$ follows from Assumption 2. *Q.E.D.*

To understand why collusion can raise aggregate consumer surplus, consider a situation in which the marginal consumer in the competitive regime has only a small positive surplus, so that consumers with somewhat higher values of x would obtain negative utility from the purchase of the home good. The cartel wishes to reduce the share of the imported good and raise that of the home good, while still covering the market. If it attempted to accomplish this solely by increasing the price of the imported good, then some of the consumers who have hitherto chosen the imported good would choose to purchase nothing. The only way to continue covering the market is to simultaneously lower the price of the home good. This raises welfare for most consumers. Therefore, when collusion raises consumer welfare relative to competition, the price of the imported good rises, but the price of the home good declines. In this region of parameters, consumers who under competition were already buying the home good (and even some near-marginal consumers who were buying their preferred imported good but now switch to the even cheaper home good) are made better off through collusion. This gain in consumer welfare dominates both the loss suffered by consumers who carry on buying the now dearer imported good and the loss experienced by some consumers who have been induced to switch to their less-favored home variety.[20]

□ **The "size" of the parameter region for which collusion enhances consumer welfare.** The natural question arises on how "large"—in terms of the economics of industries—is the range of parameters for which collusion increases consumer surplus. That is, how likely (or unlikely) are real-world markets to be characterized by such parameter values? Our aim here is *not* to argue that the range is sufficiently large that the surprising result of Proposition 1 is common and that conventional wisdom that collusion hurts consumers ought to be overturned. Such an argument would be misguided. Rather, by mapping model primitives to more readily interpretable market statistics, our approach is to point out that our *possibility* result may arise in *some* plausible market contexts.

One of the four parameters in our model (v, c, t, and θ) can be normalized without (further) loss of generality. We set $t = 1$, so values are now expressed in terms of the trade cost across local markets (or market segments). We require three market statistics to pin down the remaining parameters. The market share of the leading firm (relative to the combined share of the two leading firms) is a natural market statistic, as is the share-weighted ratio of each firm's margin divided by marginal cost. (We thus restrict the exercise to markets in which two firms are dominant, and here refer to the margin as that between price and production cost.) The first statistic, the "leader's share," corresponds to $\tilde{x}_1^C(t, \theta)$ in our model, whereas the second statistic, the (average) "margin-to-cost ratio," corresponds to $\tilde{x}_1^C(\theta + \frac{1}{3}t)/c + (1 - \tilde{x}_1^C)(\theta + \frac{2}{3}t)/c$ (in the competitive regime). As a third statistic, we utilize the share-weighted ratio of each firm's median consumer's willingness to pay (WTP) divided by price. This ratio is not readily observed, but it seems empirically more interpretable than v (the maximal WTP among the market's consumers). In our model, the (average median) "WTP-to-price ratio" is $\tilde{x}_1^C(v - \theta\tilde{x}_1^C/2)/p_{1A}^C + (1 - \tilde{x}_1^C)(v - \theta(1 - \tilde{x}_1^C)/2)/p_{1B}^C$, pinning down v.

A market (or pair of markets) with a margin-to-cost ratio of 1.6, a leader's share of 75%, and a WTP-to-price ratio of 1.15, corresponding to parameter values $(v, c, t, \theta) \approx (2.226, 0.677, 1, 0.667)$, meets the condition for consumer surplus to increase with collusion. This is an industry enjoying a high average margin relative to (the efficient level of) production cost. The leader's share (of the home market) is three times that of the second firm. Median WTP over price is somewhat low—the typical consumer does not obtain much surplus. There is moderate product differentiation in this market, with high margins supported in part by the substantial cost asymmetry between the two firms.

Further raising the margin-to-cost ratio (corresponding to lowering c and v), raising the leader's share (lowering all three parameters), or reducing the WTP-to-price ratio (lowering v), moves us "deeper" into the region where the result of Proposition 1 holds. Now consider changing more than one market statistic simultaneously while remaining inside this region, as

[20] Relative to competition, collusion impacts consumer welfare both by shifting prices (up for the imported variety and—for t high—down for the home variety) and by changing the market allocation (against imports). Because the latter effect hurts consumers and is not accounted for in typical calculations of "customer damages," one can show that there is a region of parameters in which collusion (conventionally) lowers consumer surplus yet "damages" are calculated to be negative (i.e., they are not found to occur, as the calculation does not account for the adverse variety effect, which in this case dominates a favorable overall price effect). We thank Joe Harrington for this comment.

follows. Raising both the margin-to-cost ratio from 1.5 to 3 and the leader's (local) share from 75% to 80% allows a slightly higher WTP-to-price ratio of about 1.2, rather than 1.15; there is little scope for the result to hold in markets where median WTP is not low relative to price. But there is further room to move in other directions. For example, holding WTP over price at 1.15 and raising the leader's share to 83% (from 75%) allows the margin-to-cost ratio to drop to 1.15 (from 1.6); with more asymmetric local market shares, margins need not be as high for collusion to raise consumer surplus. Quantitatively, collusion can increase consumer surplus by up to 25% for parameters similar to those listed above (of course, for other parameter values, collusion can reduce consumer surplus by an even greater percentage). In sum, although collusion in real-world markets is likely to be detrimental to consumer surplus, our model suggests that conditions for which the opposite—and unconventional—result holds should not be considered implausible.

4. Consumer welfare and autarky: another possibility result

■ We have compared consumer surplus across two alternative "trade regimes"—competitive (duopoly) trade and collusive (monopoly) trade. In contrast, the trade literature typically examines one trade regime (competitive trade) against the absence of trade. We now derive this autarkic outcome and show another unconventional result: autarky (or banning the inefficiently supplied variety) can be better than trade even for *consumers*.

In the autarkic (or incompatibility) regime (denoted by the superscript *AUTK*), each market is a monopoly (due to symmetry, we again only consider market 1). Within our parameter region of interest—that restricted by Assumptions 1 and 2—there are two kinds of monopoly outcomes. The first case occurs for v high enough, $v - c \geq 2\theta$, that the autarkic monopolist fully covers the market. (Inspection of Assumption 2 indicates that $v - c \geq 2\theta$ necessarily holds when $t \geq \theta$.) In this full-coverage case, the monopolist leaves the consumer at $x = 1$ with zero surplus, setting price $p^{AUTK} = v - \theta$.

In the second (complementary) case, for low v such that $v - c < 2\theta$, full market coverage is not optimal for the monopolist. At the monopoly price, the consumer at $\check{x}(p^{AUTK}) = (v - p^{AUTK})/\theta < 1$ is indifferent between the inside good and the outside good, that is, $v - \theta\check{x}^{AUTK} - p^{AUTK} = 0$.[21] In this incomplete-coverage case, the autarkic monopolist solves

$$\max_p (p - c)\check{x}(p),$$

yielding $p^{AUTK} = \frac{1}{2}(v + c)$, and the share of the inside good is $\check{x}^{AUTK} = (v - c)/(2\theta) < 1$.

In the remainder of this section, we consider only the first case of full coverage under autarky to show that banning trade can raise consumer surplus. (Importantly, our restriction to the full-coverage case is due to brevity; the Appendix shows that this perverse possibility result extends to the incomplete-coverage case.) Similar to Proposition 1, the condition for the consumer-surplus-enhancing result to hold (i) translates into the marginal consumer's surplus under trade (in the imperfectly competitive regime) not being too high, and (ii) requires that, on shifting from trade to autarky, the price of the home good *declines*.

Proposition 2. Autarky with full market coverage ($v - c \geq 2\theta$) raises consumer surplus relative to imperfectly competitive trade when the unit trade cost t is sufficiently high (relative to the reservation price for one's ideal product v), that is, when $(3\theta - t)(3\theta + t)/(18\theta) > 2(v - c) - (t + 3\theta)$. A necessary condition for this to hold is that the price of the home good under autarky declines relative to the competitive regime, which implies that $v - c$ falls in an interval of width $\frac{1}{3}t$, and in particular $\frac{1}{3}t + 2\theta > v - c \geq 2\theta$. Further, autarky brings gains to consumers relative to collusive trade for any trade cost $t < 2\theta$.

[21] We use $\check{x}$ rather than $\tilde{x}$, because $\tilde{x}$ has denoted the location of the consumer who—when trade is allowed—is indifferent between either inside good A or B.

Proof. Consumer surplus in autarky, CS^{AUTK}, is a triangle of area $\frac{1}{2}\theta$ (full-coverage case). Begin by calculating $CS^{AUTK} - CS^{C} = (9\theta^2 - t^2 + 18\theta(t + 3\theta - 2(v - c)))/(36\theta)$, so $CS^{AUTK} > CS^{C} \Leftrightarrow (3\theta - t)(3\theta + t)/(18\theta) > 2(v - c) - (t + 3\theta)$. The left-hand side of the inequality is positive and decreasing in t over $0 < t < 3\theta$; the right-hand side decreases in t and, under Assumption 2, is positive, first crossing the left-hand side from above and to the left of the right-hand side's t-root, which itself may lie to the left of 2θ (see Figure 2 for an illustration).

That the autarkic monopolist must necessarily reduce price relative to the imperfectly competitive home firm for consumer surplus to rise follows from noting that the area of the consumer-surplus triangle under autarky (of height $v - p^{AUTK}$ and unit base) must exceed the sum of the areas of the two consumer-surplus trapezoids under competition (the largest of which has maximal height $v - p^{C}_{1A}$). That is, $CS^{AUTK} > CS^{C} \Rightarrow p^{AUTK} < p^{C}_{1A}$. Upon substituting for prices, one can check that the condition $p^{AUTK} < p^{C}_{1A}$ is equivalent to $\frac{1}{3}t + 2\theta > v - c$, and the right-hand side of the stated condition on $v - c$ follows from the full market coverage under autarky restriction.

Finally, compute $CS^{AUTK} - CS^{JM} = (4\theta^2 - t^2)/(16\theta)$, so $CS^{AUTK} > CS^{JM}$ for $0 < t < 2\theta$. *Q.E.D.*

Proposition 2 (and Proposition 1) can be visualized in ($, t) space in Figure 2. Consider the outer line marked $2(v' - c) - (t + 3\theta)$ (drawn for $v' > \underline{v} := c - 2\theta$). The three disjoint and adjacent segments to the left of where this outer line crosses the t-axis, marked (i), (ii), and (iii), are such that $CS^{AUTK} > CS^{JM} > CS^{C}$ holds in segment (i), $CS^{AUTK} > CS^{C} > CS^{JM}$ holds in segment (ii), and $CS^{C} > CS^{AUTK} > CS^{JM}$ holds in segment (iii).[22] Segment (i) illustrates the possibility result of Proposition 1, that collusion can raise consumer surplus relative to oligopolistic competition. Recalling that the cartel restricts trade compared with the competing duopoly, notice that in this segment even the cartel's limited trade is viewed by consumers as wasteful relative to autarky. Segment (ii) arises because $(3\theta - t)(3\theta + t)/(18\theta) > 5t^2/(72\theta)$ over $0 < t < 2\theta$: this is a segment over which autarky raises consumer surplus relative to trade regimes, despite the possibility result of Proposition 1 not holding (i.e., $CS^{AUTK} > CS^{C}$ is a necessary condition for $CS^{JM} > CS^{C}$).

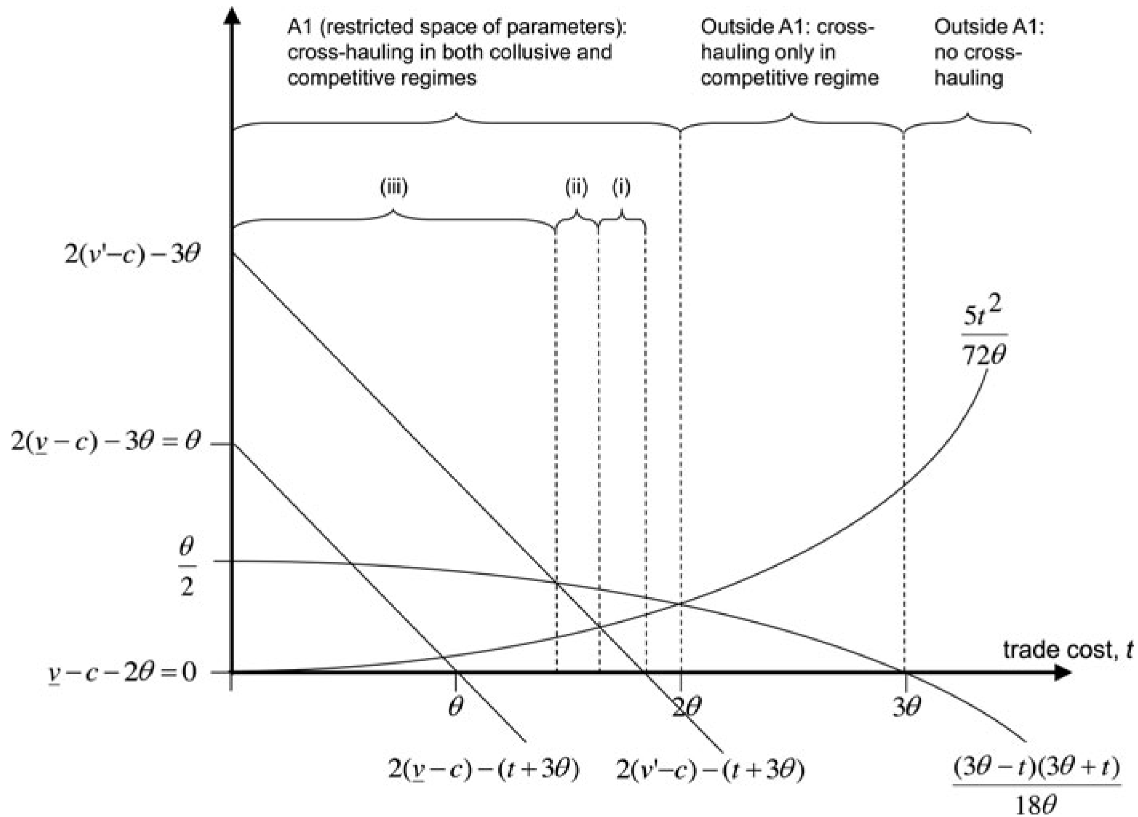
5. Concluding remarks

■ We have employed a model to show that in markets where cost-asymmetric firms compete with offerings that are differentiated to some degree (including service), coordination can enhance efficiency and even raise consumer welfare. Our conversations with executives in a real-world spatial industry that has been accused of collusion across many jurisdictions provided a motivating (albeit untested) context for this article, one where cross-hauling occurs from geographically dispersed buyers to sellers (which subsumes analogous multiple-market settings, such as systems competition). However, the mechanism we highlight—the price aggressiveness of a low-share (high-cost or low-quality) firm in imperfect competition and the *potential* monopoly gains from allocating production more efficiently, including for consumers—is more broadly applicable to individual markets. For example, when a single firm controls cost-asymmetric plants, it is likely that it will move some output from a high-cost to a low-cost facility, and as a result it *may* (under some circumstances) choose lower prices for a large enough number of buyers to achieve sales that correspond to this better allocation. It is our hope that future research empirically validates our possibility argument (in the manner of Fershtman and Pakes, 2000 and Draganska, Mazzeo, and Seim, 2009), an argument we view as potentially more applicable to merger policy and its rule-of-reason approach, as a re-evaluation of the per se prohibition of collusion is deemed neither likely nor desirable (Whinston, 2006).

[22] Along segment (i) (resp., segment (ii)), Assumption 2 is within $5t^2/(72\theta)$ (resp., $(3\theta - t)(3\theta + t)/(18\theta)$) of binding—intuitively, the marginal consumer under competition has low surplus.

FIGURE 2

THE TWO CONSUMER-WELFARE POSSIBILITY RESULTS



In segment (i), full collusion raises consumer surplus relative to price competition. In segments (i) and (ii), autarky raises consumer surplus relative to both full collusion and price competition. Consider the case for which the market is fully covered under autarky ($v' > \underline{v} := c - 2\theta$ as drawn).

Appendix

This appendix contains the autarky with incomplete market coverage. We show that banning trade can raise consumer surplus also in the second autarkic case derived in the text, for low v such that the autarkic monopolist does not cover the entire market (i.e., $v - c < 2\theta$). Consumer surplus in autarky, CS^{AUTK}, is now a triangle of area $(v - c)^2/(8\theta)$ (height $v - p^{AUTK} = \frac{1}{2}(v - c)$ and width $\check{x}^{AUTK} = (v - c)/(2\theta) < 1$, as derived in the text). Now calculate $8\theta(CS^{AUTK} - CS^{C}) = 10\theta^2 + 4\theta t - \frac{2}{9}t^2 + (v - c)^2 - 8\theta(v - c)$.

The first three terms define a concave quadratic in t, with roots at $t = 9\theta \pm 3\sqrt{14}\theta$, so they are positive and increasing in t over the interval $0 < t < \theta$ (under Assumption 2, incomplete coverage in autarky, $v - c < 2\theta$, implies that $t < 2(v - c) - 3\theta < \theta$). Clearly, the terms in t stem from $-CS^{C}$, not CS^{AUTK}, which is invariant in t. The last two terms are constant in t and are negative for $(0 <)v - c < 2\theta$, because $8\theta(v - c) > 2\theta(v - c) > (v - c)^2$. Now evaluate the sum of these five terms, $8\theta(CS^{AUTK} - CS^{C})$, at $t \to 0^+$. (At the limit $t = 0$, this sum, $(v - c)^2 - 8\theta(v - c) + 10\theta^2$, is convex and quadratic in $v - c$ with roots at $v - c = 4\theta \pm \sqrt{6}\theta$.)

For low enough v such that (by Assumption 2) $\frac{3}{2}\theta < v - c < (4 - \sqrt{6})\theta \approx 1.55\theta$, $\lim_{t\to 0^+} 8\theta(CS^{AUTK} - CS^{C})$ is positive, so CS^{AUTK} is higher than CS^{C} for $t \to 0^+$ (and the benefit of banning trade increases with t). For higher v such that $(4 - \sqrt{6})\theta < v - c < 2\theta$, CS^{AUTK} is lower than CS^{C} for $t \to 0^+$, but this difference decreases with t. In fact, $\lim_{t\to(2(v-c)-3\theta)^-} 8\theta(CS^{AUTK} - CS^{C})$ is positive for $v - c > (6\sqrt{5} - 12)\theta \approx 1.42\theta$, that is, CS^{AUTK} rises above CS^{C} as t increases toward $2(v - c) - 3\theta$.

Finally, calculating $8\theta(CS^{AUTK} - CS^{JM}) = -2\theta^2 - \frac{1}{2}t^2 + (v - c)^2$, one can similarly verify that $CS^{AUTK} > CS^{JM}$ in this same space defined by $\frac{3}{2}\theta < v - c < 2\theta$ and $0 < t < 2(v - c) - 3\theta$.

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