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REDACTED – FOR PUBLIC INSPECTION

July 8, 2011

Via Electronic Filing

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Re: *Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer Control of Licenses and Authorizations*
WT Docket No. 11-65; DA 11-799; ULS File No. 0004669383

Dear Ms. Dortch:

On behalf of Charles River Associates, consultants to Sprint Nextel Corporation, I respectfully request that the Commission include the attached Note on the Coordination Pricing Pressure Index for Parallel Accommodating Conduct ("Supplemental Economic Analysis") in the record of the above-cited proceeding.

Pursuant to instructions provided by the Deputy Chief, Mobility Division, of the Wireless Telecommunications Bureau, we are filing this redacted version of the Supplemental Economic Analysis for public inspection in addition to an unredacted version.

Sincerely,

/s/ Regina M. Keeney
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A Note on the Coordination Pricing Pressure Index For Parallel Accommodating Conduct

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I. Introduction

The CRA Reply Declaration formulated a coordination pricing pressure index (CPPI) for parallel accommodating conduct and applied it to the proposed merger of AT&T and T-Mobile.[1] The CPPI is intended to gauge concerns of parallel accommodating conduct by two firms in a market. The increase in the CPPI scores the incremental impact of a merger on these concerns. The Reply Declaration applied this CPPI to potential parallel accommodating conduct by AT&T and Verizon. This Note describes the assumptions and derives the formula for the CPPI.

Parallel accommodating conduct (PAC) is a type of coordinated conduct that does not require an agreement. Instead, it involves a firm engaging in a certain conduct, with the expectation that one or more other firms will follow that same conduct. For example, PAC could involve two leading firms raising their prices in parallel over and above the prices determined by their unilateral pricing incentives. One firm would raise price above this level and the other firm would simply follow.

[1] Joint Reply Declaration of Steven C. Salop, Stanley M. Besen, Stephen D. Kletter, Serge X. Moresi, and John R. Woodbury, attached to Reply Comments of Sprint Nextel Corporation ("CRA Reply Decl."), at Section IV.B.

Parallel accommodating conduct has a long history in oligopoly theory, dating back more than seventy years.[2] However, PAC obviously is not the only type of oligopoly conduct that might occur in a market or the only oligopoly model used by economists. For example, there are numerous oligopoly models that economists use in antitrust, including the Bertrand model with differentiated products; the Cournot model with homogeneous products; the Stigler defection/punishment model; the Stackelberg leader/follower model; and the dominant firm/perfectly competitive fringe model; among others.[3]

The Merger Guidelines refer to some of these oligopoly models.[4] In particular, the analysis of unilateral conduct in differentiated-product markets in the 1992 and 2010 Merger Guidelines is

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[2] *See*, *e.g.*, Robert L. Hall and Charles J. Hitch, *Price Theory and Business Behavior*, 2 Oxford Economic Papers 12 (1939); Paul Sweezy, *Demand Under Conditions of Oligopoly*, 47 Journal of Political Economy 568 (1939); Eric Maskin and Jean Tirole, *A Theory of Dynamic Oligopoly, II: Price Competition, Kinked Demand Curves, and Edgeworth Cycles*, 56 Econometrica 571 (1988); Jonathan Eaton and Maxim Engers, *Intertemporal Price Competition*, 58 Econometrica 637 (1990).

[3] For the Bertrand model, *see*, *e.g.*, Jerry Hausman, Gregory Leonard, and J. Douglas Zona, *Competitive Analysis with Differenciated Products*, 34 Annales D'Economie et de Statistique 159 (1994). For the Cournot model, *see*, *e.g.*, Joseph Farrell and Carl Shapiro, *Horizontal Mergers: An Equilibrium Analysis*, 80 American Economic Review 107 (1990). For the Stigler defection/punishment model, *see*, *e.g.*, James W. Friedman, *A Noncooperative Equilibrium for Supergames*, 38 Review of Economic Studies 1 (1971). For the Stackelberg model, *see*, *e.g.*, Marcel Boyer and Michel Moreaux, *On Stackelberg Equilibria with Differentiated Products: The Critical Role of the Strategy Space*", 36 Journal of Industrial Economics 217 (1987). For the dominant firm model, *see*, *e.g.*, Gautam Gowrisankaran and Thomas J. Holmes, *Mergers and the Evolution of Industry Concentration: Results from the Dominant-Firm Model*, 35 RAND Journal of Economics 561 (2004).

[4] For example, the discussion of the "leading firm proviso" in the 1982 and 1984 Merger Guidelines generally suggested one or the other of the dominant firm models.

consistent with the Bertrand model with differentiated products.[5] The concepts of the "value of diverted sales" in the 2010 Merger Guidelines and the associated "gross upward pricing pressure index" (GUPPI) also are derived from that Bertrand model.[6] Similarly, the treatment of coordinated effects in the 1982 and 1992 Merger Guidelines is consistent with the Stigler defection/punishment model.

The language of the 2010 Merger Guidelines gives greater prominence to the concept of parallel accommodating conduct than did previous Merger Guidelines. The 2010 Merger Guidelines explicitly identify these PAC effects as a form of coordinated interaction. As stated in the 2010 Merger Guidelines:

> Coordinated interaction alternatively can involve parallel accommodating conduct not pursuant to a prior understanding. Parallel accommodating conduct includes situations in which each rival's response to competitive moves made by others is individually rational, and not motivated by retaliation or deterrence nor intended to sustain an agreed-upon market outcome, but nevertheless emboldens price increases and weakens competitive incentives to reduce prices or offer customers better terms.[7]

While the Merger Guidelines suggest an index for gauging upward pricing pressure for unilateral effects, they do not suggest an index for gauging coordinated effects, whether through PAC or

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[5] Robert D. Willig, *Merger Analysis, Industrial Organization Theory, and Merger Guidelines*, 1991 Brookings Papers on Economic Activity: Microeconomics 281 (1991); Janusz Ordover and Robert Willig, *Economics and the 1992 Merger Guidelines: A Brief Survey*, 8 Review of Industrial Organization 139 (1993); Carl Shapiro, *The 2010 Horizontal Merger Guidelines: From Hedgehog to Fox in Forty Years*, 77 Antitrust Law Journal 701 (2010).

[6] Shapiro refers to the "workhorse Bertrand model" and derives the GUPPI formula from the concept of "value of diverted sales." *See id.* at 713 and 725-726.

[7] U.S. Department of Justice and the Federal Trade Commission, *Horizontal Merger Guidelines* (August 19, 2010) at 24-25.

any other flavor of coordinated interaction. To help evaluate this type of conduct in merger analysis, we have formulated such an index.

Our proposed coordination index for PAC is formulated as follows. Suppose that two firms engage in PAC.[8] We first define the "largest sustainable increase in price" (LSIP) that the two firms could achieve through PAC. This is the maximum percentage price increase that one firm is willing to initiate *and* the other firm is willing to match (absent any agreement, holding the prices of all the other firms constant). Thus, for any given pair of firms (say, Firm A and Firm B), there are two such maximum price increases, depending on whether the price increase would be initiated by Firm A or Firm B. We define the CPPI as the smaller of the two maximum price increases. This ensures that the CPPI corresponds to the largest price increase that both firms would be willing to initiate, which in turn implies that both firms would benefit from PAC. A larger CPPI implies an incentive of the two firms for larger PAC price increases, which suggests more serious PAC concerns, *ceteris paribus*.

Suppose that there is a merger in the market in which Firm A acquires a third firm (say, Firm C). In this situation, the CPPI for Firms A (now merged with C) and B may rise.[9] If so, the merger would increase the magnitude of the potential parallel price increases. Thus, the increase in the CPPI (Delta CPPI) can be used as a measure of the parallel accommodating conduct concerns raised by the merger.

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[8] In this note, we focus on potential parallel accommodating conduct by two leading firms (such as AT&T and Verizon).

[9] However, the CPPI need not increase. This differs from the GUPPI, which always implies an increase in prices.

We have formulated this CPPI to gauge upward pricing pressure for PAC under particular assumptions, for example, PAC by only two firms. However, we are not claiming that it is the only possible index that could be formulated for scoring PAC concerns. Instead, the CPPI described here is one useful index for gauging the effects of a merger on concerns about coordinated interaction through PAC in industries with differentiated products.[10] Nor are we saying, as noted above, that this is the only relevant oligopoly model for which a CPPI could be formulated. We expect that other indices can and will be formulated for other coordinated effects models.[11]

Like the GUPPI and other indices, the CPPI is an index, not a prediction of the post-merger price increase. The CPPI is used in conjunction with other evidence. Nor is the CPPI intended to capture every detail of the equilibrium outcome of a dynamic oligopoly model.

For example, the existence of a positive CPPI does not imply that PAC necessarily will occur in a market. In fact, beginning at the pre-merger Bertrand equilibrium point, the CPPI *always* suggests that the two firms have an incentive to engage in PAC. However, it often is the case that PAC does not occur. There may be various impediments to successful PAC, such as lack of information; fear of entry or repositioning; or incentives to secretly or openly cut prices after

[10] There can be multiple possible indices for a given oligopoly model. For example, gross upward pricing pressure for mergers involving unilateral effects in Bertrand markets with differentiated products have been scored with the single-product GUPPI, the simultaneous GUPPI, and the CMCR. *See* CRA Reply Decl. at Section III.B and n. 90. *See* also the Indicative Price Rise used in Office of Fair Trading, *Anticipated Acquisition of the Online DVD Rental Subscription Business of Amazon Inc. by LOVEFiLM International Limited* (2008) at 13-14.

[11] *See, e.g.,* Douglas Bernheim and Michael D. Whinston, *Multimarket Contact and Collusive Behavior*, 21 RAND Journal of Economics 1 (1990).

engaging in PAC. For this reason, we also do not focus solely or even mainly on the level of the CPPI. Instead, we also calculate the "Delta CPPI," which is the increase in the CPPI as a result of a merger. Like the GUPPI, the Delta CPPI scores the impact of the merger on the upward pricing pressure. And, like the GUPPI, the Delta CPPI does not take into account the potential for downward pricing pressure from merger-specific cost efficiencies.

It is important to note that the CPPI and the Delta CPPI also may be lower when coordination already is occurring. When there already is coordination, there is less incentive for further PAC. This raises a caution flag in order to avoid a variant of the Cellophane Fallacy. While a merger may not lead to more PAC, it could help to entrench the coordination already existing. Thus, a low CPPI and Delta CPPI does not eliminate coordinated effects concerns from a merger, when there is evidence of pre-merger coordination.

As discussed in more detail below, this CPPI for PAC formulated here exhibits two other notable properties. First, unlike the GUPPI, the Delta CPPI can be negative. This means that the incentives of Firms A and B to engage in PAC might decrease following a merger of Firms A and C. Second, under certain conditions, the formula for the CPPI has a close similarity to the simultaneous GUPPI that scores unilateral effects when the merging firm raises the prices of the products of both merging firms simultaneously.[12]

The remainder of this Note is organized as follow. Section II describes the assumptions and the formula of the CPPI. Section III analyzes the impact of a merger on the CPPI and presents some

[12] Jerry Hausman, Serge Moresi, and Mark Rainey, *Unilateral Effects of Mergers with General Linear Demand*, 111 Economics Letters 119 (2011).

illustrative examples. Section IV applies the CPPI to the proposed merger of AT&T and T-Mobile. The Appendix shows the technical derivation of the CPPI formula in more detail.

II. Largest Sustainable Increase in Price and the CPPI

In this section, we derive the formula for the CPPI from a simple model of oligopoly interaction between two firms. We first define the "largest sustainable increase in price" (LSIP) as the maximum price increase that one firm is willing to initiate *and* the other firm is willing to match (holding the prices of all the other firms constant). In general, this maximum price increase depends on which firm is initiating the price increase. Thus, there is a $LSIP_A$ for a price increase initiated by Firm A and a $LSIP_B$ for a price increase initiated by Firm B. We then define the CPPI as the smaller of these two LSIPs. The CPPI thus gauges the potential price increase that the two firms could achieve through parallel accommodating conduct. This section explains this methodology in more detail.

A. Assumptions

Consider a differentiated-products industry. We assume that the two leading firms – say, Firm A and Firm B – each contemplate raising prices through PAC.[13] We analyze the incentives of Firms A and B to raise prices in parallel, beginning either at the (static) Bertrand equilibrium or some higher price level.

We specifically model this PAC process as follows. In period 1, one of the two firms (say, Firm A) decides whether or not to initiate a price increase by raising the price of its product by

[13] For simplicity, we assume that each of these two firms sells a single product and faces a constant marginal cost of production.

some percentage amount (say, 10%). If Firm A raises its price, then Firm B decides in period 2 *either* to match the price increase (and also raise its price by 10%) *or* keep its price unchanged at the initial level.[14] If Firm B does not match the price increase, then Firm A rescinds its price increase in period 3 and reduces its price back to its initial level. If instead Firm B matches the price increase initiated by Firm A, then these parallel price increases by Firms A and B become permanent.

To simplify the analysis for the purposes of deriving a CPPI, we make several assumptions. First, we assume that Firm A takes the current price of Firm B as given and does not expect Firm B to initiate a price increase. We thus gauge Firm A's incentive to initiate a price increase relative to the status quo.

Second, we restrict the choice set of Firm B either to match exactly the price increase of Firm A or keep its price unchanged. We do not permit Firm B to raise its price by less than the increase in Firm A's price. We thus gauge Firm B's incentive to accommodate through a strictly parallel (*i.e.*, identical) percentage price increase.

Third, we consider only one round of price increases through PAC. That is, we do not allow Firms A and B to increase price gradually through several rounds of PAC. Instead, we restrict

[14] The PAC model is different from the Stackelberg leader-follower model. First, the timing assumption of the PAC model involves the leader increasing its price a period before the follower matches or not. During that period, the leader loses a relatively high volume of sales because the follower will not match the price increase until the next period. In contrast, the Stackelberg model assumes that the follower responds to the leader's price increase very quickly within the same period. Second, the price increases in the PAC model are assumed to be identical. In contrast, the follower in the Stackelberg model does not typically raise price by the same amount as the leader.

the analysis to the maximum parallel price increase that Firms A and B could achieve through a single round of PAC. This implies that, in situations in which the two firms engaging in PAC are substantially different from one another, the largest sustainable increase in price may be substantially different depending on which of the two firms initiates the price increase. However, we take into account differences in the incentives to raise prices by measuring the CPPI as the smaller of the maximum price increases initiated by either firm.

Fourth, we consider only PAC by two firms, and we do not account for potential responses by other firms in the market. We gauge the incentives of Firms A and B to engage in PAC, holding the prices of other firms constant. For this reason, our analysis may understate the potential for parallel price increases, though it is less clear whether the Delta CPPI from a merger would understate the incremental impact of a merger.

Thus, for these and the other reasons discussed earlier, the CPPI is not intended to be a precise *prediction* of the likely accommodating price increases. It is not a merger simulation or full-blown industry equilibrium model. Instead it is an *index* for gauging potential competitive concerns about parallel accommodating conduct. The CPPI and the Delta CPPI are useful to gauge how a merger affects the firms' incentives to engage in PAC and how significant these coordinated effects can be. Thus, the Delta CPPI is analogous to the GUPPI defined in the Merger Guidelines to score unilateral effects concerns.

B. The CPPI Formula for PAC

We use m_A, e_A, and q_A to denote respectively the initial percentage margin, own price elasticity, and sales volume of the product sold by Firm A. Similarly, m_B, e_B, and q_B denote the initial

percentage margin, own price elasticity, and sales volume of the product of Firm B. The diversion ratio from product A to product B is denoted by DR_{AB} and the diversion ratio from product B to product A is denoted by DR_{BA}.

As shown in the Appendix, assuming linear demand, the maximum price increase that Firm A is willing to initiate (supposing for the moment that Firm B will match) is given by:

$$S_A^I = \frac{\delta F_{BA} - \theta_A}{1 - \delta F_{BA}} m_A \qquad (1)$$

$$\text{where} \quad F_{BA} = \frac{DR_{BA} q_B e_B}{q_A e_A} \quad \text{and} \quad \theta_A = 1 - \frac{1}{m_A e_A}.$$[15]

In Equation (1), the parameter δ denotes the discount factor used by Firm A to calculate the net present value of its profits.[16]

[15] If the industry is initially in Bertrand equilibrium, then the Lerner condition implies $m_A e_A = 1$ and $\theta_A = 0$. If instead Firms A and B are already engaging in any type of pricing coordination, then $m_A e_A > 1$ and $\theta_A > 0$ (similarly, $m_B e_B > 1$ and $\theta_B > 0$). The CPPI will tend to be lower if the firms are already engaged in some type of coordinated conduct. This raises interpretation issues, as discussed in more detail below.

[16] If the (instantaneous) rate of return that the firm could earn by investing profits is equal to r, and the risk premium for engaging in PAC is equal to ρ, then the discount factor is equal to $\delta = \exp\{-(r + \rho)\Delta\}$ where Δ denotes the length of a period. We define the "length of a period" as the amount of time that would need to elapse before a firm would be able to observe a price change by its rival and be confident that the rival is trying to initiate a price increase through PAC (as opposed to having changed its price for some other reason). Thus, the value of δ can be close to 1 when such response period is very short or when the firm's risk-adjusted required rate of return is very low.

The maximum price increase that Firm B is willing to match (when Firm A initiates the price increase) is given by:[17]

$$S_B^M = \frac{\delta F_{AB} - \theta_B}{1 - F_{AB}} m_B \tag{2}$$

$$\text{where} \quad F_{AB} = \frac{DR_{AB} q_A e_A}{q_B e_B} \quad \text{and} \quad \theta_B = 1 - \frac{1}{m_B e_B}.$$

In general, when Firm A initiates the price increase, the maximum price increase that Firm A is willing to initiate (*i.e.*, S_A^I) can be higher or lower than the maximum price increase that Firm B is willing to match (*i.e.*, S_B^M). We define the largest sustainable increase in price when Firm A ($LSIP_A$) initiates the price increase as the smaller of the two maximum price increases:

$$LSIP_A = \min \{S_A^I, S_B^M\} \tag{3}$$

Similarly, we define the largest sustainable increase in price when Firm B initiates the price increase ($LSIP_B$) as:

$$LSIP_B = \min \{S_B^I, S_A^M\} \tag{4}$$

where S_B^I denotes the maximum price increase that Firm B is willing to initiate and S_A^M denotes the maximum price increase that Firm A is willing to match. These maximum price increases

[17] For simplicity, we assume that Firm A uses the same discount factor as Firm B.

are given respectively by rewriting Equations (1) and (2) with the roles of Firms A and B reversed.

Example 1

Suppose that the market initially is at the Bertrand equilibrium.[18] Firms A and B have equal volume shares and each earn a margin of $m_A = m_B = m = 40\%$.[19] Suppose that the diversion ratio between them is $DR_{AB} = DR_{BA} = DR = 25\%$ and assume a discount factor equal to $\delta = 80\%$. The maximum price increase that either firm is willing to initiate is equal to $S_A^I = S_B^I = 10\%$,[20] while the maximum price increase that either firm is willing to match is $S_A^M = S_B^M = 10.67\%$.[21] Therefore, the largest sustainable increase in price is $LSIP_A = LSIP_B = 10\%$, which does not depend on which firm initiates the price increase.

Example 2

Assume instead that the diversion ratio from Firm B to Firm A is higher, $DR_{BA} = 50\%$, but the other assumptions remain the same as in Example 1. The maximum price increase that Firm A is willing to initiate now is $S_A^I = 26.67\%$, while the maximum price increase that Firm A is willing

[18] In Bertrand markets, the Lerner conditions imply $m_A e_A = m_B e_B = 1$. We use these conditions in the footnotes explaining Examples 1 to 4.

[19] Equal volume shares and equal margins imply $F_{AB} = DR_{AB}$ and $F_{BA} = DR_{BA}$. We use these conditions in the footnotes explaining Examples 1 to 4.

[20] Equation (1) yields: $S_A^I = S_B^I = \frac{\delta DR}{1-\delta DR} m = \frac{(80\%)(25\%)}{1-(80\%)(25\%)}(40\%) = 10\%$.

[21] Equation (2) yields: $S_A^M = S_B^M = \frac{\delta DR}{1-DR} m = \frac{(80\%)(25\%)}{1-(25\%)}(40\%) = 10.67\%$.

to match is S_A^M =32%.[22] The corresponding maximum price increases for Firm B are the same as in Example 1.[23] As a result, for a price increase initiated by Firm A, the binding constraint for $LSIP_A$ is given by the incentive of Firm B to match. That is, $LSIP_A = \min\{26.67\%, 10.67\%\} = 10.67\%$. For a price increase initiated by Firm B, $LSIP_B$ is constrained by the incentive of Firm B to initiate. That is, $LSIP_B = \min\{10\%, 32\%\} = 10\%$.

* * *

We define the CPPI as the smaller of the two LSIPs, that is:[24]

$$CPPI = \min\{LSIP_A, LSIP_B\} \tag{5}$$

As shown in the Appendix, it follows from the previous equations that $S_i^I < S_i^M$ for each Firm $i \in \{A, B\}$. That is, the maximum price increase that a firm is willing to initiate is always smaller than the maximum price increase that the *same* firm is willing to match. As a result, in situations where a firm initiating a price increase (say Firm A) is constrained by the incentive of its rival (Firm B) to match (*i.e.*, $LSIP_A = S_B^M$), it is necessarily the case that when Firm B initiates the

[22] Equation (1) yields: $S_A^I = \frac{\delta DR_{BA}}{1-\delta DR_{BA}} m = \frac{(80\%)(50\%)}{1-(80\%)(50\%)}(40\%) = 26.67\%$. Similarly, Equation (2) yields: $S_A^M = \frac{\delta DR_{BA}}{1-DR_{BA}} m = \frac{(80\%)(50\%)}{1-(50\%)}(40\%) = 32\%$.

[23] This follows because Equations (1) and (2) from Firm B's perspective depend on the diversion ratio from Firm A to Firm B, DR_{AB}, which has not changed relative to Example 1.

[24] The CRA Reply Declaration and its Table 7 reported the LSIP when Firm A initiates the price increase and the LSIP when Firm B initiates the price increase. Our further analysis has led us to define the CPPI as the smaller of these two price increases.

price increase the largest sustainable increase in price will be constrained by the incentive of Firm B to initiate, not the incentive of Firm A to match (*i.e.*, $LSIP_B = S_B^I$).

This property is exhibited in Example 2. When Firm A initiates the price increase, the largest sustainable increase in price is determined by the incentive of Firm B to match (10.67%). When instead Firm B initiates the price increase, the largest sustainable increase in price is determined by the incentive of Firm B to initiate (10%).

Given this relationship, the CPPI is the smaller of the two maximum parallel price increases that the two firms would be willing to initiate. As a result, Equation (5) reduces to the following basic CPPI formula:

$$CPPI = \min\{S_A^I, S_B^I\} \tag{6}$$

C. Further Examples and Properties of the CPPI

We next briefly discuss several properties of the CPPI.

1. Symmetric Firms and the Simultaneous (Uniform) GUPPI

If Firms A and B are symmetric, so that $F_{AB} = F_{BA} = DR$, $\theta_A = \theta_B = \theta$, and $m_A = m_B = m$, then $S_A^I = S_B^I$ and the CPPI can be written as:

$$CPPI = \frac{\delta DR - \theta}{1 - \delta DR} m$$

Assume that the initial prices of these symmetric firms are Bertrand equilibrium prices (*i.e.*, $em = 1$, which implies that $\theta = 0$). Assume also that the discount rate is equal to $\delta = 1$,

corresponding either to the response time being infinitely short or the two firms being infinitely patient. Under these assumptions, the CPPI is equal to the simultaneous GUPPI used to score unilateral effects.

$$CPPI = \frac{DR}{1 - DR} m$$

For example, under the assumptions of Example 1 ($DR = 25\%$ and $m = 40\%$) the CPPI and the simultaneous GUPPI would both be equal to 13.33%.[25]

This relationship between the CPPI and the simultaneous GUPPI is not surprising. The simultaneous GUPPI assumes that the merged firm raises the prices of both products simultaneously, while taking into account the feedbacks between the products.[26] If there is no discounting and the two firms are symmetric, then the maximum PAC price increase by two independent firms is equal to the maximum price increase that would remain profitable for the merged firm. This same expression also is sometimes used for the hypothetical monopolist test for market definition, under the assumption that the hypothetical monopolist raises all prices uniformly.[27] This relationship between the CPPI and the hypothetical monopolist test is not surprising for the same reason.

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[25] That is, *CPPI* = 25% * 40% / (1-25%) = 13.33%.

[26] *See* Declaration of Steven C. Salop, Stanley M. Besen, Stephen D. Kletter, Serge X. Moresi, and John R. Woodbury, attached to Petition to Deny, Sprint Nextel Corporation ("CRA Decl.") at Section V.F and n. 167.

[27] This expression might be called the "Uniform Price GUPPI." It also is equal to twice the "Indicative Price Rise" used in the UK by the OFT. *See*, *e.g.*, Office of Fair Trading, *Anticipated*

2. Initial Coordination

If there is initial coordination instead of the Bertrand equilibrium (*i.e.*, $\theta > 0$), then the CPPI is reduced. This property also is not surprising. If there is already coordination occurring, there is less incentive for further PAC.[28] This property raises a caution. If this property were overlooked, the CPPI (and the Delta CPPI) could fall victim to a variant of the Cellophane Fallacy. It would overlook the potential for a merger helping to maintain or entrench pre-merger coordination. Thus, where there is evidence of pre-merger coordination, the CPPI may have less usefulness in ruling out coordination effects concerns.[29] However, a high Delta CPPI would still raise concerns.

3. Just-Profitable versus Profit-Maximizing Price Increases

The CPPI is defined as the maximum price increase that is profitable. This definition raises the standard issue regarding the distinction between the "just-profitable" and the "profit-maximizing" price increase. Under our assumption of linear demand, the profit-maximizing price increase is one-half of the just-profitable (*i.e.*, break-even) price

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Acquisition of the Online DVD Rental Subscription Business of Amazon Inc. by LOVEFiLM International Limited (2008) at 13-14.

[28] For example, if the two firms were symmetric and perfectly coordinating, and if there were no discounting, then the resulting CPPI would equal zero.

[29] This is analogous to the point made in the Merger Guidelines that the hypothetical monopolist test for market definition should not use the current price if there is evidence of pre-merger coordination. *See* the 1992 Merger Guidelines at Section 1.11 and the 2010 Merger Guidelines at Section 4.1.2.

increase. As shown in the Appendix, the profit-maximizing price increase is one-half of the CPPI. This is similar to the well-recognized property of the GUPPI.[30]

III. Incremental Effect of a Merger: The Delta CPPI

Suppose that Firm A acquires a third firm, Firm C. We next analyze how the acquisition changes the incentives of the leading firms (Firms A and B) to engage in PAC. Specifically, we measure the incremental effect of the acquisition on the CPPI, which we denote as the "Delta CPPI." The Delta CPPI is the increase in the maximum parallel price increase (that Firms A and B can achieve by engaging in PAC) before the merger of Firms A and C versus after the merger.

In order to simplify the calculation of the post-merger CPPI and make it more comparable with the pre-merger CPPI, we make several assumptions.

Assumption 1: In order to focus on the effect of the acquisition on potential coordination, we estimate the Delta CPPI as the increase in the CPPI, relative to the initial pre-merger price level. This assumption raises two noteworthy issues.

First, as noted earlier, this assumption can lead to a very low CPPI if the firms were engaged in coordinated conduct (whether PAC, express collusion, or whatever). Where there is evidence of significant pre-merger coordination, this expression for the CPPI may be less useful in ruling out coordination concerns. The CPPI and the Delta CPPI would not capture or measure the impact of a merger on preventing the breakdown of coordination. In addition, the CPPI and the Delta

[30] *See*, *e.g.*, Carl Shapiro, *The 2010 Horizontal Merger Guidelines: From Hedgehog to Fox in Forty Years*, 77 Antitrust Law Journal 701 (2010) at 729, 750.

CPPI could fall victim to a variant of the Cellophane Fallacy. However, a high Delta CPPI still would raise concerns.

Second, in calculating the post-merger CPPI, we abstract from any unilateral effects caused by the merger. Mergers may and often do raise both unilateral and coordinated concerns simultaneously. However, our CPPI measures the "gross" impact of the merger on PAC pricing incentives, not the "net" impact over and above the unilateral price effects. We make this assumption because the purpose of the CPPI is to gauge the effect of the merger on the incentives for PAC, not the overall upward pricing pressure from all causes. This approach is consistent with the Merger Guidelines.[31] This methodology also is somewhat simpler to calculate. Finally, this approach also is necessary because there could be other coordinated effects concerns besides PAC.

Assumption 2: We assume that Firm A would raise the prices of products A and C by the same amount if it attempts to engage in PAC with Firm B after the merger.

Assumption 3: We further assume that Firm C has the same margin and price as Firm A. We similarly also assume that after the acquisition of Firm C, the merged firm will have the same margin, elasticity, and price as initially. These assumptions could be relaxed, although it would make the formulae more complicated.

[31] In addition, if there are adverse unilateral effects of the merger, then the merger could be considered anticompetitive whether or not there are coordinated effects.

Assumption 4: The post-merger total sales volume of Firm A will increase from q_A to $q_A + q_C$ as a result of the acquisition, where q_C is the current sales volume of Firm C. The diversion ratio from Firm B to the merged firm is equal to the sum of the diversion ratio from B to A and that from B to C. The diversion ratio from the merged firm to Firm B is the share of lost sales from the merged firm following a uniform price increase that goes to Firm B.

Given these assumptions, the post-merger CPPI then can be calculated using the same equations (1) and (2) given above, but with a larger sales volume for Firm A and higher diversion ratios between Firms A and B. The higher post-merger diversion ratios tend to increase the CPPI.[32]

However, the higher post-merger market share of Firm A has an ambiguous effect. On the one hand, it tends to increase the CPPI, if the binding constraint facing PAC is the pricing incentive of the non-merging firm (*i.e.*, Firm B). On the other hand, it tends to decrease the CPPI, if instead the binding constraint is the pricing incentive of the merging firm (*i.e.*, Firm A). This "volume effect" can dominate the "diversion effect." Under these circumstances, it is possible that the acquisition of Firm C by Firm A could reduce Firm A's incentive to engage in PAC with Firm B. As a result, the post-merger CPPI could be lower than the pre-merger CPPI and the Delta CPPI could be negative, if PAC is constrained by the pricing incentives of the merging firm (*i.e.*, Firm A).

The impact of these conflicting effects is illustrated in the following two examples.

[32] This can be checked using Equations (1) and (2).

Example 3

In this example, the "volume effect" and the "diversion effect" exactly counterbalance one another, and the CPPI remains constant. Consider again the assumptions of Example 1 ($DR = 25\%$ and $m = 40\%$) at the Bertrand equilibrium. Assume further that Firms A and B each have a market share of 20%. Assume next that Firm A merges with Firm C, which has a market share of 10% and also earns a margin of 40%. Assume that the other diversion ratios are $DR_{A'B} = 2/7$ and $DR_{BA'} = 3/8$ (where the subscript A' now denotes the merged firm).[33] The maximum price that Firm B is willing to initiate is now equal to 20.87%,[34] while the maximum price increase Firm B is willing to match is 24%.[35] Given these assumptions, the maximum price increases that the merged firm is willing to initiate and match remain the same as for Firm A in Example 1 and are equal to 10% and 10.67%, respectively.[36]

These assumptions lead to the result that the CPPI does not change after the merger. When the merged firm initiates the price increase, the largest sustainable increase in price is equal to 10%, coinciding with the pre-merger $LSIP_A$. When Firm B initiates the price increase, the largest sustainable increase in price is equal to 10.67, which is constrained by the merged firm's

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[33] These assumptions are consistent with proportional diversion and a retention ratio of 100%.

[34] Notice that $F_{A'B} = \frac{q_{A'}DR_{A'B}}{q_B} = \frac{(30)(\frac{2}{7})}{(20)} = 3/7$. Equation (1) then yields: $S_B^I = \frac{\delta F_{A'B}}{1-\delta F_{A'B}} m = \frac{(80\%)(\frac{3}{7})}{1-(80\%)(\frac{3}{7})}(40\%) = 20.87\%$.

[35] Equation (2) yields: $S_B^M = \frac{\delta F_{A'B}}{1-F_{A'B}} m = \frac{(80\%)(\frac{3}{7})}{1-(\frac{3}{7})}(40\%) = 24\%$.

[36] Notice that $F_{BA'} = \frac{q_B DR_{BA'}}{q_{A'}} = \frac{(20)(\frac{3}{8})}{(30)} = 25\%$, which coincides with F_{BA} in Example 1.

incentive to match. Thus, the value of the CPPI remains at 10% both pre-merger and post-merger.

Example 4

In this example, the "diversion effect" dominates the "volume effect" and the CPPI rises. Beginning with the assumptions of Example 3, consider instead a slightly higher assumption for the diversion ratio from Firm B to the merged firm, $DR_{BA'} = 50\%$. In this example, the maximum price increases that Firm B would be willing to initiate and match would remain the same as in Example 3. However, the maximum price increases that the merged firm would be willing to initiate and match now increase respectively to 14.55% and 16%.[37] Therefore, when the merged firm initiates the price increase, the largest sustainable increase in price is equal to 14.55%, as constrained by the merged firm's initiating incentive.[38] When Firm B initiates the price increase, the largest sustainable increase in price is equal to 16%, as constrained by the merged firm's matching incentive.[39] Thus, the merger increases the CPPI from 10% pre-merger to 14.55% post-merger.

[37] Now $F_{BA'} = \frac{q_B DR_{BA'}}{q_{A'}} = \frac{(20)(50\%)}{(30)} = 33.3\%$. Equation (1) then yields: $S_{A'}^{I} = \frac{\delta F_{BA'}}{1-\delta F_{BA'}} m = \frac{(80\%)(33.3\%)}{1-(80\%)(33.3\%)}(40\%) = 14.55\%$. Similarly, from equation (2), $S_{A'}^{M} = \frac{\delta F_{BA'}}{1-F_{BA'}} m = \frac{(80\%)(33.3\%)}{1-(33.3\%)}(40\%) = 16\%$.

[38] That is, $LSIP_{A'} = \min\{S_{A'}^{I}, S_{B}^{M}\} = \min\{14.55\%, 24\%\} = 14.55\%$.

[39] That is, $LSIP_{B} = \min\{S_{B}^{I}, S_{A'}^{M}\} = \min\{20.87\%, 16\%\} = 16\%$.

IV. Application to AT&T/T-Mobile Proposed Merger

In this section we elaborate on the CPPI analysis for the proposed merger of AT&T and T-Mobile from our Reply Declaration.[40] We first estimate the CPPIs and Delta CPPI under the assumption the diversion ratios are proportional to market shares. We then estimate the CPPIs and Delta CPPI under the assumption the diversion ratios are proportional to porting percentages in the NRUF/LNP porting data.

A. Proportional Diversion

The 2010 postpaid wireless market shares for AT&T and Verizon are 31.7% and 38.6% respectively. Assuming a retention ratio of 100%, these would lead to a diversion ratio from AT&T to Verizon of 56.5%, and a diversion ratio from Verizon to AT&T of 51.7%. After the proposed merger of AT&T and T-Mobile, the market share of the merged firm would be 43.1%. Hence, under proportional diversion the diversion ratio from the merged firm to Verizon would be 67.9%, and the diversion ratio from Verizon to the merged firm would be 70.2%.

Table 1 presents the CPPIs and Delta CPPI for retention ratios of 60%, 80%, and 100%, and margins of 70% and 40.7%. We assume a discount factor δ equal to 90%.

Given these proportional diversion ratios, the merger would raise concerns about parallel accommodating conduct. The pre-merger CPPIs are high. Moreover, the Delta CPPIs also are high. For example, for a 70% margin and an 80% retention ratio, the CPPI rises from 35.2% to 57.9%, giving a Delta CPPI (after rounding) of 22.8%. For a 40.7% margin and an 80%

[40] *See* CRA Reply Decl. at Section IV.B.

retention ratio, the CPPI rises from 20.4% to 33.7%, giving a Delta CPPI (after rounding) of 13.2%.

B. Diversions Based on Porting Data

The Commission has made NRUF/LNP porting data available to us. Based on these data, and assuming a retention ratio of 100%, these porting data would lead to a pre-merger diversion ratio from AT&T to Verizon of **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**, and a diversion ratio from Verizon to AT&T of **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**. After the proposed merger of AT&T and T-Mobile, the corresponding figure from the merged firm to Verizon would be **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**, and from Verizon to the merged firm would be **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**. Table 2 presents the CPPIs and Delta CPPIs using diversion ratios based on the NRUF/LNP porting data and the same other assumptions as for Table 1.[41]

The CPPIs based on porting data are **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]** than the corresponding CPPIs based on proportional diversion, while the Delta CPPIs are all **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]** of the corresponding numbers based on proportional diversion. For example, for a 70% margin and an

[41] As noted above, Table 7 in the Reply Declaration reported the LSIPs as the CPPIs. In these revised tables, we have defined the CPPIs according to Equation (6). (What was denoted as CPPI in the Reply Declaration is now denoted as LSIP, and we have added rows for the CPPIs and Delta CPPIs.)

80% retention ratio, the CPPI **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**, giving a Delta CPPI of **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**. For a 40.7% margin and an 80% retention ratio, the CPPI **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**, giving a Delta CPPI of **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]**.

* * *

Using **[begin NRUF/LNP confidential information]** [redacted] **[end NRUF/LNP confidential information]** proportional diversion, these CPPI calculations show that the proposed merger of AT&T and T-Mobile would raise concerns about parallel accommodating conduct. The concerns would be even greater if there were evidence of pre-merger parallel accommodating conduct or other forms of coordination.

Table 1: CPPI Results Using Proportional Diversion: Postpaid Market

	Margin = 70%			Margin = 40.7%		
Retention Ratio	60%	80%	100%	60%	80%	100%
AT&T Initiates Price Increase						
Pre-Merger LSIP	24.3%	37.2%	54.6%	14.2%	21.7%	31.8%
Post-Merger LSIP	36.0%	57.9%	91.3%	20.9%	33.7%	53.1%
Verizon Initiates Price Increase						
Pre-Merger LSIP	23.4%	35.2%	50.3%	13.6%	20.4%	29.2%
Post-Merger LSIP	38.2%	63.8%	106.8%	22.2%	37.1%	62.1%
Pre-Merger CPPI	23.4%	35.2%	50.3%	13.6%	20.4%	29.2%
Post-Merger CPPI	36.0%	57.9%	91.3%	20.9%	33.7%	53.1%
Delta CPPI	12.6%	22.8%	41.0%	7.3%	13.2%	23.9%

Notes:
LSIP = Largest Sustainable Increase in Price
CPPI = Coordination Pricing Pressure Index

The following postpaid market inputs were used for the above analysis:

Carrier	Subscriber Share
Verizon	38.6%
AT&T	31.7%
T-Mobile	11.4%

Sources:
Wireless carrier SEC 10-K filings, annual reports, press releases, and investor presentations.

Table 2: CPPI Results Using Porting Rates: Postpaid Market

[begin NRUF/LNP confidential information]

[end NRUF/LNP confidential information]

Technical Appendix

This appendix describes the formal analysis of the model of parallel accommodating conduct (PAC) used in this Note and derives the formula for the coordination pricing pressure index (CPPI).

We consider a differentiated-product market with linear demand and assume that two firms, say, Firm A and Firm B, might engage in PAC. For each Firm $i \in \{A, B\}$, define the initial price (p_i), margin (m_i), sales volume (q_i), and own-price elasticity of demand (e_i). Let DR_{AB} be the diversion ratio from Firm A to Firm B, and DR_{BA} be the diversion ratio from Firm B to Firm A. Note that, if the market initially is at the Bertrand equilibrium, then the Lerner condition implies $e_i m_i = 1$. However, we allow the market to begin at initial prices other than the Bertrand equilibrium prices.

Suppose that, in period 1, Firm A were to initiate a price increase by raising the price of its product from p_A to $(1 + s)p_A$ and this price increase were not followed immediately by any other firms. With linear demand, this price increase would lead to a reduction in Firm A's sales volume by $se_A q_A$ units in period 1.[42]

The price increase likely would have an adverse impact on Firm A's profits in period 1. It would lead to incremental profits on the volume that Firm A would continue to sell, but lost profits on

[42] We are assuming that, in period 1, Firm A would lose only a fraction of its volume of sales following the price increase, i.e., $se_A < 1$.

the customers who would leave Firm A following the price increase. The net lost profits for Firm A in period 1 would amount to:

$$\begin{aligned} L &= se_A q_A p_A m_A - (q_A - se_A q_A) s p_A \\ &= s q_A p_A (e_A m_A - 1 + se_A) \end{aligned} \tag{A.1}$$

Now consider the effect of Firm A's price increase on Firm B's profits in period 1. The price increase would lead to an increase in Firm B's sales volume of $se_A q_A DR_{AB}$ units. Thus, in period 1, Firm B would gain additional profit equal to:

$$G = se_A q_A DR_{AB} m_B p_B \tag{A.2}$$

In period 2, suppose that Firm B could decide either to match Firm A's price increase or keep its price unchanged. For simplicity, assume that in either case all other firms would maintain their prices at their initial levels. If Firm B decided not to match the price increase, then Firm B would obtain the gain G in period 2. However, Firm B would understands that if it did not match the price increase, then Firm A would reduce its price in period 3 from $(1 + s)p_A$ back down to p_A. Thus, evaluated at period 2, the strategy of not matching the price increase would give Firm B a gain of G in period 2 (the same gain as it obtained in period 1) and no gain thereafter.

If instead Firm B decided to match the price increase, then in period 2 the sales volume of Firm B would fall by $se_B q_B - se_A q_A DR_{AB}$ units relative to its initial output.[43] Firm B would lose

[43] We are assuming that Firm B would lose at most a fraction of its volume of sales, i.e., $se_B q_B - se_A q_A DR_{AB} < q_B$.

profits from these customers, but would gain additional profit on the remaining customers following the price increase. The net change in Firm B's profit in period 2 would amount to:

$$\begin{aligned}\Delta_B &= (q_B - se_B q_B + se_A q_A DR_{AB}) sp_B - (se_B q_B - se_A q_A DR_{AB}) m_B p_B \\ &= sq_B p_B (1 - se_B - e_B m_B) + se_A q_A DR_{AB} p_B (s + m_B).\end{aligned} \tag{A.3}$$

We assume that if Firm B decided to match Firm A's price increase, then the two price increases would become permanent. Assuming no response by other firms, it follows that Firm B would have an incentive to match the price increase if and only if:

$$\frac{\Delta_B}{1-\delta} > G \tag{A.4}$$

where δ denotes the discount factor used by Firm B to calculate the net present value of a permanent change in profit of Δ_B per period (starting in period 2 and lasting forever).

Using equations (A.2) and (A.3) , one can rewrite equation (A.4) as follows:

$$\frac{DR_{AB} q_A m_B}{q_B} > \frac{se_B + m_B e_B - 1}{s + \delta m_B} \tag{A.5}$$

Suppose now that equation (A.4) is satisfied so that, in period 1, Firm A expects that Firm B would match the price increase in period 2. Then in period 1, Firm A would have an incentive to initiate the price increase if and only if the loss incurred by Firm A in period 1 is less than the net present value of the gains realized in all subsequent periods:

$$L < \delta \frac{\Delta_A}{1-\delta} \tag{A.6}$$

where Δ_A is the net change in profits that Firm A would receive in each period (starting in period 2) if both Firm A and Firm B raised prices; the derivation is analogous to (A.3):

$$\Delta_A = sq_A p_A(1 - se_A - e_A m_A) + se_B q_B DR_{BA} p_A(s + m_A) \tag{A.7}$$

Note that Firm A is assumed to have the same discount factor as Firm B. Using equations (A.1) and (A.7), condition (A.6) can be rewritten as follows:

$$\frac{DR_{BA} q_B e_B}{q_A} > \frac{se_A + m_A e_A - 1}{\delta(s + m_A)}. \tag{A.8}$$

Equations (A.5) and (A.8) both must be satisfied in order for the price increase to be sustainable through PAC.

We can use these conditions to calculate the largest sustainable increase in price (LSIP); $LSIP_i$ is the maximum price increase that Firm *i* is willing to initiate and that Firm *j* is willing to match through a single round of PAC.

To simplify the resulting equations, we define:

$$F_{ij} = \frac{DR_{ij} q_i e_i}{q_j e_j} \quad \text{and} \quad \theta_i = 1 - \frac{1}{m_i e_i} \quad \text{for } i, j \in \{A, B\} \tag{A.9}$$

Firm A would find it profitable to initiate PAC as long as conditions (A.8) and (A.5) are satisfied, and these conditions are satisfied as long as s is sufficiently small. We define S_A^I to be the maximum percentage price increase that firm A would find it profitable to initiate given the expectation that Firm B would match that percentage price increase in the next period; S_A^I is the value of s that satisfies (A.8) with equality. Rearranging (A.8) gives:

$$S_A^I = \frac{\delta F_{BA} - \theta_A}{1 - \delta F_{BA}} \, m_A \tag{A.10}$$

With linear demand, Firm A's profit from a price increase s that is matched in subsequent periods is quadratic in s, and therefore Firm A would initiate a profit-maximizing PAC price increase of $S_A^I/2$.

The maximum price increase that firm B would be willing to match, S_B^M, is given by rearranging (A.5):

$$S_B^M = \frac{\delta F_{AB} - \theta_B}{1 - F_{AB}} \, m_B \tag{A.11}$$

We define $LSIP_A$ as the smaller of these two maximum price increases:

$$LSIP_A = \min\ \{S_A^I, S_B^M\} \tag{A.12}$$

$LSIP_A$ is the maximum price increase that Firm A would find profitable to initiate and that Firm B would be willing to match.[44]

Turning next to the possibility that Firm B will initiate PAC, we define $LSIP_B$, which is the maximum price increase that Firm B would be willing to initiate and that Firm A would be willing to match. Using an analogous derivation,

$$S_B^I = \frac{\delta F_{AB} - \theta_B}{1 - \delta F_{AB}}\, m_B \tag{A.13}$$

$$S_A^M = \frac{\delta F_{BA} - \theta_A}{1 - F_{BA}}\, m_A \tag{A.14}$$

$$LSIP_B = \min\{S_B^I, S_A^M\} \tag{A.15}$$

where S_B^I denotes the maximum price increase that Firm B would be willing to initiate (assuming that Firm A would match) and S_A^M denotes the maximum price increase that Firm A would be willing to match.[45]

[44] The profit-maximizing price increase that Firm A would initiate is given by $\min\{S_A^I/2, S_B^M\}$.

[45] The profit-maximizing price increase that Firm B would initiate is given by $\min\{S_B^I/2, S_A^M\}$.

Note that, because (A.10) and (A.14) differ only by an additional δ in the denominator, $S_A^I < S_A^M$ for all $\delta < 1$. Similarly, comparing (A.11) and (A.13), $S_B^I < S_B^M$.

We define the CPPI as the smaller of the two LSIPs:[46]

$$CPPI = \min\{LSIP_A,\ LSIP_B\} \tag{A.16}$$

Since the maximum price increase that a firm would be willing to match is always at least as large as the largest increase in price that the same firm would be willing to initiate, the CPPI will always be equal to either S_A^I or S_B^I. The CPPI thus is the smaller of these two price increases:[47]

$$CPPI = \min\{S_A^I, S_B^I\} \tag{A.17}$$

[46] The profit-maximizing price increase corresponding to the CPPI is equal $\min\{\min\{S_A^I/2, S_B^M\}, \min\{S_B^I/2, S_A^M\}\}$, which reduces to one half of the CPPI. This assumes that $CPPI/2 < \min\{1/e_A, 1/e_B\}$. This assumption is satisfied in the application to the proposed AT&T and T-Mobile merger in section IV.

[47] The CPPI is stable in the sense that each firm would prefer to maintain this price increase rather than switching back to its initial price. That is, suppose that after the PAC succeeds, Firm A were to contemplate reducing its price back down to the initial level, knowing that it would be followed a period later by Firm B. Starting from a PAC with a price increase s, the condition for when reverting to the initial price would not be profitable is identical to the condition for matching a PAC price increase s starting from the initial price. Thus, as long as PAC established a price increase $s < S_A^M$, Firm A would have no incentive to deviate from PAC and switch back to its initial price. This implies that Firm A would not deviate from a PAC at the level of the CPPI, since $CPPI \leq S_A^I < S_A^M$. Analogously, Firm B would not deviate from the CPPI price increase since $CPPI \leq S_B^I < S_B^M$.

If Firms A and B are symmetric, so that $F_{AB} = F_{BA} = DR$, $\theta_A = \theta_B = \theta$, and $m_A = m_B = m$, then equations (A.10) and (A.13) are identical, and the CPPI can be written as:

$$CPPI = \frac{\delta DR - \theta}{1 - \delta DR} m \tag{A.18}$$

If in addition Firms A and B begin in a Bertrand equilibrium, so that the Lerner condition $em = 1$ implies $\theta = 0$, then the CPPI simplifies to:

$$CPPI = \frac{\delta DR}{1 - \delta DR} m \tag{A.19}$$

I declare under penalty of perjury that the foregoing is true and correct.

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