On the Anatomy and Application of Coordinated Effects Theories of Harm in Merger Cases*

by

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PRELIMINARY AND INCOMPLETE *

*** SOME IDEAS FOR DISCUSSION ****

Abstract: *This paper considers a variety of mechanisms under which mergers can, according to conventional economic theory, potentially generate coordinated effects. The literature has emphasized a number of disparate possible mechanisms, often within the context of complex underlying economic models. In this paper we attempt to describe and illustrate a variety of potential mechanisms that can result in coordinated effects of mergers using a very simple economic simulation model – one potentially suitable to underpin analysis within casework. Motivated by casework we suggest that an appropriate model for evaluating coordinated effects of mergers, whether qualitatively or quantitatively, incorporates both standard Incentive Compatibility Constraints (ICC's) and also what we call Agreement and Monitoring Constraints (AMC's). Numerical simulation of such models builds intuition for the forces at work the kinds of circumstances under which coordinated effects theories of harm may potentially be worth exploring in casework. Variants of the simulation model we use may also be taken to data in cases following the general approach described in Davis (2006), Sabbatini (2006) and applied by Davis and Huse (2009). Along the way we discus one possible interpretation of the recent US horizontal guidance on coordinated effects.*

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Introduction

Competition authorities around the world can block horizontal mergers on the grounds that tacit collusion will be more likely if a merger is allowed; i.e., the proposed merger would result in a 'coordinated effect.' In fact, such effects of mergers were the primary reason given for blocking mergers until at least the early 1990's when 'unilateral effects' theories, the idea that when firms producing close substitutes merge static equilibrium prices may go up, also emerged as a potent ground for concern. Recent cases where antitrust authorities have invoked the theory of coordinated effects when attempting to block mergers include *Nestle-Perrier*, *Kali and Salz*, *Gencor-Lenrho*, *Airtours, Sony-BMG (and the appeals by Impala to CFI and subsequent appeal by Sony-BMG to ECJ) and ABF/GBI* cases in the EU jurisdiction and *Safeway* in the United Kingdom. (See also Dick (2003) for a discussion of the large number of recent coordinated effects cases in the US.) The EU, US and UK horizontal merger guidelines all refer to the possible coordinated effects of mergers and the ECJ in Airtours and Sony-BMG has made it clear that economic analysis of coordinated effects of mergers must be consistent with the theory of tacit collusion (see Kuhn (2004)).

Currently, the practical analysis of 'coordinated effects' of mergers is largely limited to informal analysis of the features of markets likely to make them subject to concerns about coordination. Stigler(1964) in particular built on Chamberlin (1929) to argue that in order to sustain collusion firms must be able to (i) come to an agreement (which can be difficult when products are complex and differentiated), (ii) monitor each others' behavior (in order to detect cheaters) and (iii) enforce collusive behavior collectively by punishing those firms who cheat. Sometimes the analysis of such features such as pricing transparency can become quantitative, see for example Scheffman and Coleman (2003).

In practice judgments based on the Stigler framework are difficult to make and the UK, for example, has consequently not prohibited a merger on the basis of a coordinated effects theory of harm for at least a decade. Coordinated Effects theories of harm have been considered in a number of cases including Safeway (supermarkets, 2003), Baggeridge/Wienerberger (bricks, 2006), *DS Smith/Linpack* (corrugated cardboard, 2004) and Stena/DFDS (Ferries, 2011) but each time decision makers have judged that there has not been sufficient evidence to reach an SLC finding.[1] DG Comp has recently required divestment remedies in *ABF/GBI* for the first time since its *Airtours* decision and subsequent reversal following the appeals.

[1] The OFT investigated and subsequently closed down an investigation into corrugated cardboard sheets, concluding there was no compelling evidence of an agreement or concerted practice (Competition Act 1998 case closure summaries, 2006.) Deloitte (2009) however noted that 48% of customers surveyed in 2009 considered that a series of post-merger price rises were attributable to the merger (compared with 43% who said the merger had no effect on prices). See the discussion of the merger and subsequent OFT investigation in http://www.competition-commission.org.uk/our_role/analysis/review_merger_decisions.pdf (pages 50-59).

The economic literature has developed a number of disparate mechanisms which can result in mergers having coordinated effects. In this paper we build on the literature following Friedman (1971)[2] to describe a number of possible mechanisms by which mergers can, on the basis of conventional economic theory (dynamic game theory) result in harm. We demonstrate these effects by building a simple simulation model and presenting carefully selected numerical examples of the effects at work. In doing so, our aim is to build intuition for the economic forces at work and the consequences for observed prices and market shares within the context of a relatively simple economic model – one that is potentially suitable for use within cases. It seems highly unlikely to suppose that agencies will typically have the resources required to use dynamic models with imperfect information in casework (at least in the medium term) so we expressly aim to work with a simpler and more tractable model which can (i) incorporate substantive elements of dynamic game theory and (ii) also consider the implications of real-world tacitly collusive strategies for incentives and ability of firms to coordinate.

Specifically we propose to introduce into a simple dynamic oligopoly model constraints that may arise from the need to agree and monitor a tacitly coordinated situation. We call these constraints Agreement and Monitoring Constraints (AMC's) and attempt to motivate their use from (i) past experience in cases, (ii) the ECJ's judgment in *Impala* which emphasizes that tacit coordination "*is likely to emerge if competitors can easily arrive at a common perception as to how the coordination should work*" and "*coordinating undertakings must be able to monitor to a sufficient degree whether the terms of coordination are being adhered to.."*[3] [and (iii) experimental work on the role of information and complexity on the ability to sustain tacitly coordinated outcomes NEED TO CONSIDER.] While such considerations can be evaluated qualitatively, we think simple models are often helpful for 'decision support' so that proper judgments can be made by competition authorities in the context of a specific investigation. This paper represents an attempt to provide one such practical framework for evaluating incentive and ability to coordinate in the presence of limitations on firm's ability to define what is meant by coordination and also ability to monitor each others' behavior which are motivated in a case specific manner. As the EU horizontal merger guidelines describe:

"Coordination by way of market division may be relatively straightforward if it is easy to identify each customer's supplier and the coordination device is the allocation of existing customers to their incumbent supplier." (para 46)

"Coordinating firms may, however, find other ways to overcome problems stemming from complex economic environments short of market division. They may, for instance, establish simple pricing rules

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[2] See Aumann (1986,1989) and Mertens (1987) for surveys.

[3] Each quote from: Case C-413/06 P Bertelsmann and Sony Corporation of America v. Impala paragraph 123. OJ C 223, 30/8/2008 page 7.

that reduce the complexity of coordinating on a large number of prices. One example of such a rule is establishing a small number of pricing points, thus reducing the coordination problem." (para 47)

In each case, the Agency is able to define in simple terms what it believes it means for firms to coordinate and the question is whether by writing down a simple model of such a mechanism help evaluate its credibility as a theory of harm. Specifically, we would like to (i) capture the essence of these constraints in a meaningful way that is tractable for policy analysis and (ii) use the model to inform us of the implied constraints from the proposed method of coordination.

As a concrete example, suppose coordinating firms introduce a simple formula for pricing complex differentiated products, perhaps based on a publically observable product characteristic - such as the distance between cities j and k in the airline industry d_{jk} with a 'per-mile' multiple λ of the distance defining cooperating prices, $p_{jk} = \lambda d_{jk}$. We propose that agencies will sometimes be able to usefully quantitatively evaluate the role of such simplifying 'agreement' or 'monitoring' constraints on the incentive and ability to tacitly coordinate by using a simple coordinated effects merger simulation model. Such AMC's introduce important, costly, limitations on pricing flexibility under coordination and, in order to judge the likelihood of coordination, an agency must in principle balance the costs of reducing complexity in this manner against the benefits of doing so.

Along the way we also discuss the role of coordinated effects under both the Airtours conditions in Europe and provide one possible interpretation of the new element in the US (2010) Horizontal Merger Guidelines.[4] Specifically, [in contrast to the ECJ's approach now embodied in the EU Merger Guidelines] the US guidelines appear to have extended the potential scope of a coordinated effects theory of harm as they de-emphasis the Stiglerian requirement for an agreement by stating that:

> "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." (page 24, US Horizontal Merger Guidelines 2010).

We discuss one potential interpretation of this statement - one which (i) is not in tension with an important role for both ICC's and AMCs and (ii) emphasizes the potential role of learning in games with strategic complementarities (see for example Milgrom and Roberts (1990)) and in particular the limits of learning in games of strategic substitutes.

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[4] See http://www.ftc.gov/os/2010/08/100819hmg.pdf

Literature

There is a massive literature in both theory and empirical IO on coordination, but there is a smaller literature examining the coordinated effects of mergers.

For example, the empirical IO literature has a substantial number of tests for tacit coordination (see for example the discussion following Green and Porter (1984) in Porter (198x), Ellison (19xx), Porter and Zona (19xx) and Knittel and Stango (2005)). These test rely on datasets including periods with and without tacit coordination and comparing the distribution of observed prices. Most directly, in principle, it is possible to apply the Bresnahan (1982) test of whether the observed price and quantities appear more consistent with competition or coordination.[5] Such approaches build on the earlier conjectural variations approach which has recently received a degree of renewed attention (see Weyl and Jaffe (2011) and OFT(2011).) In merger evaluation however such tests based on the observed distribution of prices (and or quantities) may well not be feasible to apply for the simple reason that merger analysis is necessarily prospective so we may not have yet seen tacit coordination in a market.

The literature to date has suggested two basic approaches to modeling the effect of mergers on tacit coordination. First, authors have suggested examining the incentive for coordination measured at the difference between Nash and collusive profits resulting from a merger (Kovacic et al (2006)). Second, but relatedly, (Davis (2006) and Sabatini (2006)) suggest that the incentive to cooperate is properly captured by the incentive compatibility constraints that emerge from dynamic game theory – rather than the raw difference in potential profitability. Those authors thus suggest that a simulation model, closely related to that used in unilateral effects cases, may sometimes prove helpful when considering the potential for coordinated effects in actual cases. Davis and Huse (2009) consider such an empirical coordinated effects simulation model and provide a 'topsy-turvy' (in the language of Shapiro(1989)) result suggesting that in differentiated product setting mergers may on occasion actually hinder coordination. Thus it is particularly interesting to consider the mechanisms that conventional theory does suggest *can* generate coordinated effects of mergers. These should, following the ECJ judgments in *Airtours* and *Sony-BMG* form the basis of coordinated effects Theories of Harm used by competition authorities in future cases.

For a model to be appropriate for casework it will often need to confront at least some degree of product differentiation and/or other asymmetry and the approach we take here builds on some recent progress in papers by Compte, Jenny and Rey (2002) Vasconcelas (2005) and Kuhn (2004) who study asset transfers in differentiated product markets. We use a simpler framework and take primarily a numerical approach but the

[5] De la Mano (2008) reports that the Bresnahan (1982) approach did not work in the ABF/GBI case since: (i) there was no proper benchmark to establish the significance of the estimated conduct parameter (ii) there were no appropriate firm-level instruments available and (iii) there were incomplete data on demand and cost shifters over time and space.

messages that emerge from this theoretical literature will be relevant here as well. Namely that asymmetry produces differential (i) incentives to coordinate and (ii) incentives to punish. Specifically, it will tend to be the smaller firms who will be most difficult to induce to coordinate – since at least in the absence of binding capacity constraints they may do best from deviating from a coordinating agreement. And it will typically be the largest firms who will be hardest to induce to punish since they are the firms who, in punishing a deviator, suffer the largest loss of profit on existing sales. While we will keep such effects in mind – we will follow Friedman (1971) and use grim strategies rather than harsher punishment strategies so that following a punishment strategy in the face of a rival's deviation will always be incentive compatible. We do so primarily because the possibility of harsher punishments than grim strategies will facilitate the inducement of coordination whereas even with grim strategies coordination is often possible in this class of models – suggesting that the return to considering even harsher punishments may be limited.

Since Stigler (1964) the role of agreement and monitoring constraints have been emphasized in the literature. The role of communication and limitations on agreeing what it means to coordinate are playing an increasingly important role in the experimental literature examining tacit coordination (see Kuhn and Cooper (2010)). [Probably MORE needed here…]

Notation

This section introduces the notation we use throughout the paper. Following the unilateral effects merger simulation literature we will consider a differentiated product Bertrand pricing game as the stage-game in a dynamic oligopoly model. (See Werden and Froeb (1991), Berry (1994), Hausman et al (1994), Berry, Levinsohn and Pakes (1995) and Nevo (2001).)

Each firm *f* produces a sub-set of products, $\Im_f \subset \{1,..,J\}$, and in a standard static differentiated product pricing game would choose the prices of those products to maximize its profits:

$$\max_{\{p_j | j\in\Im_f\}} \sum_{j\in\Im_f} (p_j - c_j) D_j(p_1, p_2, ..., p_J)$$
$$s.t. \quad p_j \geq 0 \qquad for \quad j \in \Im_f$$

where c_j is the marginal cost of product j, assumed constant and demand for product *j* may be written as a function of the prices of all the goods in the market, $D_j(p_1, p_2, ..., p_J)$. We will also write $\underline{p}_f$ to denote the vector of prices of goods produced by firm f and $\underline{p}_{-f}$ to denote the vector of prices charged by rivals. As usual, a static Nash equilibrium is a vector of prices p^{NE} such that each firm is solving its profit maximization problem given the prices of its rivals and no firm has any incentive to change. Firm *f* 's set of products are denoted $\Im_f$, while we denote the full set of products, $\Im$, and an ownership structure Δ which is a JxJ matrix with a one in jkth position if products j and k are owned by the same firm and a zero otherwise.

Baseline Models of Coordination

The literature considers two baseline models of coordinated outcomes. The first assumes tacitly coordinating firms will attempt to maximize their joint profits – which we denote as Joint Profit Maximization (JPM). The second assumes cartel members resolve their differing objectives via Nash Bargaining (NB).

In each case we will wish to incorporate incentive compatibility constraints (ICCs) following the super-game literature in the analysis and we consider two different ways to incorporate ICC's. First we define the general set of prices $A(\Delta,\delta,\Im^{coordinating})$ which restricts the feasibility of prices to be supported by coordination and is assumed to depend on the ownership structure of firms Δ and on the firms' discount factors, $\delta = (\delta_1,...,\delta_F)$. Typically it will also depend on demand and cost parameters, though we have left the dependence implicit for conciseness. The leading example of such a constraint set emerges from the super-game analysis presented by Friedman (1971) who builds on Selten (1965) to provide the ICC's which result from firms playing 'grim' strategies[6]. In that case we can define the constraint set to be the set of prices where the payoff to collusion is greater than the payoff to defection for every tacitly cooperating firm f:

$$A(\Delta,\delta,\Im^{coordinating}) \equiv \left\{ \, p \,|\, V_f^{collusion}(p;\delta_f,\Delta) \geq V_f^{defection}(p;\delta_f,\Delta) \quad \text{for} \quad all \quad f \in \Im^{coordinating} \right\}$$

where the payoff to coordination is $V_f^{Collusion}(p^{collusion};\delta_f,\Delta) = \frac{\pi_f\ (p^{collusion};\Delta)}{1-\delta_f}$ while under grim strategies the payoff to defection is $V_f^{defection}(p^{collusion};\delta_f,\Delta) = \pi_f^{defection}(p_{-f}^{collusion}) + \frac{\delta_f \pi_f^{NE}}{1-\delta_f}$

where

$$\pi_f^{defection}(p_{-f}^{collusion}) \equiv \max_{p_f} \pi_f(p_{-f}, p_{-f}^{collusion}).$$

[6]There are numerous alternatives to using grim strategies to sustain collusive arrangements and the techniques outlined here can, at least in principle, be amended to allow their evaluation. For example, the results provided in Abreu (1988) provide an algorithm for checking whether more sophisticated 'simple penal codes' are sub-game perfect Nash equilibrium strategies. We choose to focus primarily on grim strategies because they are simplest, are well understood, do not assume that companies can punish optimally and will generally provide a coherent benchmark against which to judge whether there are likely to be increased incentives for tacit collusion. Softer 'price-matching' punishments are considered in the context of a Cournot game by Lu and Wright (2010).

ICC's induced by alternative collusive strategies will differ in detail but the approach will always provide a constraint set capturing the requirement that each firm must be induced to coordinate.[7]

1. ***Joint Profit Maximization:*** define $p^{JPM}_{\Im^{coordinating}} \equiv \arg\max_{\{p_f | f \in \Im^{coordinating}\}} \sum_{f \in \Im^{coordinating}} \pi_f(p)$ and then ask whether the solution to the unconstrained cartel problem is feasible, $p^{JPM}_{\Im^{coordinating}} \in A(\Delta, \delta, \Im^{coordinating})$ *.* We will denote the joint profit maximizing payoff to firm f as π_f^{JPM}. Often this has been used to define the question for the analyst as considering whether actual discount factors are larger than the critical (set) of discount factors above which firms can support the perfect coordination: $\delta^{critical} \equiv \min_{\{\delta\}} \| \delta \| \quad s.t. \quad p^{JPM}_{\Im^{coordinating}} \in A(\Delta, \delta, \Im^{coordinating})$

2. **Joint profit maximization with Incentive Compatibility (JPM-IC).** A natural alternative description of the problem for the group of would-be tacitly coordinating firms involves them setting prices to maximize their joint profits subject to the constraints on their ability to do so***.***

$$V^{JPM-IC}(\Im^{coordinating}, \Delta, \delta) \equiv \max_{\{p_f | f \in \Im^{coordinating}\}} \sum_{f \in \Im^{coordinating}} \pi_f(p)$$
$$s.t. \quad p \in A(\Delta, \delta, \Im^{coordinating})$$

By removing the requirement that we must only consider perfect collusion, JPM-IC points us to the 'most' collusive arrangements which are sustainable by collusive strategies. We denote the payoff to firm f under such prices, the joint profit maximizing payoff subject to incentive compatibility, π_f^{JPM-IC}.

3. Nash Bargaining: The Nash Bargaining (NB) prediction for the outcome of a tactitly coordinated arrangement involves the solution to:

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[7] Alternative coordination strategies will change the detail of this constraint set, but not the basic idea. For example, some models allow for 'defection' which causes a reversion to Nash equilibrium (or other punishment) for less than the rest of time. Other models allow punishments greater than those associated with grim strategies. See for example Green and Porter(1984). The result will change the detail of this constraint set in two ways: First the detail of the ICC constraints associated with the need for coordination to be more profitable than defection in periods of coordination. Second, we may introduce additional ICC's from the requirement that punishment must also be incentive compatible – if we ever reach a punishment period, then by subgame perfection the punishment action prescribed by the collusive agreement must be incentive compatible. Such constraints can, for example, mean that the larger firms face particular constraints on their ability to credibly punish bad behavior by cutting prices since their own lost profit from deciding to punish others may be far larger than the losses incurred by smaller rivals. By focusing on Grim strategies in the numerical analysis that follows we are effectively abstracting from the constraints on large players constraints on their incentives to punish.

$p^{NB}_{\Im^{coordinating}} = \underset{\{p_f | f \in \Im^{coordinating}\}}{\arg\max} \prod_{f \in \Im^{coordinating}} \left(\pi_f(p) - \pi_f(p^{Nash})\right)$ and then ask whether the solution to the unconstrained NB problem is feasible, $p^{NB}_{\Im^{coordinating}} \in A(\Delta, \delta, \Im^{coordinating})$. We will denote the NB payoff to firm f as π_f^{NB}.

4. ***Nash Bargaining subject to Incentive Compatibility (NB-IC):*** A natural alternative description for the would be tacitly coordinating firms involves them setting prices to maximize the Nash Bargaining profits subject to the relevant constraints on their ability to do so:

$$V^{NB-IC}(\Im^{coordinating}, \Delta, \delta) \equiv \max_{\{p_f | f \in \Im^{coordinating}\}} \prod_{f \in \Im^{coordinating}} \left(\pi_f(p) - \pi_f(p^{Nash})\right)$$

$$s.t. \quad p \in A(\Delta, \delta, \Im^{coordinating})$$

This model allows the coordinating firms to find the 'most' collusive arrangements (in a Nash bargaining sense) which are sustainable. We denote the payoff to firm f under Nash Bargaining subject to the incentive compatibility constraints as π_f^{NB-IC}.

Under JPM and NB a merger will only have a coordinated effect if coordination so defined was (i) unsustainable before the merger and (ii) sustainable afterwards. The aim of merger control would then be to test the feasibility of such schemes before and after merger.[8]

JPM-IC and NB-IC are more flexible cooperative schemes and the consequence is a change in focus since feasibility of some degree of coordination is no longer in doubt since Nash prices are always within the feasible 'coordinating' set. In such contexts the focus of analysis turns primarily towards establishing the degree to which collusive prices would rise a result of the merger.

[8] One can push this idea too far. An industry found to be tacitly coordinating before and after the merger may find that an agency interpreting an SLC (US, UK) or SEIC (EU) test strictly would approve an actual concentration as a simple replacement for a tacitly coordinating pre-merger situation. Of course, many agencies would be unsurprisingly hesitant to go with such a literal interpretation of 'SLC' since the approach would appear directly contrary to the spirit, even if arguably not the letter, of merger control. The reason agencies would typically avoid such an outcome is the belief that tacitly coordinating agreements, even reasonably stable ones, are probably unlikely to be equivalent to actual mergers as a mechanism for coordinating outcomes. On the other hand, if we always compare non-coordination to before a merger to coordination afterwards then we risk testing whether coordination is feasible at all – rather than the effect of a merger on the ability to sustain coordination.

Following the observations in Davis (2006), Sabbattini (2006) and Davis-Huse (2009) if we estimate the demand system and infer or otherwise obtain data on the level of marginal costs for each firm, we can use each of these models as the basis for a coordinated effects simulation model analogous to those available from the unilateral effects literature.

Extensions to the Baseline Models of Coordination

In addition to incorporating ICC's in casework we may want to take account of two other types of constraints.

1. **External stability constraints**. These will arise from either the presence of fringe firms or imports. For simplicity in the text we will treat fringe firms as having second mover status, so that the fringe firms set Nash equilibrium prices taking the potential coordinating prices $p_{\Im^{coordinating}}$ as fixed. With this second mover structure, we can define the resulting constraints on the coordinating firms as requiring that observed prices are within the external stability set:

$$E(p_{\Im^{coordinating}}) \equiv \left\{ (p_{\Im^{fringe}}, p_{\Im^{coordinating}}) \mid p_f = \arg\max_{\{p_f\}} \pi_f(p_f, p_{-f}) \quad for \quad all \quad f \in \Im^{fringe} \right\}$$

   Alternatively, to avoid the second mover structure we can consider collusive prices to be the outcome of a game between the coordinating (but constrained) firms and the fringe. Doing so involves solving effectively a unilateral effects merger simulation model wherein the tacitly coordinating firms are treated as a hypothetical single entity. This latter approach is taken in Harrington and Bo (2010) and Davis and Huse (2009).

2. **Agreement and Monitoring Constraints (AMC's).** In practice, tacitly coordinating firms operating in relatively complex environments may sometimes be constrained to live, for example, with greatly simplified pricing structures or fixed market shares. In the airline industry, for instance, industry observers have alleged cooperative agreements have involved using simplifying assumptions such as 'per-mile' pricing while historically similar allegations were made about the steel industry's use of base-point-pricing (see for example Thisse and Vives (1992).) Similarly, allegedly, attempts at tacit coordination by GE and Westinghouse in the 1970's involved the production of price-books and a "multiplier" so that complex electrical turbines could be priced according to a published formula and then coordination could occur on the 'multiplier' rather than need to involve an agreement which flexed all the prices of all components (Porter (1980)).

We can denote such a constraint as defining a set of prices $B(\lambda, w)$ where λ denotes some parameters and w some product characteristics. To fix ideas we provide two possible examples of this constraint set, each motivated by the structure of actual alleged attempts at tacit coordination in differentiated product markets:

$$B_1(\lambda, x) = \left\{ p \mid p_j = \lambda w_j \quad for \quad \lambda > 0 \quad and \quad for \quad all \quad j \in \Im_f, f \in \Im^{coordinators} \right\}$$ and

$$B_2(\lambda) = \left\{ p \mid \sum_{j \in \Im_f} p_j D_j(p) / \sum_{k=1}^{J} p_k D_k(p) = \lambda_f \quad forall \quad f \in \Im^{coordinators} \right\}$$

The first represents a pricing constraint based on an observable exogenous characteristic(s) of the product, w_j. In the case of airline 'per-mile' pricing this would be the distance between the origin and destination pair. The second example represents a pricing constraint based on the requirement that revenue market shares must be equal to (or weakly greater than) an exogenous constant level λ_f for each firm – such as those revenue shares associated with Nash equilibrium outcomes. If adhered to, such constraints on outcomes would be revealed in datasets. Such constraints could also potentially be motivated as describing focal points (Schelling (1960)) for tacit coordination such as those which may emerge from the presence of price-caps (for an analysis relating to Credit Cards in the US see Knittel and Stango (2003).)

In the interests of simplicity we do not attempt to provide an underlying model to justify such restrictions explicitly - for example due to the presence of imperfect information or the foundations for a focal point. Rather, we consider such constraints to be well motivated by past experience of tacitly coordinated outcomes and potentially helpful for agencies thinking through the 'pro's and con's of coordination for firms even in the absence of a full underlying model explaining their presence or absence. For example, constraints on pricing flexibility necessitated to sustain coordination may on occasion be a material disadvantage relative to the flexibility of pricing structures allowed by firms independently competing. National pricing by retail chains for example could, in principle, be motivated by a reduction in firm specific management costs or reduction in the complexity of coordination. Whatever their source, it is interesting to consider whether such pricing restrictions change the incentive for, or sustainability of, coordination- and in particular whether those incentives change as a result of a merger.

Sometimes such constraints will be difficult to motivate in the context of a merger inquiry. On other occasions they will be easier to motivate. For example, evidence of past explicit coordination may well include an indication of the kind of agreements which have worked to sustain coordination in an industry in the past and these may inform potentially relevant AMC's. Alternatively, AMC's may emerge from the evidence base because prices must be based on a formula involving only publically available information. In each instance a focus on such constraints supplements the analysis that emerges from considering ICC's alone.

Mechanisms that Generate Coordinated Effects of Mergers

In this section we examine the mechanisms by which a merger can affect the feasibility of coordinated outcomes. Some of these mechanisms will increase the feasibility of coordination and therefore generate a potential Theory of Harm suitable for a merger inquiry while others will *reduce* the potential for coordination. We break these mechanisms into two subsets – those which affect internal stability and those which affect external stability. First however we must define what we mean by a coordinated effect of a merger. There are a number of possible definitions:

Definition 1 [Price Effects]: A merger has 'coordinated effects' if (i) the merger changes one or more of the internal or external stability constraints previously hindering coordination and (ii) there is an increase in the prices paid by at least some consumers.

Definition 2 [Incentive Effects]: A merger has 'coordinated effects' if (i) the merger changes one or more of the internal or external stability constraints hindering coordination and (ii) the result is an increase in the incentive to coordinate.

Note that neither definition includes 'unilateral effects' since under definition 1 the requirement is that the merger changes one or more of the internal or external stability constraints. Under definition 2, the incentive effect would ordinarily be measured using $V^{coordination} - V^{defection}$ (or following Kovacic et al (2006) could be measured using $\pi^{coordination} - \pi^{Nash}$.) Analogously, under definition 1 the actual pricing effect could be measured using $P^{coordination} - P^{Nash}$ where P denotes a suitable price index, such as the Stone price index $\ln P = \sum_{j \in \Im} w_j \ln p_j$ where w_j denotes revenue share of good j.

Depending on your interpretation of the statutory question competition authorities must ask (SLC in the US and UK or SEIC in the EU), other definitions are certainly possible. For example we could require total or consumer welfare to decline rather than simply that a single price rises as a result of a merger.

Effects of Mergers on the Coordinating Group: Internal Stability

The first mechanism by which mergers can enhance firms' ability to sustain coordination is if the merger results in a relaxation of the constraints arising from internal stability of the coordinating group of firms. This can happen in a number of ways.

Mechanism 1: Merger *reduces* the number of binding ICC's by combining the ICCs of the merging firms

First we note that under pre- and post-merger symmetry, for example, in symmetric differentiated product pricing models, where all firms have the same incentive compatibility constraint this mechanism will simply never be relevant (by assumption) other than for a 2:1 merger. (See eg Davis (2006)). Furthermore, while mergers will *always* reduce the number of ICC's by one in a fully specified model - since mergers reduce the number of firms in an industry, they may even *increase* the number of effective ICC's. For example, when the merger moves an industry from a pre-merger symmetric situation to post-merger asymmetric situation.

Those caveats aside, under pre-merger asymmetry, a merger can remove an incentive compatibility constraint for a merging party. However for this mechanism to be important the merger must involve a firm whose ICC was binding at pre-merger coordinated prices.

Thus mechanism 1 will not be relevant if coordination is incentive compatible for both parties before and after the merger, although merging parties may in practice be decidedly reticent to deploy the argument that they were tacitly coordinating before the merger so there were no coordinated effects from the merger.

The literature on coordination under asymmetry has demonstrated that it will often be 'small' firms which are hardest to induce to coordinate and hence those will be the ones whose ICC's may bind in a pre-merger equilibrium (an effect we will demonstrate below.) In casework this situation can arise when a merging party appears to be operating pre-merger as a 'Maverick' (See also Baker (2011).)

In summary, mergers will not always reduce the number of ICC's constraining the set of prices that are incentive compatible relative to the pre-merger situation, but can do so under conditions of (i) pre-merger asymmetry and (ii) a binding pre-merger ICC for a merging party.

Mechanism 2: The merger reduces the cost of capital of the merging firms and thereby extends the feasible region for coordination in a manner which leads to an increase in prices.

When a firm with a high cost of capital (low discount factor) is taken over by a rival with a lower cost of capital, the merged firm may sometimes inherit the lower cost of capital. This may for example be the case when a large multinational with favourable access to capital markets acquires a smaller rival with less favourable access. Mechanism 2, while plausible, is an 'efficiency offense' – so agencies may be rightly concerned that inappropriate enforcement on the basis of this mechanism would raise the concern of punishing efficiency enhancing behaviour and thus dampening the incentives for desirable activities.

Mechanism 3: The merger relaxes one or more binding ICC's by *increasing* the payoff to coordination for at least one player (by more than the payoff to deviation increases).

The simplest example of mechanism 3 is provided by a symmetric pure Bertrand stage-game model. In that case, each firm receives an equal fraction of industry cartel profits under coordination and the whole of industry profits under defection - but only for one period after which each firm reverts to Nash which under Bertand involves a zero payoff. The ICC for each of N firms would be written as N identical constraints: $V^{collusion} = \frac{\Pi}{N(1-\delta)} > \Pi + 0 = V^{defection}$. Since these N constraints are identical a merger for any N>1 a merger would not change the effective *number* of constraints (mechanism 1). But under the assumption of pre- and post-merger symmetry, mergers can change the ICC by increasing the return to coordination. In this example, reducing N necessitates a re-equilibration to a new post-merger symmetric equilibrium with each firm receiving a higher share of perfectly collusive profits. Doing so relaxes the constraint set – since it is easier to induce each of these Bertrand firms to coordinate.

A less familiar example of this mechanism would arise when a merger eases coordination difficulties and thereby raises the returns to coordination for all the remaining firms in a market, including those who were previously unwilling to cooperate. Mergers between rivals whose ICC's are not binding pre-merger can, in principle, relax the ICC's of non-merging firms by increasing their returns from coordination.

In addition, we will see below that under imperfect coordination, larger firms will sometimes find it appropriate to 'reward' smaller rival's cooperation by charging higher than perfectly collusive prices – thereby allowing smaller rivals to 'undercut' the large firms collusive prices and earn an increased return from coordination. We can thereby observe 'price leadership' in simultaneous move environment.

Mechanism 4: The merger relaxes one or more binding ICC's by *decreasing* the payoff to defection for at least one firm

First we note the probable limits to this mechanism. If problematic mergers tend to raise collusive prices, we may normally expect the return to under-cutting strategies to be greater rather than smaller in the short term for non-merging firms. Indeed, Davis and Huse (2009) establish the result that if firms produce substitutes then, absent efficiencies, Nash equilibrium profits for non-merging firms may rise as a result of merger for unilateral effects reasons. This will tend to make defection relatively more attractive for non-merging firms, not less.[9]

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[9] This mechanism can be demonstrated using Figure 1. Considering a merger of the entire industry so that post-merger, $A(\Delta^{POST}, \delta, \Im^{coordinating}) = p^{Monoopoly}$ so that the only element of the set is the singleton on the Pareto frontier consisting of monopoly prices. Thus, all mergers to monopoly shrink the feasible set and trivially cannot generate coordinated effects. While the

That said, there are situations where mechanism 4 can arise. For example, if a merger generates substantial efficiencies, so non-merging firms face newly efficient firms post-merger the return to defection (particularly those in Nash reversion periods) would typically fall relative to the pre-merger situation.

Another example of such a mechanism could involve a merger which significantly enhanced the merging parties' ability to monitor deviations may also serve to generate a Theory of Harm using this mechanism. When the period before other firms can react to secret price cutting decreases, the payoff to deviating from a cooperative outcome will decline.

In our discussion thus far we have focused on grim strategies, thereby focusing on the traditional ICC rather than the requirement imposed from sub-game perfection with richer punishment regimes, namely that if we impose a punishment it must be incentive compatible to do so. Under grim strategies, punishment via Nash-reversion is always incentive compatible. However, introducing richer – harsher - punishment schemes would provide additional 'mechanisms' potentially. We do not focus on those mechanisms because the central message of the optimal punishment under asymmetry literature appears to be that the larger the firm the more difficult it may be to support coordination since punishments may not be sub-game perfect. Such logic may potentially provide compelling evidence/logic to help approve a merger but on the face of it seems unlikely to provide the basis of support for a Theory of Harm to block a merger – the focus here.

We now turn to the role of constraints from the competitive fringe.

Mechanism 5: A merger of a fringe firm with a potentially coordinating firm may relax the external stability constraint from the fringe

A possible definition of the term 'maverick' used in the horizontal merger guidance in many jurisdictions arises from the idea that a fringe firm merging with any member of the coordinating group will relax the external stability constraint being imposed on the coordinating group of firms.

And finally to the role of what we have called 'agreement and monitoring constraints.' Following Stigler (1964) it is widely accepted that mergers can in principle both reduce

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result that mergers to monopoly don't generate collusion is obviously uninteresting, the reason is nonetheless instructive. Namely that the unilateral effect of the merger is large. To see this mechanism in the picture, note that we are moving from the pre-merger Nash equilibrium (shown as the point at the bottom left of the picture) upwards all the way to the pareto frontier. Doing so means the set narrows to remove all points below the pareto frontier. Simultaneously, since all prices above the pareto frontier involve profits less that monopoly profits, any points above the pareto frontier also shrink and hence the merger to monopoly results in a singleton feasible set.

the need for monitoring and simplify the task of reaching an agreement. The consequence can be that the constraints on complexity of a tacitly coordinated agreement may reduce. This in turn can remove constraints faced by firms attempting to tacitly cooperate.

Mechanism 6: A merger can reduce the constraints on tacitly coordinated outcomes which arise from a need to agree and/or monitor outcomes.

To illustrate this mechanism in our set-up suppose we had an Agreement or Monitoring Constraint (AMC) which said coordination would occur by keeping a subset of observables at some levels (or alternatively avoid others). Examples of such constraints include the alleged collusive practice in Nasdaq to avoid quoting prices in 'odd-eighths'. For now we will present the constraints that would emerge if a coordinated agreement were to involve keeping revenue market shares at some fixed levels, independent of the merger. Specifically we can describe the implied constraints on coordinated prices as

$$B_2(\lambda) = \left\{ p \mid \sum_{j \in \Im_f} p_j D_j(p) / \sum_{k=1}^{J} p_k D_k(p) = \lambda_f \qquad forall \quad f \in \Im^{coordinators} \right\}$$

where λ_f are (in a strong assumption – but one which may potentially be justified in a given case) supposed known to the competition agency and correspond to the tacitly agreed levels. One example of such a constraint might be involve keeping non-merger firms at their pre-merger levels and the merging firm at their combined market share. Obviously we will not observe such market sharing agreements under a tacitly coordinated outcome- but these are exactly the kind of agreements we see in Cartel cases. For example, in the Citric Acid Cartel (1991-1995) sales quotas were allocated to firms and fixed on a worldwide basis based on the average of the prior three years of sales (1988-1991). The Lysine cartel (1992-1995) also involved a worldwide market allocation. (See Harrington (2010)).[10] Clearly in such cases, a merger would immediately replace two constraints imposed on the group of coordinating firms with one for the merged firm. In practice of course there's a question about whether to treat the merger as irrelevant for the cooperative agreement or whether we need to more carefully consider re-negotiation may occur as a result of the merger. Within the context of the model we're proposing authorities use we can simulate the implications of possible renegotiations but cannot obviously endogenize them.

Alternative examples are also easy to construct and may be motivated by the facts on a given case. Specifically, suppose firms can make inferences about each others' pricing

[10] See Harrington's delightful examples available from his webpage: http://www.econ.jhu.edu/People/Harrington/Harrington_CRESSE_7.10.pdf

behaviour so that prices must be based on verifiable information available to all coordinating players. By examining overlaps in the information available to players, an agency may be able to see that the constraint set:

$$B_2(\lambda, x) = \left\{ p \mid p_j = \lambda_1 x_1 + \lambda_1 x_2 \quad (x_1, x_2) \quad known \quad by \quad all \quad j \in \Im^{coordinators} \right\}$$

Enlarges to include a greater set of information (x_1, x_2) post-merger and hence allows greater coordinating pricing flexibility post-merger. Such information differences might for example arise through cross-shareholdings or through firms having different customers in common. In *ABF/GBI* the EU authorities noted that local/regional distributors (of yeast to bakers) were playing an important role in creating a degree of market transparency, collecting information from bakers downstream and reporting it at their aggregate level to their supplier of yeast - sometimes on the basis of a contractual requirement to report prices upstream.

The merger reducing the number of players to two and the commission argued doing so substantially increased market transparency since each player face only one competitor.

Thinking in these terms can also help raise questions in particular cases about whether the merger does aid coordination. For example, suppose an agency considered the role of national pricing in evaluating a (say) retail merger. If prices for specific products are constrained to be equal across markets for a given firm, so pre-merger coordinating firms can price discriminate across firms shops within market – whereas post-merger they would not be able to. The additional constraints post-merger may help indicate whether tacit coordination using this simplifying mechanism would be profitable. A merger would increase the number of constraints imposed by a national pricing strategy – hindering its profitability as a simplifying device - but may also affect the optimal national price level or the ability to sustain tacit coordination via any one of mechanisms 1 to 5 above.

We now turn to briefly consider (i) understanding what it means to coordinate and (ii) the role of learning in dynamic games of tacit coordination.

Mechanism 7: In games of strategic complements a merger can increase the likelihood of learning to coordinate by removing barriers to firms acting <u>as if</u> maximizing joint profits subject to ICC's.

A baseline model of coordination is that our coordinating firms would like to solve a constrained optimization problem:

$$V^{JPM-IC}(\Im^{coordinating}, \Delta, \delta) \equiv \max_{\{p_f \mid f \in \Im^{coordinating}\}} \sum_{f \in \Im^{coordinating}} \pi_f(p)$$
$$s.t. \quad p \in A(\Delta, \delta, \Im^{coordinating})$$

Given a shared understanding of this problem, whether tacitly coordinating firms are able to do so robustly depends on whether it is possible to reach a mutual understanding of the properties of this problem, under reasonable assumptions. For example, if the objective function were known, concave and the constraint set were known to define a convex set then we would know that a large variety of iterative learning schemes would tend to bring us towards an optimal solution. Thus mergers which increase potentially tacitly coordinating firms' ability to understand the joint profitability of their actions can facilitate coordination. For instance in 3-to-2 mergers, such as the ABF/GBI 'yeast' merger, each post-merger firm needs only to understand the determinants of profitability of one rival.

More generally, the super-modularity literature has emphasized that games of strategic complements such as the pricing games we study are likely to converge towards an equilibrium even in the presence of a competing fringe in both theory (see Milgrom and Roberts(1990)) and also experimentally (see Chen and Gazzale (2004) and Potters and Suetens (2009)). Specifically, in super-modular games, learning schemes of the 'best response' variety typically converge to an equilibrium of the game. In our case the equilibrium to the dynamic game would then be found by supposing that the coordinating firms act as if solving the JPM-IC problem. We relate this class of models to the super-modular game literature further below.

Naturally, one important way in which mergers may enhance firms mutual understanding of their mutual interest is by simplification of eg pricing strategies. Thus in some regards there will be overlaps between Mechanisms 6 and 7 even though the concern in mechanism 7 is perhaps 'deeper' in the sense that it seeks to understand why firms will not understand the determinants of each other's profitability before the merger – and ask whether the merger will change the situation.

Mechanism 8: In games of strategic substitutes, a merger which removes a second 'fringe' competitor to a tacitly coordinating group of firms may lead to an increased likelihood of coordination.

Turning to games of strategic substitutes, Vives (1990) shows that Cournot duopolies can also be considered supermodular games – even though they are games of strategic substitutes. However, the convergence results associated with games of strategic complements (Milgrom and Roberts(1990)) do not apply to three-player of higher player games of strategic substitutes. Thus in games with strategic substitutes the super-modular theory literature appears to suggest that coordination will be harder once there are three-players. In the dynamic game, "three players" means three players treating the group of tacitly coordinating firms as-if they were acting jointly to solve the constrained problem. Thus the Vives (1990) convergence result appears to suggest that mergers which remove a 'second' fringe firm in games of strategic substitutes may be particularly problematic.

By way of caveat to this mechanism, we note that the results in Huck, Normann and Oeschssler (2004) show that 'trial and error learning' (wherein each player checks whether an increase or decrease in her quantity results in an increase or decrease in her own payoff) converges to the joint-profit maximizing outcome in the context of a standard Cournot oligopoly. This result may suggest that there are limits to the predictive power of the Vives result – and hence the appropriate scope of Mechanism 8.

From Mechanisms to Coordinated Effects

In considering the impact of these various mechanisms it is important to note that some mergers will actually shrink the set of prices that can be supported as incentive compatible and not every merger that expands the set will actually lead to coordinated effects from the merger. Feasible regions will sometimes expand in directions that support collusive arrangements that are unattractive to the cooperating firms (this will sometimes happen, for example, when the feasible cooperative set expands beyond the Pareto Frontier – see eg

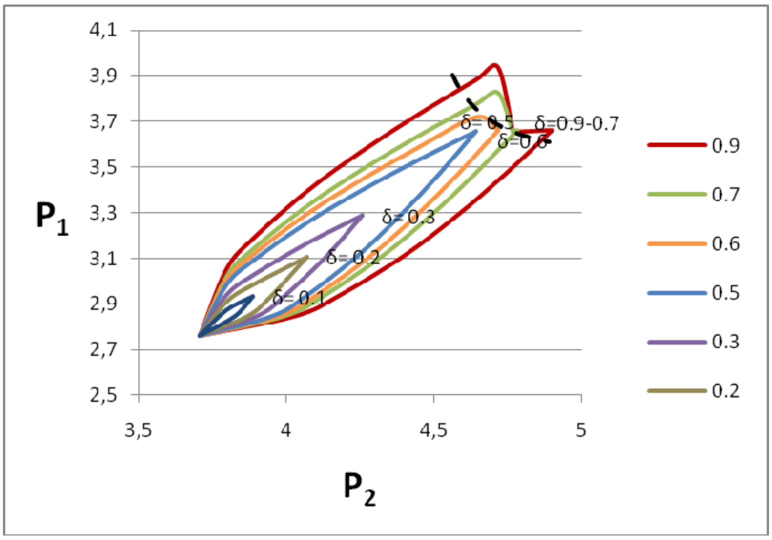

Figure 1 below).

Furthermore, as we will see below, the consequences of a change in the feasible collusive set for whether there actually is a coordinated effect from a merger, depends on the assumed collusive scheme. We have outlined four potential models to determine collusive prices. Namely, JPM, JPM-IC, NB and NB-IC. The two unconstrained problems JPM and NB generate collusive prices which may or may not be incentive compatible. If the resultant prices are not incentive compatible then the proposed collusive agreement is not feasible. In these models, when considering the coordinated effects of mergers we will want to know whether asset concentrations mean that coordinated outcomes that were not sustainable pre-merger are sustainable post-merger. To the extent that the theoretical literature has emphasized JPM it has emphasized that mergers may result in coordination being rendered infeasible (or feasible) following mergers – for example the part of the literature which describes the determinants of "critical" discount factors.

Within the unconstrained models, there are also important differences. Specifically, a difference between JPM and NB is that, under Nash Bargaining, "perfectly collusive" prices depend on ownership structures while under JPM they do not.

In contrast to JPM and NB, the constrained problems JPM-IC and NB-IC always have a feasible 'collusive' solution. That means that for any ownership structure, collusive prices will emerge from JPM-IC and NB-IC and thus we will need to be concerned with the degree with which collusion is sustainable in the sense that the extent to which prices are above Nash equilibrium outcomes, rather than whether coordination is sustainable per se.

To make ideas concrete we illustrate the shape of the feasible set by reporting an example using linear demand and two single product firms with equal discount factors in

Figure 1. It shows first that the lower the discount factor the smaller the set of incentive compatible prices and second that the Pareto optimal frontier (Pareto - in the sense that no profit maximizing firm can be made better off without the other company being made worse off.) The 'point' at the bottom left hand corner of the graph corresponds to the Nash equilibrium prices.

Notice that the feasible set defined by incentive compatibility will - at high discount rates - extend further towards to the top-right-hand corner of the graph than the Pareto frontier, so that it is possible to sustain higher prices than those on the Pareto profit frontier. We will show below that this region of the incentive compatibility set can play an important role in some imperfectly collusive schemes as individual players can on occasion induce rivals to coordinate by charging higher than their optimal collusive prices. Doing so has a cost relative to the first best for the firms, but can nonetheless be worthwhile if it suffices to induce rivals to be willing to coordinate.

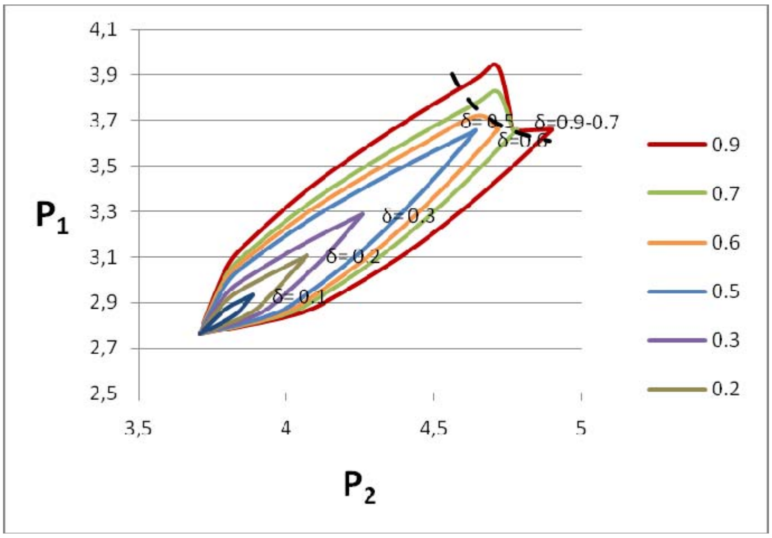

Figure 1 The set A in the case of two single-product firms and different discount rates.

Lemma 1 provides a basic comparative static result that the feasible set for cooperative outcomes which satisfy the ICC's , A_δ, is increasing (in a 'set' sense) in the vector δ very generally under grim strategies. Note that we are using the term 'increasing' in the sense that the set always gets larger as δ increases so that if a price p is a feasible collusive price under discount factors δ it will always be feasible at some higher vector of discount rates $\delta' \geq \delta$. This result will also allow us to describe the tacit coordination game within the framework of a branch of theory called 'super-modular' game theory. Even so – we will avoid the technicalities wherever we can.

Lemma 1: Under grim strategies, A_δ is increasing in δ. That is, if $p \in A_\delta$ and $\delta \leq \delta'$ then $p \in A_{\delta'}$.

Proof: (see Annex)

Figure 1 demonstrates that this lemma holds in the linear demand case – as it can be seen that the feasible set 'grows' as the discount factor gets larger. The implication of Lemma 1 is that this feature of the structure of the problem applies more generally when players are playing grim strategies. (We hypothesize that it also applies to a wider set of strategies.)

It is striking for merger analysis with coordinated effects that, as the coordinated effects mechanisms described above have indicated, and the examples below will illustrate further, comparative static results in the ownership structure are far more subtle in character than the comparative statics in δ. While we can provide a 'set order' which ranks concentration – eg., $\Delta \le \Delta'$ if in Δ' there is a '1' in at least every place a '1' appears in Δ - the analogous comparative static statement that A_Δ is increasing (or decreasing) in Δ will <u>not</u> generally be true. We do know from unilateral effects analysis that the bottom left-hand 'point' of the diagram will plausibly increase (minimal supportable prices – Nash prices - will increase) as a result of the merger when the firms produce substitutes. However, the fact that mergers which generate unilateral effects will also robustly raise the attractiveness of defection for non-merging firms provides an indication that for a fixed δ and higher Δ (i.e., higher concentration) the set will also shrink in places while the merging of the merging parties ICC also creates opportunities for the set to expand. I.e., the net effect of an increase in concentration on the set of feasible cooperative prices is ambiguous.

Coordinated Effects: Some Examples

In this section we provide some illustrations of our various mechanisms working under the different types of collusive agreements (JPM, NB and JPM-IC, NB-IC) in differentiated product markets. In doing so we aim to build intuition for the coordinated effect mechanisms at work in the different models and hence the ways in which mergers can generate coordinated effects.

We do so by providing a series of carefully crafted numerical examples. We will use the same demand and cost assumptions throughout the section to make life manageable. Specifically, we consider a case where there are a total of six products j =1,2,...,6 in the market and where there are no efficiencies that result from the merger, so that $c_j^{PRE} = c_j^{POST} = 1$ *for all j*. We further suppose that demand is linear and of a particularly simple form, namely we employ the Shubik–Levitan function (see eg Shubik and Levitan(1980) or Motta (2004, p. 568-569)

Kommentar [PJD1]: This could all just be described in terms of a standard linear demand curve…. which may be simpler to motivate – this demand specification looks more complicated than it needs to be…..

$$q_j = D_j(p_1, p_2, ..., p_J) = \frac{\beta}{n}\left[\frac{\alpha}{\beta} - \left[1 + \frac{n-1}{n}\gamma\right]p_j + \frac{\gamma}{n}\sum_{k=1}^{n} p_k\right]$$

This function allows us to study the properties of collusive equilibria with different degrees of differentiation (γ parameter). In examples 1-5 below, we set α = 60, β = 3 and take a baseline value of γ = 3.6, before allowing this parameter to vary more generally. In this model the diversion ratio is

$$DR_{kj} = \frac{\partial q_k / \partial p_j}{\partial q_j / \partial p_j} = \frac{\frac{\beta}{n}\left[\frac{\gamma}{n}\right]}{-\frac{\beta}{n}\left[-\left[1 + \frac{n-1}{n}\gamma\right] + \frac{\gamma}{n}\right]} = \frac{\gamma}{-\left[-n-(n-1)\gamma+\gamma\right]} = \frac{\gamma}{\left[n+(n-2)\gamma\right]}$$

which for fixed number of products n is determined by the parameter controlling substitutability, γ.

Example 1: JPM. In this example we consider multiple symmetric mergers so that we can preserve symmetry of market structure both before and after the merger. Table 1 describes the set of discount factors under which coordination is sustainable for any given market structure and those where coordination cannot be sustained. Specifically, it shows the value of collusion and the value of defection under three different market structures using the notation that a market structure is described by a vector $(n_1,..,n_F)$ where n_f f=1,..,F describes the number of products produced by firm f.

The three pair-wise mergers which move us from the market structures (1,1,1,1,1,1) to (2,2,2) would generate coordinated effects if $\delta = 0.6$ since pre-merger coordination is not possible whereas post-merger(s) it is and [under definition 1] prices rise and [under definition 2] incentives to coordinate rise.

Under JPM we consider primarily when perfect collusive outcomes are feasible. Following the literature, we can consider the answer by defining a single critical discount rate for a given market structure Δ:

$$\delta^*(\Delta,\Im) = \frac{\pi^{collusion}(p^{collusion};C) - \pi^{defection}(p_f^{defection}, p^{collusion};\Delta)}{\pi^{NE}(p^{NE};\Delta) - \pi^{defection}(p_f^{defection}, p^{collusion};\Delta)}.$$

Since maximally collusive profits are independent of market structure Δ, there are only two possible links between market structure and the critical discount rate under JPM. First, Nash equilibrium payoffs – which will tend to increase with market concentration and so tend to decrease the critical discount rate – since coordination becomes harder to sustain as the alternative becomes better. Second, the defection payoff – the incentive to cheat on a coordinated outcome declines (on a per product basis) as an individual firm owns a larger product line since it internalizes a greater fraction of the costs of price-cutting. The last two lines of Table 1 shows that the payoff to collusion is constant while the payoff to defection per product even accounting for the unilateral effect (which makes defection more attractive all else equal) declines as the market becomes more concentrated if $\delta = 0.6$ while the effect goes away for $\delta = 0.7$ (and higher) since at higher discount rates the weight of the effect on the Nash payoff increasingly dominates the NPV of defection. If $\delta = 0.6$ the mergers generate coordinated effects via mechanism 1: there are binding ICC's for the merger parties in the pre-merger situation which no longer bind post-merger(s).

	(1,1,1,1,1,1)		(2,2,2)		(3,3)	
δ	Coordinate	Defect	Coordinate	Defect	Coordinate	Defect
0.0	45.1	70.5	90.3	128.5	135.4	174.5
0.1	50.1	73.7	100.3	135.5	150.4	186.2
0.2	56.4	77.7	112.8	144.3	169.2	200.8
0.3	64.5	82.9	128.9	155.6	193.4	219.5
0.4	75.2	89.8	150.4	170.7	225.6	244.5
0.5	90.3	99.4	180.5	191.9	270.8	279.5
0.6	112.8	113.8	225.6	223.6	338.5	332.0
0.7	150.4	137.9	300.8	276.4	451.3	419.5
0.8	225.7	186.0	451.3	382.1	676.9	594.5
0.9	451.3	330.4	902.5	699.1	1353.8	1119.5
Payoffs per product						
0.6	112.8	113.8	112.8	111.8	112.8	110.7
0.7	150.4	137.9	150.4	138.2	150.4	139.8

Table 1 ***JPM: Cheating and collusive profits under different symmetric market structures***

Example 2: JPM-IC Under JPM-IC cooperation is always feasible, but if IC constraints bind they will constrain coordinated outcomes below the level associated with a perfect cartel. In addition, players whose IC constraints would make infeasible the perfect cartel outcome will need to be compensated in order to induce them to tacitly cooperate. The consequence is that in the presence of asymmetries, prices and payoffs will tend to be more favourable for firms whose IC constraints would otherwise bind. In the case of Grim strategies, this will be the smaller firms.

To illustrate the mechanism at play, Figure 2 provides a numerical example. The top line shows that, with the pre-merger industry structure (4,1,1), if the discount rate is below approximately $\delta = 0.55$, all three firms' incentive compatibility constraints bind; each firm must be induced to collude. For $\delta > 0.55$ the large (4 product) firm's ICC does not bind and so the limits of collusive outcomes at higher discount rates are determined by the incentives of the smaller firm under grim strategies. It is the smaller firms which are hardest to induce to coordinate.

Comparing the top line, showing the number of binding ICC's pre-merger, with the other two lines allows us to see the impact of (different) mergers on the number of binding IC constraints. In particular, the range of discount factors at which all active firms ICC's bind, $\delta \in (0,0.55)$, changes little as we merge the two smallest firms (4,1,1) to (4,2) but the range falls to $\delta \in (0,0.5)$ as a result of the asymmetry increasing merger (4,1,1) to (5,1). This situation contrasts with the situation at higher discount rates. In particular, under the post-merger industry structure (4,2) neither firm is constrained by its ICC when $\delta > 0.8$ (approximately) whereas one firm continues to be constrained under the industry structure (5,1) however high the discount factor. This follows because the highly asymmetric market structure (5,1) cannot support perfectly collusive coordination under grim strategies as the small firm's incentive to deviate (undercut a large rival charging relatively high prices) is always so high she cannot be induced to implement the fully collusive payoffs for the industry however high her discount rate.

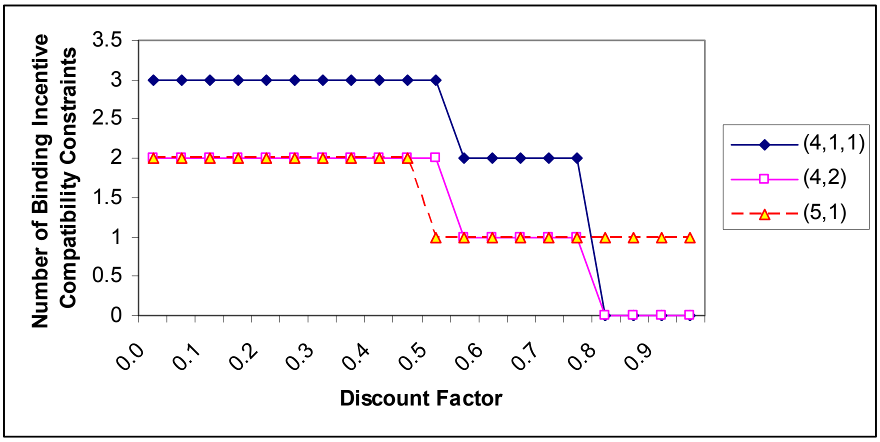

Figure 2 **The number of binding incentive compatibility constraints.**

Under JPM-IC the small firm in the post-merger market structure (5,1) can be induced to collude – but because the ICC would bind at the 'perfect cartel' prices, the smaller firm must be compensated relative to the 'perfect cartel' outcome in order to relax its ICC and thus be induced to coordinate.

This example demonstrates Mechanism 1 under JPM-IC. Along the way we note that the merging party whose ICC is relaxed by the merger may differ according to the relevant discount factors. In particular, for $\delta \in (0.5,0.55)$ coordinated effects from the merger (4,1,1) to (5,1) arise from the relaxation of the large merging firm's ICC post merger.

While at higher discount rates, coordinated effects arise from the relaxation of the smaller firm's ICC.

If $\delta = 0.7$ the pre-merger only firms (1,1) ICC's were binding. After either merger only the smaller firm's ICC would bind so the question of which merger generates a bigger coordinated effect depends on whether coordinated prices (or profits) are greater under (5,1) or (4,2). For (4,1,1) to (5,1) the merger has removed a merging firms ICC that was previously binding For (4,1,1) to (4,2) the merger has removed a merging firms ICC that was previously binding – thus in each case this is mechanism 1 in action.

At higher discount rates, say $\delta = 0.9$, no ICC's bind pre-merger under (4,1,1) or under (4,2) so there is no coordinated effect of the merger via mechanism 1. In contrast, following merger (4,1,1) to (5,1) the non-merging small firm's ICC does bind and so far from sustaining a possible Theory of Harm, this merger actually generates a potential efficiency defense – since the merger increases asymmetry it makes tacit coordination actively harder. In practice it would probably be surprising if merging parties did attempt to make this argument.

Example 3: *JPM-IC and Market share dynamics*

With low values of the discount factor (that is, when the constraints are binding for all firms) the adoption of a JPM-IC scheme implies collusive market shares in line with competitive market shares. This is an important property as we know, from the empirical literature on cartels[11], that colluders try to replicate their competitive market shares. They do it for at least two reasons: a) it is the simplest way to reach an agreement; b) firms know that soon or later cartels expire: so some of them don't want to be in a weaker position at a later stage, which could be the case if they accept a reduction of their market share – for example if there is brand loyalty or indeed some other reason for adjustment of market shares to be costly.

We, first, consider firm market shares (by volume) for different market structures and discount factors (Figure 3). A discount factor equal to zero implies competition.

[11]E.g. Harrington, 2006, "How do cartels operate", paper, downloadable from ssrn.com ; Connor, 'Global price fixing' (2008).

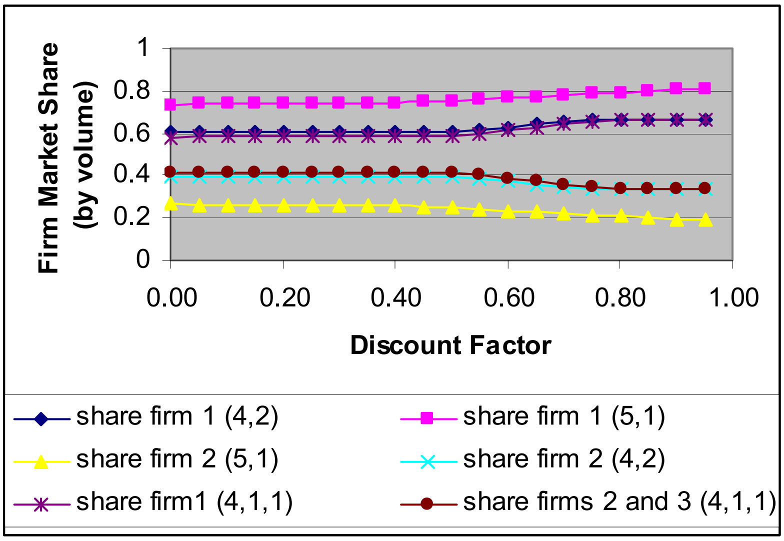

Figure 3 Market shares at the firm level (aggregated across own brands) against the discount factor in the optimally incentive compatible collusive agreement. For the case of (4,1,1) we plotted the sum of the two small firms market shares.

At low discount rates firms' incentive compatibility constraints bind and market shares at the firm level remain remarkably close to the Nash equilibrium market shares (as shown by the intercept). In the imperfectly collusive equilibrium the small firm is being compensated for colluding by being allowed to charge a lower than fully collusive price and therefore selling more than it would in the fully collusive equilibrium. As a result, as we move towards full collusion (for higher values of the discount factor) the market share of the small firm decreases.

Product level market shares are presented in Figure 4. For a wide range of low discount rates the product level market shares are very close to being constant *and furthermore are approximately equal to the competitive market share*. In such a situation constraints such as those derived from AMC which restrict market shares to be at their competitive levels would appear to be sometimes largely superfluous. At higher discount rates (when constraint are not binding), the market share of the brand of the smaller firm declines towards the fully collusive market share. On the other hand, since with F firms there are F binding ICC's at low discount rates while in a general differentiated product setting there may be a far larger number of products the persistence of firm-level market shares appears likely to break down in the presence of enough asymmetry and product differentiation. Thus this example is probably most pertinent to either relatively homogenous product cases where there is firm asymmetry –

perhaps from costs. Or else differentiated product settings where there is a considerable degree of symmetry across brands.

Mergers generally trigger an adjustment in collusive market shares. At relatively low discount factors, this move is coincident with the movement predicted by unilateral effects mergers wherein the small firm takes a larger market share for its brand when facing a newly enlarged rival (eg, 5,1) compared to the per-brand market share under the industry structures (4,1,1) or (4,2). This is shown in the graph by the fact that the share for the second firm in the post-merger structure (5,1) is the top line in the graph – indicating it has the highest sales per brand.

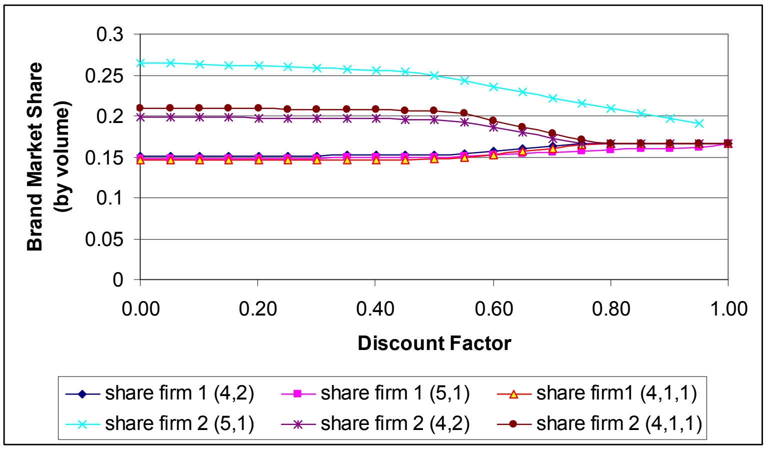

Figure 4 Brand level market shares (market share per brand) by discount rate. The lines converge towards the fully collusive equilibrium brand market share, which in this case since we have six symmetric products with equal marginal costs involves an equal market share of 1/6 = 0.1667.

Example 4: Comparing NB and JPM

Table 2 reports the collusive and defection payoffs under pure Nash Bargaining situation and indicates when the ICC's would be satisfied. We wish to compare the ICC under NB and under JPM.

First notice that in Table 2, the post-merger market structure (5,1) *can* support perfectly coordinated outcomes at high enough discount rates under NB – in contrast to the equivalent JPM model. The reason is that under NB the distribution of collusive gains is "fairer" since every firm is always ensured a payoff above their Nash equilibrium payoff (assuming that is their 'threat-point.') Such a situation is not always the case under JPM where it can, for example, be optimal for the cartel to simply shut down an individual plant. There are of course consequences of such an allocation - namely the NB outcome may not maximize total industry profits, even though it is by definition

Pareto efficient.[12] ***By employing the Nash Bargaining rule, a group of tacitly coordinating firms can sometimes deal with asymmetry even in those contexts which make JPM unsustainable.***

	Pre-Merger: (4,1,1)				**Merger 1: (4,2)**				**Merger 2: (5,1)**			
	Firm with 4 products		Firms with 1 product		Firm with 4 products		Firm with 2 products		Firm with 5 products		Firm with 1 product	
δ	Coll	Cheat	Coll	Cheat	Coll	Cheat	Coll	Cheat	Coll	Cheat	Coll	Cheat
0	157	202	56	73	168	205	102	132	206	229	61	74
0.1	174	217	62	77	186	220	114	141	229	250	68	80
0.2	196	235	70	83	210	240	128	151	258	276	77	87
0.3	223	259	79	89	239	264	146	165	295	309	87	95
0.4	261	291	93	98	279	298	170	184	344	354	102	107
0.5	313	335	111	111	335	344	204	210	413	417	122	123
0.6	391	402	139	130	419	413	256	248	516	511	153	148
0.7	522	513	185	162	559	529	341	313	688	669	204	189
0.8	783	736	278	225	838	761	511	442	1032	983	306	270
0.9	1565	1402	556	414	1676	1456	1022	831	2063	1925	612	515

Table 2 ***Cheating and collusive profits under different asymmetric market structures under NB***

Secondly, and relatedly, ***under NB the small firm is easier to induce to coordinate while the larger firms are more difficult to induce to coordinate than under JPM.*** To see why, notice that under JPM it was the small firm who we found hardest to induce to coordinate (in the sense that her ICC was satisfied only at higher discount rates than her larger potential co-conspirator.) The reason is that under industry profit maximizing prices, the small firm may well not do at all well - in extreme cases her production may even be shut down entirely! In contrast, she may often profit considerably by undercutting either a cartel or a large rival in Nash equilibrium. In stark contrast, under NB, the cartel proposes only cooperative prices which make all firms better off than they would be under competition. The consequence is that the small firm is far easier to induce to cooperate with such schemes, while the large firms – whose gain to coordination is reduced relative to that under JPM – are 'harder' to induce to

[12] For a further discussion of Nash Bargaining see for example Mas-Colell-Whinston "Microeconomic Theory"p.842-843.

coordinate. For example, the NB outcome in the (4,2) post-merger market structure involves firm 2 charging less than the fully collusive price of 10.5, while the larger firm increases her prices beyond the fully collusive price. The small firm generates a payoff of 102.2 which compares to a payoff of 90.25 from owning two brands in a symmetric situation (as can be seen from Table 1 by looking at the payoff to coordination in the row with $\delta = 0$, which reports the one period payoff.) Table 3 reports this implies that the ranking of the critical discount factors across these models are very different under the same set of underlying demand and cost assumptions.

Market Structure (4,1,1)	Joint Profit Maximization (JPM)	Nash Bargaining (NB)
Large Firm	$\delta^{crit} \cong 0.4$	$\delta^{crit} \cong 0.7$
Small Firm	$\delta^{crit} \cong 0.8$	$\delta^{crit} \cong 0.5$

Table 3 Comparison of Critical Discount factors: Nash Bargaining and JPM

An interesting implication of this observation is that – at least in principle – Nash-bargaining and maximal collusion are not observationally equivalent in the presence of asymmetric asset ownership structures and hence threat points. Put simply, the different objective functions for the tacitly coordinating firms under JPM and NB have different implications for observed (tacitly collusive) prices.

From Table 2 we can see that under NB, if both firms have discount rates below 0.4, the mergers from (4,1,1) to (4,2) or (5,1) would not have coordinated effects since both pre- and post- merger none of the firms would be willing to coordinate. For discount rates in the region of 0.6, either merger would have coordinated effects since post-merger both firms would be willing to coordinate where pre-merger they were not.

a. In the merger (4,1,1) to (5,1) this is because the new larger merged entity is willing to cooperate where it was not before (mechanism 1). It's payoff to cooperation under (4,1,1) was 391 whereas post merger it rises to 516.
b. In the merger (4,1,1) to (4,2) the payoff to coordination for the non-merging firm rises (from 391 to 419) by more than the payoff to defection rises (from 402 to 413). This merger thus relaxes a binding ICC by increasing the payoff to coordination for the non-merging firm by more than the increase in their defection payoff. (Mechanism 3).

Example 5: Unilateral and Coordinated Effects under JPM-IC

The aim of this example is to build intuition for the relationship between the presence of unilateral and coordinated effects. To do so, we describe the maximal incentive compatible profits as a function of the (assumed common) discount factor (Figure 5).

More specifically, we do so for the JPM-IC model for three possible symmetric industry structures (1,1,1,1,1,1) and (2,2,2) and (3,3) following our earlier mergers preserving symmetry examples. In the graph, the unilateral effect of a merger on industry Nash equilibrium profits can be read off by examining changes in the intercept terms (so for example, the three mergers associated with the move from (1,1,1,1,1,1) to (2,2,2) increase per period industry profits from 170 to 190) while the fully collusive profit of 270 is achieved only at higher discount rates.

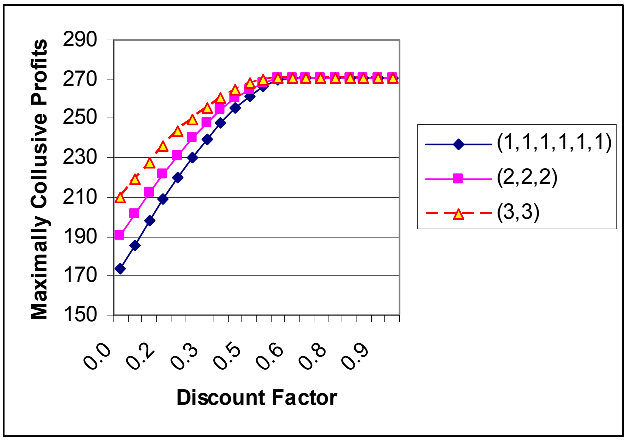

Figure 5 The maximally collusive payoff for each value of discount factor.

First notice that it is clearly the case that mergers which generate larger unilateral effects leave 'less room' for coordinated effects – in the sense that the gap between perfectly collusive payoffs (here 270) and the Nash payoffs (shown on the right hand side of the graph) shrinks the higher the unilateral effect of a merger. In this simple example, the JPM-IC payoff for any given market structure increases in the common discount factor towards perfectly collusive payoffs. In addition, at any given discount factor, the industry profits post-merger are above those pre-merger.

Using a benchmark assuming a degree of coordination pre-merger, the coordinated effect of these mergers can be seen from the movement upwards in the line from the lowest line corresponding to the industry structure (1,1,1,1,1,1) to the middle line which is associated with industry structure (2,2,2) to the most concentrated and highest industry structure (3,3) at any given discount factor. In the JPM-IC model it does not make sense to consider no coordination pre-merger – since some degree of coordination is always possible.

Notice that in this example, if there is a unilateral effect from a merger then there is also a coordinated effect either relative to a benchmark of pre-merger Nash competition or relative to the benchmark of pre-merger coordination. However, the coordinated effect can be seen to be smaller than the unilateral effect. Thus a merger investigation which blocks a merger on the basis of a unilateral effect would capture all such coordinated effects of mergers.

Figure 5 shows that the coordinated effect a merger relative to a benchmark of pre-merger coordination (ie the movement between lines) is correlated (but in these instances smaller for any given discount factor) than its unilateral effect (change in the intercept from the merger). Intriguingly, under the conditions captured by this picture, a policy rule which prohibits mergers that generate a unilateral effect would more than suffice to capture the mergers which should be blocked because of their coordinated effects (relative to a benchmark of pre-merger coordination.)

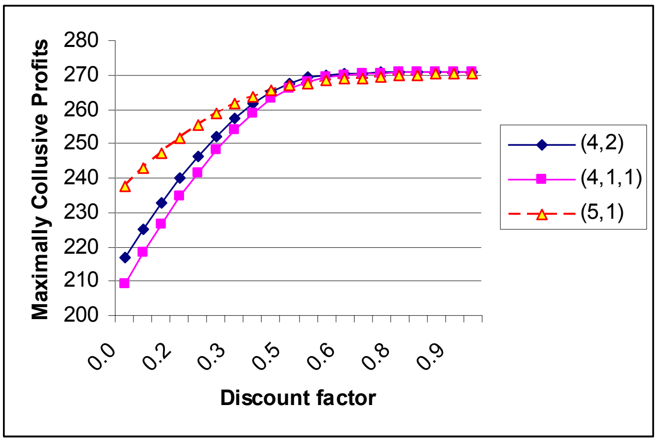

Figure 6 **The maximally collusive payoff for each value of the discount factor.**

Figure 6 illustrates the move from an industry structure (4,1,1) to either (4,2) or (5,1) under JPM-IC.

First, notice that the merger which leads to the most concentrated market is the one which generates the highest Nash static profits and the highest shift upwards in the JPM-IC function at lower discount rates.

Secondly, recall that with these parameter values, perfect coordination is not incentive compatible under market structure (5,1) no matter how high the discount rate. This can be seen in Figure 6 since the line labeled (5,1) is just below the fully collusive industry payoff level (270) at high discount rates. In contrast, this perfectly collusive outcome are is achieved under (4,1,1) and (4,2) at high enough discount rates. The fact that the JPM-IC outcome is very close to perfect coordination suggests that the prediction of the pure JPM model, wherein we consider (perfect) coordination as either present (incentive compatible) or not, will not always provide a robust approach.

The reason JPM-IC behaves this way is simple. When the $\delta = 0$ the most collusive payoff that is incentive compatible is the Nash payoff so that Nash equilibrium and coordinated profits are equal $\pi^{coordinated} = \pi^{NE}$. Mergers therefore raise the sustainable level of 'coordinated' profits at $\delta = 0$ to the extent they result from unilateral effects. The consequence is that the merger with the highest unilateral effect (max price change) is also the merger with the highest upward shift (if the merger which causes the highest average price is also the one which causes the highest sum of profits, a not unreasonable assumption).

This result however is useful precisely because it is not general. In a homogenous product Bertrand model for example, unilateral effects will be small since products are undifferentiated provided the merger is not to monopoly. In contrast, coordinated effects may be large. This suggests that it is useful to study the role of product differentiation in studying coordinated effects.

Example 6. Coordinated effects and AMC's – Price Matching

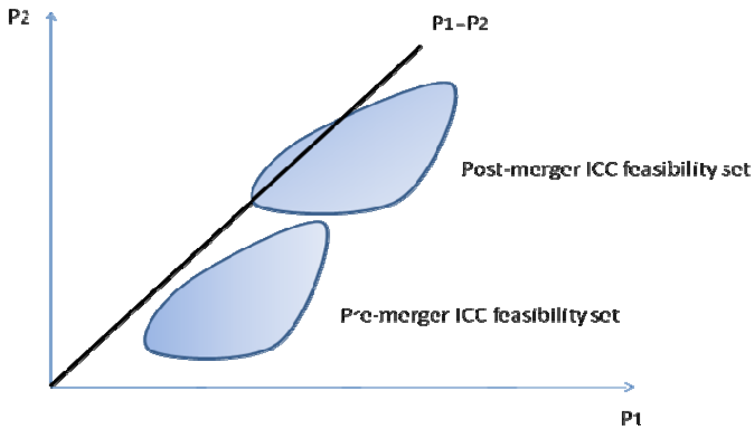

Figure 7 The implication of the simplest AMC for coordinated effects from mergers

This example supposes that that AMC is of the simplest form possible, namely that the tacit coordination agreement involves charging the same prices for the two goods in this example. Put simply, the agreement to coordinate means charging matching prices. In Figure 7 the Agreement and Monitoring Constraint set (AMC) is shown as the diagonal line while the intersection between the ICC constraint set pre-merger and the AMC describes he feasible collusive prices for this model. Pre-merger the intersection is shown empty so that coordination is not feasible. The merger changes the ICC constraint set and in this instance introduces a non-empty intersection between the price-matching AMC and the post-merger ICC so the merger generates coordinated effects via mechanism 6.

Additional Remark: On the relevant discount factor

In any practical implementation of the model described above to a coordinated effects merger case we must set discount rates. Vives (1999, p306) suggests three possible motivations for the discount factor: 1) the rate of time preferences r; 2) Hazard, the risk that the game ends at a certain period, μ; 3) the length of the period, that is the reaction time in case of cheating, τ. Vives argues these three components can be combined so that we write $\delta = \mu e^{-r\tau}$.

Both the cost of capital for the firm and the length of the time period are each factors which can be informed from evidence obtained in the course of a merger inquiry.

First, the length of a period is appropriately defined as the amount of time that it would take for rivals to detect a pricing deviation and change their prices appropriately, which under grim strategies would mean reverting to the Nash equilibrium. We believe it will often be possible to infer an appropriate period length on the basis of the observed historical frequency of price changes and timeliness of rival responses to news in a specific application, though deciding on an appropriate period length will of course require some judgment.

The discount rate could come from company documents or else finance tools such as CAPM. Davis-Huse (2008) for example use CAPM together with the firms actual interest costs and their debt-equity structure to calculate the quarterly working average cost of capital (WACC) discount factors for firms in the network server market which ranged from 0.957 to 0.990.

Personally, we find the hazard rate interpretation considerably harder to motivate empirically. There's no obvious sense in which most firms engaged in merger inquiries – except perhaps in declining industries – anticipate their industry will come to an end with say 85% probability next year given it has survived to date. And in any event to the extent that such events correspond to perhaps the arrival of a new entirely disruptive technology, a standard discount factor calculated via WACC would ordinarily be interpreted to include the risk of such events. In consequence the hazard rate interpretation appears not to obviously solve the apparent result that ***under either JPM or NB coordination is generically always sustainable at realistic discount factors.***

If so, then mechanisms 1 to 4 are theoretical possibilities but, by implication, unlikely ***by themselves*** to generate material coordinated effects of mergers in practice. That fact suggests that the focus of much effort in casework should be on the role and implications of other constraints lost by merger – eg., those associated with Agreement and Monitoring constraints (AMC's). Of course once there are constraints on the set of feasible collusive prices that emerge from agreement and monitoring constraints (AMC's) the intersection of ICC's and AMC's becomes the relevant object for feasible cooperative prices. This fact then re-establishes the relevance of mechanisms 1 to 4 once AMC's are present.

While introducing AMC's we can remain consistent with European Court judgments by retaining the discipline introduced by ICC's while placing a significant amount of focus on the way in which mergers ease constraints on coordination that arise from monitoring and agreement constraints.

Discussion

In this paper we have explored using simple theoretical examples how we can build theory consistent baseline structures which are sufficiently simple that they could potentially help competition authorities analyze the coordinated effects of mergers. Our aims have been to (i) build at least our (but we hope also others') intuition for the forces at work in generating coordinated effects of mergers and (ii) provide a simple framework for coherently evaluating the central questions in a coordinated effects merger investigation.

In doing so we draw a number of tentative conclusions.

First, considering coordinated effects analysis within a narrowly drawn context of JPM and simply testing whether perfectly collusive outcomes are incentive compatible in a model of perfect information is not likely to be a productive approach. In particular, it is shown to result in conclusions about the sustainability of coordination which are sensitive to very small deviations – for example even if perfect collusion is not possible for an industry structure we showed that sometimes imperfect but very close to perfect coordination would be possible. Empirically pure NB and JPM models suggest that at realistic discount factors coordination will generically be sustainable both pre- and post-merger so that there will be no 'coordinated effects' associated with a merger.

Secondly, a framework which allows for imperfect coordination – even in the decidedly "reduced form" way suggested here - seems more likely to be productively put to use within merger cases. Doing so moves agencies away from the theorist's favorite activity of establishing critical discount rates towards explicit consideration of the constraints on the ability to agree and monitor tacit agreements given the facts of the case at hand. In the long term it would be nice to have a fully specified model, but in the practical world the use of constraints motivated by evidence on the nature of coordinated agreements seems useful.

Incorporating constraints arising from the need for an industry to reach agreement and monitor that agreement (perhaps on the basis of public information) may be very helpful in understanding both the advantages and disadvantages of cooperating or not cooperating in a given situation. Restraints on the flexibility of pricing for example will all else equal often be actively a considerable disadvantage for at least some firms relative to competitive outcomes. Such a disadvantage may of course be worth suffering if the consequence is the facilitation of coordination.

The leading examples of Agreement and Monitoring Constraints (AMCs) may well emerge in case work from evidence on past attempts at coordination. For example, airlines have in the past considered 'per-mile' pricing for flights between cities while other examples such as base-point pricing have emerged in other industries. A focus on constraints that arise from such schemes provides a small step in making clear the differences of practical coordination realities relative to perfectly coordinated outcomes and also, in particular, allows a focus on the likely costs and benefits of, for instance, pricing simplification or revenue sharing arrangements.

Finally we note that while we have presented the model as a numerical one which is useful because it helps build intuition, we have noted elsewhere Davis(2005), Sabbatini(2006), Davis and Huse (2009) that such models rely on little more information than that used by the unilateral effects merger simulation literature, namely demand and cost functions. In addition to whatever information is required for the AMC, the additional information required involves only the discount rates to be applied to future profit streams. Thus such a framework can either be used as a qualitative framework for coordinated effects analysis – with AMC's playing the role of placing considerable focus on the pro's and con's of particular approaches to tacit coordination, or as a basis for a more quantitative analysis using the model as a simple simulation model.

Thirdly, we make a number of observations regarding this class of simplified coordination models.

First, that ICC's alone are likely to suggest coordination is inevitable at realistic discount rates. AMC's may nonetheless properly make coordination harder within the context of this class of models.

Second, we note that in the absence of side payments, the models associated with JPM-IC and NB-IC are <u>not</u> observationally equivalent to either each other or to Nash equilibrium. Thus in principle we can tell which of these models 'fits' a given dataset – at least if we have appropriate variation in our data.

Third, theory and experimental evidence suggests that learning processes in industries characterized by strategic complementarities – eg where pricing is a central strategic dimension – may generally converge to an equilibrium of the relevant game. In games of strategic complementarities, such results do not depend on the number of players. In contrast, in games of strategic substitutes, convergence relies heavily on the presence of two or fewer effective actors. If merging parties act 'as if' they were a single firm, albeit one constrained by the need to reward each member of the tacitly coordinating group, then this literature seems to suggest a particular focus on mergers which result in the removal of a second ‘fringe’ firm.

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