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Umbrella Effects

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UMBRELLA EFFECTS[◦]

by

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Abstract

We analyse the key determinants of umbrella effects, which arise when the price increase or quantity reduction of a cartel diverts demand to substitute products. Umbrella effects arise irrespective of whether non cartelists act as price takers (“competitive fringe”) or respond strategically to the increased demand. Sizable umbrella effects can also arise when non-cartelists are outside the relevant market (in the sense of a SSNIP test), provided that the cartel’s price increase is substantial. Further, a shift of demand to non-cartelists, triggering a price increase, can be induced also when their purchasers themselves benefit from higher demand as rivals purchase from the cartel and pass-on the respective price increase. To identify the actual damage it is thus key to take into account the overall adjustments among cartel members and outsiders as well as their respective, potentially competing purchasers. We also discuss how future analysis of the endogenous formation of cartels with partial market coverage should inform theories of the determinants of umbrella effects.

JEL Classification: K21, L13, L41.

Keywords: umbrella effect, partial cartel, pass-on, cartel effect, quantification of damages, merger effects, private enforcement, standing, market definition, cellophane fallacy, antitrust.

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1 Introduction

The role of private enforcement as a complement to public enforcement of competition law has rapidly increased in the EU in the last few years not least due to the efforts of the European Commission that culminated in the recent publication of a draft guidance paper on the quantification of harm and a proposal for a “Directive of the European Parliament and the Council on certain rules governing actions for damages under national law”.¹ The quantification of damages is an essential element in damage claims resulting from breaches of Article 101 and 102 Treaty on the Functioning of the European Union (TFEU) and at least since *Courage and Crehan*² and *Manfredi*³ it is generally accepted that *any* individual can claim compensation for harm suffered from an infringement of EU competition rules.⁴ This would at least seemingly imply that victims that have suffered harm based on so-called “umbrella effects” of cartels should be entitled to claim compensatory damages.

Umbrella effects arise when price increases of certain products lead to a diversion of demand to substitute products. As cartels usually cover less than 100% of the firms in a market, i.e. there are non-cartelized firms whose products are substitutes for the cartel products for at least some buyers, umbrella effects arise. As cartels generally reduce quantities and increase prices, this leads to a substitution away from the cartels’ products to substitute products produced by cartel outsiders. As we discuss in this article, the increased demand for substitutes typically leads to higher prices of the substitute products.⁵ Such price increases are called umbrella effects. We also discuss to what extent this holds both when the producers of these substitutes act merely as price takers and when they strategically react to the increase in demand.

Understanding (and quantifying) umbrella effects is of particular importance in the context of private enforcement in the EU as they are – economically speaking - directly attributable to the cartel (in the sense of causality) and should therefore be the legitimate subject of a claim for damages. As the proposed Commission directive does not address causality (foreseeability and remoteness)⁶ and thereby defers to the legal systems of EU member states concerning this question, a harmonised and economically coherent treatment of such claims is crucial. As member states remain bound by the principles of *equivalence* and *effectiveness*⁷ this also seems feasible.

The pressing need for a coherent legal interpretation of umbrella effects is a matter that was further emphasized by a recent request to the Court of Justice of the European Union for a preliminary ruling from the Oberster Gerichtshof, the highest court in Austria, concerning the question whether EU competition law has to be “*interpreted as meaning that any person may claim from members of a cartel damages also for the loss which he has been caused by a person not party to the cartel who, benefiting from the protection of the increased market prices, raises his own prices for his products*”

¹ See European Commission (2011a) and (2013). Other key documents include European Commission (2005) and European Commission (2008). On the complementary nature of public and private competition law enforcement see Davis and Lande (2013).

² See case C-453/99, *Courage ad Crehan*, [2001] ECR I-6297.

³ See joined cases C-295/04 to C-298/04, *Manfredi*, [2006] ECR I-6619.

⁴ See Ashton and Henry (2013) for a legal introduction and overview of the topic. Overviews emphasizing the economic aspects of damages actions and quantification are found in Maier-Rigaud and Schwalbe (2013) and Inderst *et al.* (2013).

⁵ While less relevant in a damages context, it is clear that umbrella effects also arise in the context of mergers for example. If two firms merge, any direct unilateral price effect due to the merger entails umbrella effects which in turn also increase the magnitude of the optimal price increase of the merged entity. This will be briefly discussed below in the context of the SSNIP test.

⁶ See Maier-Rigaud (2013) for a critical discussion of the proposed directive.

⁷ See joined cases C-295/04 to C-298/04, *Manfredi*, [2006] ECR I-6619, [at 98].

*more than he would have done without the cartel (umbrella pricing)."*⁸ In order to gauge the legal repercussion of the question put to the Court it is important to understand the underlying economics of such effects.

This is also of central importance for the overall coherence of competition law, in particular in light of a more economic approach, as the consideration of such effects is also important for the proper assessment of effects in the context of merger control and it would seem inconsistent to consider such effects too remote in private enforcement when the concept is part of the accepted effects analysis in public enforcement.⁹

From a legal point of view it may be noteworthy to point out that reactions of cartel outsiders, whether in the same relevant market or not, cannot be considered free-riding in the sense of a wilful exploitative act (possibly to be sanctioned by competition law in itself) but should rather be seen as an economically optimal reaction by these outsiders to changes in demand. In fact, when cartel outsiders are price-takers ("competitive fringe"), higher prices may simply reflect higher marginal costs of production at higher output (given the demand diverted away from cartel members). As we explore below, when cartel outsiders strategically react to an increase in demand caused by higher prices or lower output of cartel members, then this may, depending on the nature of strategic interaction in the market, sometimes even mitigate the negative effects of the cartel, even though the price for the cartel outsider's own output increases relative to the counterfactual case without a cartel.

A deeper economic analysis also shows that umbrella effects may arise even when those who buy from cartel members could not be expected to switch to the other suppliers, for example when markets for the considered product or input are local. Still, when firms that are affected by a price increase of cartel members pass-on some of this increase, this will lead to higher demand for firms operating on the indirect purchaser level that are unaffected by the cartel. An umbrella effect will then still be very likely as an increase of these firms' derived demand will cause their respective suppliers to increase prices. In this case, however, firms purchasing from these suppliers may not suffer overall damages from the cartel as they benefit from the increase in their rivals' costs. Overall, our analysis also explores the relationship between pass-on and the umbrella effect.

To lay out the economics of umbrella effects we proceed as follows. As already noted above, one of our objectives in this paper is to show that when the market is not fully covered, a price increase also by cartel outsiders can typically be expected, at least when the cartel operates for a sufficiently long

⁸ See Case C-557/12, Request for a preliminary ruling from the Oberster Gerichtshof (Austria) lodged on 3 December 2012 - KONE AG, Otis GmbH, Schindler Aufzüge und Fahrtreppen GmbH, Schindler Liegenschaftsverwaltung GmbH, ThyssenKrupp Aufzüge GmbH v ÖBB-Infrastruktur AG.

⁹ In the merger between Hutchison 3G Austria and Orange Austria the Commission argued: "generally accepted and robust economic theory demonstrates that the profit-maximising response of competitors to a price increase would be to increase prices themselves [...] The rationale behind this expectation is the following: if the merged entity were to raise prices, some customers would consider switching to one of the other two providers who would not have done so in the absence of the merger. The merged entity will make its calculation balancing this loss of revenue against the higher revenue on the customers who remain. These newly available customers then increase the demand faced by the other competitors, as a result of which they have an incentive also to increase prices themselves. If [the competitors] have incentives to respond to a price increase of their rivals by themselves increasing price, then prices are called 'strategic complements'. [...] the Commission notes that in standard models of oligopolistic price competition, strategic complementarity of pricing decisions always arises unless very extreme assumptions apply. [...] Therefore, and because strategic complementarity of prices is rather robustly observed in oligopolistic models, the Commission considers that [there is] no reason in this case to depart from the robust conclusion that competitors would be very likely to respond to a price increase by a competitor by increasing prices themselves." See Commission Decision in case M.6497 Hutchison 3G Austria/Orange Austria, Recitals 376-372.

time and when its price increase is substantial. We, however, also describe specific circumstances when such a price increase should be rather subdued. It is shown that umbrella effects will occur irrespective of whether the non-cartelized firms act as price takers or whether they set their prices or quantities strategically, taking into account the behaviour of the cartelized firms. We also demonstrate that further determinants such as for example the type of competition (price or quantity), the degree of product differentiation, the elasticity of demand and supply have an impact on the amount of the umbrella effects. Further, we demonstrate that umbrella effects and market definition are conceptually related. As cartels in general lead to higher prices, products become substitutes at the inflated cartel prices which would not be considered substitutes under effective competition. Finally, we discuss some problems that are related to the theory of partial cartels, i.e. the question arises whether a partial cartel and the related umbrella effects arise in equilibrium.

This paper deals mainly with the theory of the umbrella effect. The presence of an umbrella effect has, however, also implications for the quantification of damages. This concerns first and foremost the quantification of damages that are caused through umbrella effects. While in principle the same econometric tools that are employed to quantify damages for direct purchasers of cartel members can be employed here as well, we note, in particular, in Sections 4 and 5 that in this case the calculation of a simple cartel induced price overcharge may be grossly misleading. As these techniques have been treated in detail elsewhere,¹⁰ we do not discuss them in detail. Umbrella effects should, however, also be taken into account when assessing the cartel induced damages to direct purchasers, provided that the prices set by cartel outsiders are used as counterfactuals or as comparators (e.g., in a cost-price margin yardstick analysis). Then, to the extent that there is an umbrella effect, using the respective prices in this way would result in an underestimation of damages also for purchasers from cartel members.

2 Principles

In this section we discuss the economic foundations of umbrella pricing effects caused by cartels. Depending on the conditions in the respective markets, different scenarios have to be considered. For example, the magnitude of umbrella effects might depend on whether the market is characterized by price (Bertrand) or quantity (Cournot) competition, whether the goods that are traded in the market are homogeneous or differentiated or whether the non-cartelized firms behave strategically or (non-strategically) as price takers. Finally, umbrella effects might also depend on whether the firms sell to final consumers or to firms that do not compete with each other or whether the cartelized firms sell to competing firms, i.e. whether or not there is downstream competition.

At a first stage, we consider in this section a scenario where i) the non-cartelized firms behave competitively and where ii) the parties that are affected by the price increase are final consumers or firms that are not in competition with each other. The lack of competition on the direct purchaser level downstream will, as we show further below, take away a channel that may both increase or decrease an umbrella effect. Still, our subsequent observations will also apply when firms compete downstream but are equally affected by a quantity reduction or a price increase of cartel members and a reaction of cartel outsiders. If there is competition and firms are differently affected by the respective quantity reductions or price increases, however, there are additional effects at play that we discuss below in Section 4.

¹⁰ See, for instance, European Commission (2011a) or Maier-Rigaud and Schwalbe (2013).

2.1 Umbrella Effects with Non-Strategic Cartel Outsiders

Suppose that several firms in a market form a non-inclusive cartel and jointly raise the prices of their products or reduce the quantity supplied. As the cartel is incomplete, there is at least one producer of potential substitutes that is not part of the cartel.¹¹ Furthermore, we assume a given price increase or quantity reduction that the cartel agreed upon without considering whether this price increase or quantity reduction should be expected to arise in equilibrium and consider the extent to which this gives rise to umbrella effects. In Section 5 we will argue, however, that the extent to which the cartel will reduce the quantity supplied or increase price should depend, among other things, on the market coverage of the cartel.

2.1.1 Price Competition

Consider a market where firms compete in prices and produce differentiated goods. We assume that there are two groups of firms. Firms in group one set the prices of their products strategically, that is taking into account the effects of their behaviour on the other firms while the firms in group two, the suppliers of a considered substitute good, are price takers given their small size, i.e. we assume a “competitive fringe”. We further assume that all firms produce with increasing marginal cost as with constant marginal cost a non-inclusive cartel (with price-taking cartel outsiders) has no impact on the market outcome. Then, any increase in price by the cartel would be fully compensated by an increase in the quantity produced by the competitive fringe. Stated otherwise, the competitive fringe will always set a price according to the condition “price equals marginal cost” and produce a quantity such that the price is driven down to the then constant marginal cost.

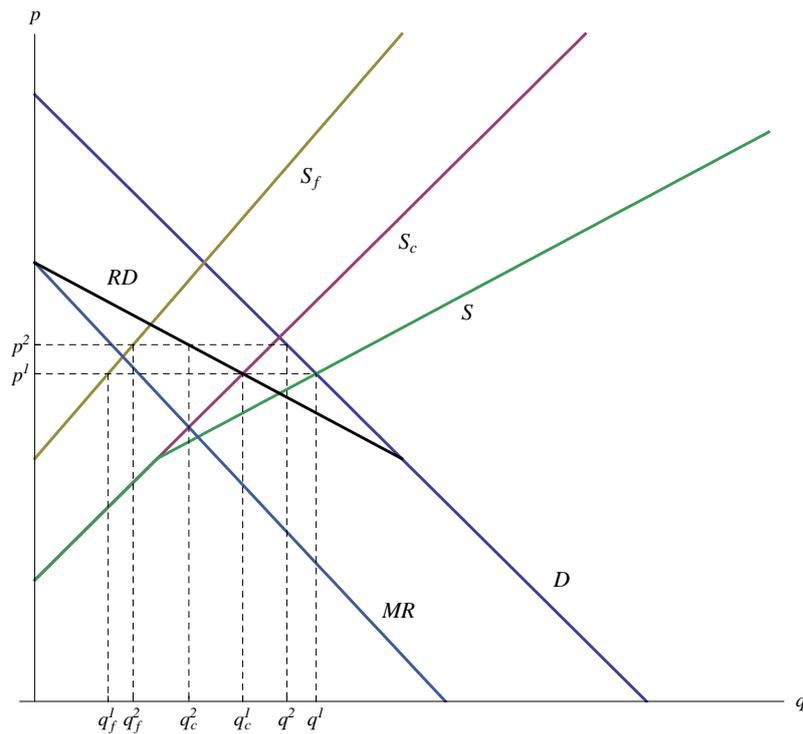
When the firms in group one form a cartel, they raise the prices of their products. To the extent that there are non-cartelized viable substitutes this will increase the demand for these substitutes, at least when the mark-up is substantial and when the cartel operates for a sufficiently long time.¹² Graphically speaking, the price increase induced by the cartel has the immediate effect of shifting outwards the residual demand curve faced by the competitive fringe, i.e. the demand that is not satisfied by the cartelized firms. Notice that our assumption of increasing marginal cost implies that the supply function of the competitive fringe is not perfectly elastic. Otherwise, as noted above, any attempt by a cartel to increase the market price is defeated by an increase in the supply of the competitive fringe.

In this case, the supply curve of the competitive fringe is strictly increasing and a profitable price increase of the cartel is possible even when the cartelized and the outsiders’ products are relatively close substitutes (or even in the case of perfect substitutes). The umbrella effect in the case of homogeneous product price competition with a competitive fringe is illustrated in Figure 1 taken from Blair and Maurer (1983) who have analysed this case.

¹¹ Firm A remains a cartel outsider or if the relevant market is fully covered, firm B remains an outsider. There are several contributions that demonstrate that cartels with partial market coverage may arise in equilibrium (see Section 5).

¹² This model is equivalent to models of collusive price leadership which have been analysed e.g. by d’Aspremont *et al.* (1983) or Donsimoni *et al.* (1986).

Figure 1: Umbrella effect with price-taking cartel outsiders



Here, D denotes the market demand, S is the total supply with S_c being the supply (or marginal cost) curve of the strategic firms and S_f the supply (or marginal cost) curve of the competitive fringe. RD denotes the residual demand for the firms in group one and MR the marginal revenue for the firms in group one. Without a cartel, the equilibrium is found at the intersection of the market demand and the total supply function at a quantity of q^1 and a price p^1 . When the firms in group one form a cartel, they maximize their profits given the residual demand function, i.e. they equate the corresponding marginal revenue with marginal cost. Formation of a cartel leads to a reduction in the supply of the firms in group one from q_c^1 to q_c^2 and the resulting market price is p^2 . The increased price, however, implies an expansion of the supply of the competitive fringe from q_f^1 to q_f^2 . Total quantity supplied decreases from q^1 to q^2 . The umbrella effect is the increase in price from p^1 to p^2 . In the case of a homogeneous product, the price increase is the same for cartelized and non-cartelized firms.

The umbrella effect is *ceteris paribus* the higher the lower the price elasticity of the supply of the competitive fringe, i.e. roughly speaking the steeper the residual supply curve is in the relevant range. This should in turn be the case when the respective firms' capacity is small or when their average costs of production increase steeply with a larger quantity.¹³ The price increase resulting from the outwards shift in residual demand remains higher also in the long run if there is less scope for entry.

Consider now the case where the firms in the two groups produce differentiated goods. Here, the degree of substitutability between the products of the cartelized and non-cartelized firms has to be

¹³ While a positive umbrella effect arises under the discussed typical circumstances, in principle one could also conceive of situations where a negative effect may arise. Consider for example a situation where, due to the increased residual demand, firms in the competitive fringe may now employ a technology that allows them to produce this larger quantity with lower marginal and average cost. Note, however, that holding the technology of the fringe firms constant, this would not occur as a profit maximizing firm will never produce an output in the region of decreasing average cost.

considered. For a given price increase induced by the cartel, the umbrella effect should be more pronounced the higher the degree of substitutability between the cartelized and non-cartelized product is, as the increase in residual demand is more pronounced. This is the case when more of the displaced demand is indeed diverted to the substitute good.¹⁴ Keeping the price increase as given, the umbrella effect should also be more subdued when the market for the non-cartelized substitutes is large, i.e. when the market coverage of the cartel is small. In this case, the residual supply curve should be more elastic.¹⁵

Note that in the case of differentiated products an additional aspect has to be taken into account. Depending on the magnitude of the price increase caused by the cartel-induced quantity reduction, additional products could become attractive substitutes, i.e. the number of fringe firms might increase.

For the present discussion it is not essential that cartel outsiders directly observe the price increase of cartel insiders, let alone the reasons for such a price increase. Instead, their own price increase is a best response to how the cartel outsiders own (residual) demand changes with respect to the price increase of cartel members. Hence, to make their own price increase optimal it is only necessary for cartel outsiders to perceive a change to their own demand.

2.1.2 Quantity Competition

Another workhorse model in market analysis is that of competition in quantities (so-called Cournot competition), which is sometimes meant to capture firms' choice of capacity. These models are usually employed in cases where quantities (or capacities) cannot be easily adjusted and also in cases where firms first choose a capacity and then charge a price such that this capacity is fully employed. Consider first a market where firms compete in quantities and produce a homogeneous product. Again, assume that there are two groups of firms, one group that behaves strategically, i.e. chooses the quantities taking into account the effect on the market price, and one group where the firms behave non-strategically.¹⁶ Firms in the second group are price takers and supply a quantity such that price equals marginal cost.

Before cartel formation, the strategic firms set their respective quantities non-cooperatively, taking into consideration that the non-strategic firms will choose quantities according to the price equals marginal cost rule. If the firms in group one form a cartel, they will reduce their quantities supplied which in turn leads to an increase in market price. This higher market price induces the firms in group two to increase their quantities. This increase in quantity partially alleviates the cartel induced price

¹⁴ There is obviously a close relationship to the diversion ratio that is used in merger analysis. In a nutshell, the diversion ratio answers the following question: if the price of some good A rises, to what extent will customers switch from A to another good B? The diversion ratio from A to B is then, at least in a local approximation, equal to the cross-price elasticity of demand from A to B, divided by the own-price elasticity of demand for A. (See for example Shapiro (1996), OECD (2012) or Bishop and Walker (2010)) Consider the following example taken from Shapiro (1996): assume A has an own-price elasticity of demand of 2.0, so that a 1% increase in the price of A results in a reduction of the marginal sales by 2%. Assume further that the cross-price elasticity of demand from A to B is 0.5 and that both firms produce the same quantities. The diversion ratio from A to B is then 0.5 divided by 2.0, i.e. 25%. This means that one-quarter of the lost marginal sales of good A, following a (small) price increase, will be captured by the producers of product B. While for the present discussion there is clearly no need to fully calculate the diversion ratio, as we are not directly interested in the demand that is lost for the cartel, this shows the close relationship between the umbrella effect and the quantity reduction for the cartelized goods. We return to this in Section 3.

¹⁵ As already noted, however, both closer substitutes and a more incomplete market coverage should make a significant price increase infeasible or at least unprofitable, as is further discussed in Section 3.

¹⁶ Cournot oligopolies with a competitive fringe have been analysed by Ulph and Folie (1980), Okuguchi (1983) and (1985). See also Martin (2002).

increase but total quantity supplied remains reduced. Thus, the resulting market price is higher in a cartelized market as compared to a situation where the firms in group one behave non-cooperatively. Similar results arise in models with quantity competition and differentiated products e.g. where the product of the firms in group one differs from the product of the fringe firms. In such cases the quantity reduction induced by the cartel leads to a less pronounced quantity expansion of the competitive fringe the more differentiated the products are. The reason is that the diversion of demand from the cartelized to the non-cartelized firms is less pronounced the more differentiated the products are. Thus, the prices of both products increase but the increase in the price of the cartelized product increases by more than the price of the non-cartelized product, i.e. the price difference between the two products changes. The degree of differentiation can be captured by a similar measure as the diversion ratio used in the case of price competition where the diversion ratio is defined in terms of quantities that is diverted from one product to the other. In the case of quantity competition a “price diversion ratio” could be employed.¹⁷

The discussion has shown that under quantity competition, despite the fact that the non-cartelized firms produce a larger quantity, the total quantities produced decline as the additional quantity supplied by the fringe firms is not sufficient to compensate for the cartel induced quantity reduction. Thus the market prices increase and umbrella effects occur in both, models of quantity competition with homogeneous products and with differentiated products. This implies that also the customers of the fringe firms pay higher prices as compared to a situation without a cartel. Note, however, that the question of the magnitude of the umbrella effect only arises when the substitute good and the cartelized good are differentiated or when at least some customers cannot easily switch. If the firms produce a homogeneous product, customers of the non-cartelized firms pay the same price as the customers of the cartelized firms and the umbrella effect is identical to the cartel-induced price increase. In fact, when economists consider markets with capacity competition, the workhorse model that underlies much of applied work assumes homogeneous goods, in which case the cartelized good and the perfect substitutes would command the same price.

The preceding observations have demonstrated that umbrella effects may also arise in cases where the firms not participating in the cartel behave non-strategically as mere price takers. In fact, the reaction of cartel outsiders was presently represented simply by the respective supply curve, as derived from their profit-maximizing behaviour. An umbrella effect arises then simply from the interplay of the increase in residual demand induced by the diversion of demand away from cartel members and the imperfectly elastic supply of the substitute. In the following discussion we will focus on the case where the non-cartelized competitors react strategically to the changes in prices and quantities caused by a cartel.

2.2 Umbrella Effect with Strategic Cartel Outsiders

2.2.1 Price Competition

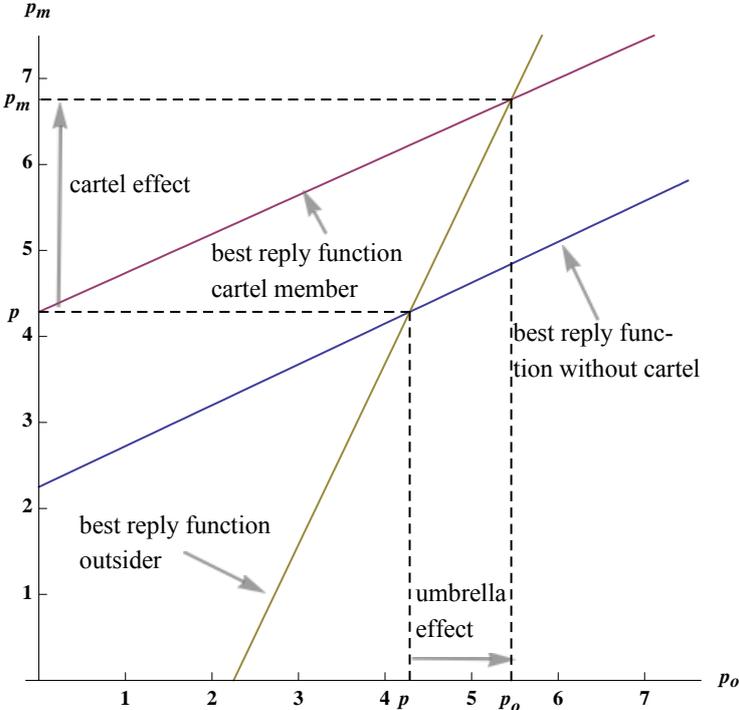
We now suppose that the cartel outsiders producing the substitute good possess some market power. Then, each of the cartel outsiders no longer acts as a price taker when it faces an increase in its residual demand. Firms with market power do not simply accommodate the higher demand, but adjust prices optimally.

¹⁷ See Moresi (2010).

If firms are identical, produce a homogeneous product with constant marginal cost and compete in prices, we are in the standard Bertrand model where the market outcome is the same as in a market where all firms are price takers. Forming a non-inclusive cartel to increase the market price is pointless as capacity unconstrained competition of the non-cartelized firms will drive down the price to the competitive level. Thus, in this case, a cartel triggers neither price- nor any umbrella effects.

Consider thus a situation where firms produce differentiated products and compete in prices. The optimal response of a non-cartelized firm to a given price increase by the cartelized firms will now depend on how it trades off an increase in the price of its own product, resulting in a higher margin, with a more or less pronounced increase in the quantity produced. In most of the standard demand systems, prices are strategic complements: As one or several competing firms increase their respective prices, it is optimal for any other firm to also increase its price.¹⁸ As cartelization leads to a price increase of the affected products, the best reply of the cartel outsiders is to increase the prices of their products as well. The increase in the price of the products of the non-cartelized firms is given by the slope of the reaction function.

Figure 2: Umbrella effects with price competition and strategic outsiders



Consider the case of a linear demand function and constant marginal cost. With linear demand an incremental increase in price has always the same incremental effect on demand, irrespective of the prevailing price and quantity level. In this case, intuitively also the reaction functions of firms are linear, i.e., when a firm anticipates that the price of a rival is incrementally larger, then its best response prescribes a fixed incremental increase in its own price, irrespective of the prevailing price level. In this case, the price increase by non-cartelized firms is also obtained in a straightforward manner. It is determined simply by the shift in the reaction function of the cartelized firms and the constant slope of the best-reply function. This case is illustrated in Figure 2 where we assume three firms in a market, a linear demand function, equal and constant marginal cost and equally differentiated products. The two potential cartel members are in group one and one firm is the

¹⁸ This holds if the demand function is log-concave. See e.g. Vives (1999:94).

outsider. The best-reply functions are drawn for two representative firms, one potential cartel member and the outsider. Before a two-firm cartel is formed, the equilibrium prices are given by the intersection of the best-reply function without a cartel with the best-reply function of the outsider. When the two firms in group one form a cartel, the reaction function of a representative cartel member shifts upward and the new equilibrium prices are now given by the intersection of the best reply functions of a cartel member and the outsider. The direct effect of the cartel on the price of the cartelized products is given by the increase from p^* to p_m^* and the umbrella effect is the price increase from p^* to p_o^* .¹⁹

As in the case where the substitute good is supplied competitively by price-taking firms, the umbrella effect should be more pronounced when firms produce with increasing marginal costs or when they are subject to capacity constraints as in this case the reaction functions are characterized by an increasing slope. Also, the degree of substitutability as measured by the diversion ratio has an important impact on the magnitude of the umbrella effect. The higher the degree of substitutability, the higher the umbrella effects will be. This is due to the fact that the demand spill-over from the cartel to the non-cartelized outsiders is more pronounced the closer substitutes the products are.

Also, the magnitude depends positively on the size of the cartel. Intuitively, if the cartel has only a small market coverage, the induced price increase is only moderate and only a small part of the demand is diverted to each cartel outsider. Therefore, each outsider will increase the price of its product only slightly. If the cartel is larger, however, the cartel induced price increase is more pronounced and thus more demand is diverted to the few remaining outsiders who will increase their prices by a larger amount.

We illustrate this with the previously introduced case of linear demand and constant marginal cost. We take a market with ten identical firms. We then calculate the umbrella effect for each of the outsiders when a cartel of different size forms. We vary cartel size from 2 to 9, i.e. all firms except one form a cartel.²⁰

Table 1: Umbrella effects and cartel size

Cartel size	2	3	4	5	6	7	8	9
Price cartel	2.980	3.067	3.164	3.274	3.398	3.538	3.697	3.880
Price outsider	2.908	2.918	2.933	2.954	2.983	3.020	3.066	3.123
Cartel effect	0.077	0.164	0.261	0.370	0.494	0.634	0.794	0.977
Umbrella effect	0.005	0.0145	0.023	0.052	0.080	0.117	0.163	0.220

Note that the price increase is calculated with reference to the symmetric non-cartel price (of 2.903). Depending on the size of the cartel, the umbrella effect in the linear case ranges between 7% and 23% of the cartel price increase despite the low degree of substitutability between the products.

¹⁹ This example is based on a linear model with profit functions given by $\pi_i = p_i(a - b p_i + d \sum_{j=1}^n p_j) - c_i p_i$ and with values of $a = 10, b = 2, c = 1$ and $d \in (0,1]$.

²⁰ The values are generated with the demand function $10 - 2p_i + 0.1 \sum_{j=1}^{10} p_j$ for all $j \neq i$ and constant marginal cost $c = 1$. Notice that we made the preceding analysis taking a cartel's size as given. However, not all considered cartels might satisfy the conditions of internal and external stability. This problem is discussed in section 5.

2.2.2 Quantity Competition

If firms compete in quantities or in capacities installed, the best reply functions are typically downward sloping, i.e. quantities or capacities are strategic substitutes in most cases.²¹ As one or several competing firms decrease their respective quantities, it is optimal for any other firm to increase its own. The reason is that a decrease in the supply by the cartelized firms will lead to an increase in the market price and this makes it attractive for the outsiders to profit from a larger quantity as well as a higher price. In contrast to price competition, this result holds even if the firms produce with constant marginal cost.²² The price increase induced by the cartel will typically not be overcompensated by the increased quantity of the non-cartelized firms so that total quantities produced decrease and prices increase. Similar results hold in the case where the cartelized and non-cartelized firms produce differentiated products. The main difference between the model with a competitive fringe and a strategic fringe with respect to the umbrella effects is that in the latter case the quantity responses of the fringe firms are less pronounced as they take into consideration the impact of their quantity choice on the market price.²³

The preceding discussion has shown that umbrella effects arise in a variety of circumstances, e.g. with price or quantity competition, with homogeneous or differentiated products and if the non-cartelized firms act as price takers or if they behave strategically.²⁴ The magnitude of the umbrella effects depend negatively on the degree of substitutability between the cartelized and non-cartelized products. If products are homogeneous, there is no difference between the cartel-induced price increase and the umbrella effect. If the products are highly differentiated, a price increase or a quantity reduction by the cartel leads only to a limited diversion of demand from the cartelized to the non-cartelized firms and thus only to a limited reaction in form of a price or quantity increase. Also, in the case of price competition, the magnitude of the umbrella effect depends positively on the market coverage or size of the cartel.

3 Umbrella Effect, Cartel Stability and Market Delineation

3.1 Umbrella Effect with Partial Coverage of the Relevant Market

Before considering umbrella effects under a partial cartel, i.e. a situation where the cartel covers the relevant market only partially, the relevant market has to be determined. In many jurisdictions a key tool in defining the relevant market is the hypothetical monopolist test (HMT).²⁵ This test asks

²¹ This is satisfied if the demand function is not too convex, i.e. if a firm's marginal revenue decreases if any competitor increases its output. See e.g. Vives (1999:94).

²² A stable cartel with a Cournot-fringe exists if demand is linear and firms are producing with constant marginal cost and the cartel is not too large, i.e. the number of fringe firms is sufficiently large. See for example Shaffer (1995).

²³ It is interesting to note that when firms compete in quantities and when these are indeed strategic substitutes, then for a given cartel output the price increase, both of the cartelized good and the substitute good, would be more pronounced when cartel outsiders do not learn (sufficiently quickly) about the changed market conditions. This is the case when cartel outsiders do not increase their output in response to higher demand. This is one of the instances where an active response by cartel outsiders to the changes induced by a cartel mitigates the total damages of the cartel.

²⁴ The only exception is the case where firms compete in prices, produce a homogeneous product and face constant marginal cost. In this case, only an all-inclusive cartel has any effect on the market outcome.

²⁵ See European Commission (1997), US Department of Justice and Federal Trade Commission (2010), European Commission (2004) paras. 19-25 and European Commission (2011b) paras. 112-126, as well as European Commission (2010) paras. 86-95. See also OECD (2012) for a discussion of the role of market definition in competition law and regulation throughout the world and the recent US debate on market definition and alternative tools.

whether a hypothetical profit-maximizing monopolist would effect a small but significant and non-transitory increase in the price (SSNIP) of its products. Here, “small but significant” is usually taken to be about 5%-10% and “non-transitory” a time period of about one year. If, starting from a “candidate market”, this condition is not satisfied, than a profit maximizing monopolist would not engage in such a price increase as this would lead to considerable demand substitution by customers. Therefore, the candidate market is enlarged by adding substitutes and carrying out the HMT for this enlarged set of products. The relevant market is then defined as the smallest set of products that satisfies this condition, i.e. would allow a profitable price increase by a hypothetical monopolist. Proceeding in this way, the boundary of the market is drawn where such a price increase is profit-maximizing for the hypothetical monopolist as products not in the relevant market do not exert sufficient discipline to render the price increase unprofitable as they do not attract enough demand.

In merger control, the analysis usually starts at the prevailing price level while under abuse of dominance, the price level from which the analysis starts is the hypothetical price level that would prevail under effective competition. The analysis at the hypothetical level under effective competition is conceptually necessary, albeit difficult to accomplish in practice, as an analysis at the prevailing prices could fall foul of the so-called “cellophane fallacy”: As a firm with significant market power could have already raised the prices for its products to the monopoly level, a further increase would be unprofitable as a large number of consumers would switch to other products. As a result the market would be expanded leading to a relevant market that is too large as it comprises also products that are substitutes only at the monopoly price but were not substitutes at a price that would prevail under effective competition. As a result, the market share and the market power of a dominant firm would be underestimated.²⁶

If a cartel in a properly defined relevant market does not cover the market fully, it risks that cartel outsiders will free ride on it. This is depicted in Figure 3 where firms A to C are cartelized and firm D, that is part of the relevant market is a cartel outsider. In the shadow of the cartel, outsiders may then be able to enjoy a much larger demand, but they are also able to raise their price. Demand replacement is, arguably, lower when the umbrella effect is stronger, i.e., when in response to a higher cartelized price also cartel outsiders increase their price. Put differently, a cartel’s stability is less endangered when there is a stronger umbrella effect. A relatively high umbrella effect could, for instance, also arise when the cartel’s price is used as a focal price also for the implicit coordination between and with cartel outsiders.

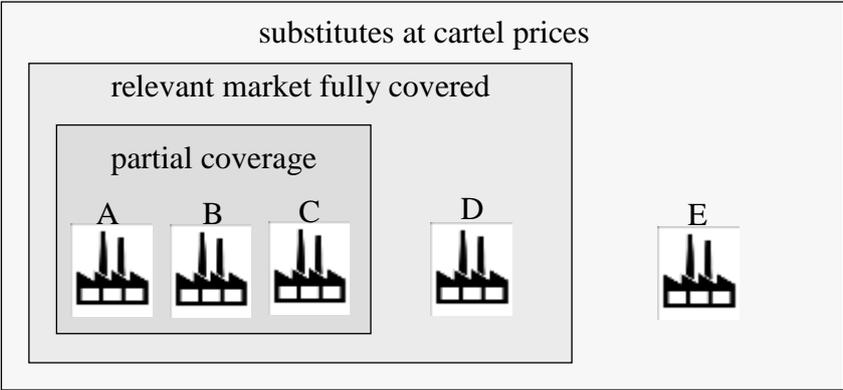
Due to the central focus on demand substitution in the absence of price reactions by firms outside the candidate market, umbrella effects are closely linked to the HMT. If the conditions of the HMT are not satisfied based on a particular candidate market and competitive prices, it is not only clear that the relevant market is larger but also that even a complete cartel covering this candidate market is unlikely to be profitable in the absence of umbrella effects, i.e. in the absence of price increases by firms whose products are in the relevant market but were excluded in the candidate market. As the SSNIP excludes responses by firms that are not part of the candidate market, the SSNIP essentially excludes umbrella effects.²⁷ Expanding the candidate market gradually by adding substitutes, enlarges the set of firms in the new candidate markets by those that are most central to the cartel, up to the point where a candidate market is found on which a complete cartel (a hypothetical

²⁶ See OECD (2012) in particular Box 4.

²⁷ The SSNIP neither foresees a strategic response triggering the largest umbrella effect, nor changes in price taking behaviour.

monopolist) would find it profitable to raise the price. Cartels, however, do not necessarily require that all firms on the relevant market defined in this fashion are part of the cartel, as cartelists can count on umbrella effects not part of the SSNIP analysis. In that sense it may be sufficient to form a complete cartel on a candidate market and that cartel would be profitable if optimal responses by firms not included in the candidate market but part of the relevant market are considered.

Figure 3: Umbrella effects within and outside the relevant market



Suppose that the HMT indicates that cartelists (firms A, B and C in Figure 3) and an outsider firm (firm D) belong to the same relevant market. Suppose also that absent the cartel, it could be demonstrated that highly competitive prices would prevail, e.g., in case of sufficiently homogeneous products. If no umbrella effect is assumed, the cartel outsider (D) cannot increase its price in reaction to a price increase above the competitive level of 5-10%. By definition of the relevant market, such a price increase would not be profitable for cartel members (A, B and C). Hence, if the cartel imposes a high mark-up, this could only be profitable if the cartel outsider (firm D) increases its price as well. While this discussion does not suggest a particular level for the umbrella effect *per se*, for example in relation to the cartel’s mark-up, it emphasizes that an umbrella effect is very likely when cartel outsiders belong to the same market.

As a result of the preceding discussion there is a clear relationship between market definition, how many firms in the relevant market are part of the cartel (i.e. whether the cartel is partial or complete) and umbrella effects. If a cartel outsider is within the relevant market (firm D), the umbrella effect will be large as diversion between products (substitutes) within a relevant market is large. This implies that a partial cartel will only be profitable if outsider firms increase price sufficiently to counter the diversion of demand from the cartelists to the outside firms, i.e. if the umbrella effect is large.²⁸ As a result there are two possibilities either the cartel mark-up is very small so that diversion is limited even in the absence of umbrella effects, or the mark-up is large, implying that the cartel outsider within the relevant market (D) would draw a substantial part of demand in the absence of a large umbrella effect. If a partial cartel forms (A, B and C) and if that partial cartel exhibits a high mark-up, then the umbrella effect must be large as otherwise the cartel would not be stable.

That umbrella effects not only arise within a properly defined relevant market in case of cartel outsiders but may also arise outside a relevant market is the subject of the next section.

²⁸ With homogenous products and in the absence of capacity constraints this is particularly salient as the cartel will not be profitable and therefore not be formed if a cartel outsider in the same relevant market does not adjust prices. In the extreme case of Bertrand competition this firm would simply undercut the cartel and thereby capture all demand.

3.2 Umbrella Effects when Outsiders are not in the Relevant Market

Suppose now that the market coverage of the cartelists is complete, i.e. that all firms in a properly defined relevant market participate in the cartel (firms A to D in Figure 3). By definition of the SSNIP test, a small price increase of the cartelists starting from *competitive prices* would not lead to a large diversion of demand to outsiders (firm E). This is likely, however, to be different when instead of competitive prices, cartel prices are considered. In particular if the cartel mark-up over the competitive price is substantial, products that are not part of the relevant market become substitutes for consumers at cartel prices. As a result, if cartel prices are substantially above competitive prices, these consumers will divert demand to these products even if they are not sufficiently close substitutes at competitive prices to be in the same relevant market. As these products, however, remain more remote substitutes than those in the relevant market, the size of the umbrella effect will be driven mainly by the size of the mark-up.

This is intuitive if one considers the cellophane fallacy already mentioned previously. If cartel prices were used in the market definition²⁹, the relevant market would be defined too widely (comprising firms A to E) as products would be treated as substitutes that are only substitutes at these higher prices. If, however, a complete cartel is formed on a properly defined relevant market (firms A to D), then umbrella effects may occur outside that relevant market (firm E) as they are linked to relevant substitutes. If that was not the case, there would be no cellophane fallacy.

In order to see this consider a simple example of three firms offering differentiated products.³⁰ Firm 1 and 2 produce close substitutes and firm 3 produces a more distant substitute. If these firms maximize profits independently, a set of equilibrium prices can be derived. Applying the SSNIP test, by increasing the price of the products of firm 1 and firm 2 by 10% above this competitive price and calculating profits reveals that such a price increase is profitable.³¹ As a result, the product of firm 3 does not belong to the relevant market as it does not exert a sufficient constraint. Consider now the case of a cartel fully covering the relevant market, i.e. a cartel comprised of firm 1 and 2 with firm 3, being neither part of the relevant market nor of the cartel. If firm 1 and 2 form a cartel, they will maximize their joint profit. As a result, not only the prices of the products of firm 1 and 2 but prices of all three products will increase. If now a SSNIP test of 10% is performed based on the cartel prices of firm 1 and 2, such a further price increase would not be profitable, wrongfully suggesting that product 3 should be included in the relevant market. This will also hold for an increase of only 5%. Under this test, it is again assumed that firm 3 does not adjust its price in response to the price increase. If, however, firm 3 were to adjust the price of its product optimally to the 10% increase in prices for product 1 and 2, it would render the 10% increase profitable. This would also hold for a 5% SSNIP with optimal adjustment of the price of product 3. This shows that a product that is not in the relevant market under conditions of effective competition may become a relatively close substitute under cartel prices.

While this is nothing else than an example of the cellophane fallacy (if one were to base market definition on this test), it demonstrates that products that are not in the relevant market may

²⁹ Prevailing prices are used in market definition in a merger context whereas hypothetical competitive prices are used in a monopolization/dominance context.

³⁰ The example is derived from the following profit functions for the three firms: $\pi_1 = p_1(a_1 - b p_1 + d p_2 + e p_3) - c_1 p_1$; $\pi_2 = p_2(a_2 - b p_2 + d p_1 + e p_3) - c_2 p_2$; $\pi_3 = p_3(a_3 - b p_3 + e p_1 + e p_2) - c_3 p_3$, where $a_1 = a_2 < a_3$, $b > d > e$ and $c_1 = c_2 = c_3$.

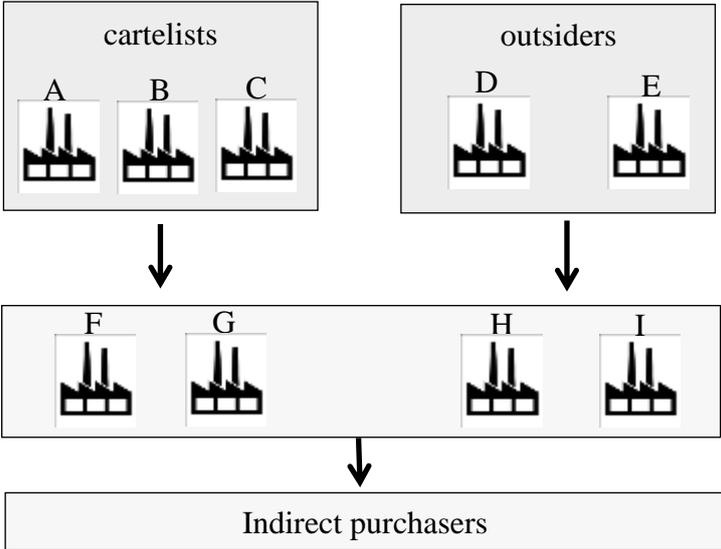
³¹ Such a price increase may even remain profitable if, in contrast to usual practice under the SSNIP, firm 3 is assumed to respond optimally to this price increase.

become important substitutes when it comes to cartel prices. As a result, even when the cartelisation of a market is complete, the firms that are not in the relevant market may generate umbrella effects as their products become relevant substitutes under cartel prices diverting demand away from the cartelists. While the umbrella effect (for a given mark-up) will be higher if the cartel outsider is in the relevant market, as substitution is already relevant at competitive prices, umbrella effects can be substantial also when firms are not in the relevant market as long as the mark-up is sufficiently high.

4 Downstream Competition

In the preceding discussion we did not address the question of whether the downstream firms that procure from the cartel are in direct competition with those that procure from cartel outsiders. In this section it is shown that this makes an important difference. Depending on whether direct purchasers (firms F to I in Figure 4) are in direct downstream competition with purchasers of non-cartelized suppliers or not, the latter may or may not be harmed by the presence of a cartel even when there is an increase also of the price of non-cartelized producers of substitutes (firm D and E).

Figure 4: Umbrella effects with downstream competition



Recall first that if suppliers offer perfect substitutes and if there are no capacity constraints or particular firm-specific preferences (such as geographic distance) for one product over the other, then the question of whether an umbrella effect arises is pretty much superfluous. Under these assumptions all products should command the same price.³² Consider now the opposite scenario for illustration, namely that, from the point of view of the respective direct purchasers, there is no direct substitution between the cartel’s products and products supplied as inputs by other firms (i.e. firms F and G can only purchase from A to C and firm H and I only from D and E). As an example, consider the case where the respective input, given its cost of transportation, is only locally procured but where the final product is offered on a national or global market (i.e. firm F through I operate on a common market). While this should indeed preclude direct substitution between the cartel’s product and the product offered by other suppliers, a higher price of one product will still push up demand for the other and possibly lead to a higher price. As we show, the implications of such a price increase

³² In case of price competition, when there are outsiders to the cartel and goods are homogeneous, then the cartel will not be in a position to raise the price above the competitive level to begin with.

triggered by the cartel will, however, be markedly different. Once this is established, we consider again the case where the cartel's product and the product offered by outsiders are substitutes.

Take a given price increase of a cartel that the direct purchasers F and G (partially) pass-on to their indirect purchasers. The larger this pass-on, the less competitive these direct purchasers will become. Consequently, demand will shift to rival firms H and I. In order to serve this increased demand, rival firms H and I demand more of the respective input provided by other suppliers not part of the cartel (firms D and E). Following the arguments presented before, this should typically induce a price increase of these inputs. Moreover, as the size of the expected price increase depends clearly on how far demand has shifted outwards, this effect is closely related to the pass-on of direct purchasers to indirect purchasers and, thereby, to the cartel mark-up. Typically, the competitive advantage of the rivals H and I vis-à-vis the direct purchasers F and G will remain (albeit reduced) despite the fact that their own input prices increase as well. After all, it is the expansion in their own demand, following a reduction of competitiveness of direct purchasers F and G of the cartel that subsequently leads to an expansion of their demand for inputs, which then triggers a price increase for the respective input. Put differently, the benefits obtained from an increase in output, as the direct purchasers F and G of the cartel become less competitive, will typically outweigh the higher induced input price that H and I face.

As previously noted, the extreme case where firms procuring their inputs from the cartel cannot switch the source of supply has been presented for illustrative purposes only. Suppose now that there is some degree of substitution while maintaining that those procuring from the cartel and those procuring from cartel outsiders remain rivals on the downstream market. There are then two reasons for why the price of cartel outsiders increases. As the cartel's price increases, demand shifts away from the cartel (A, B and C) to firms outside the cartel (D and E), which was the primary trigger for the umbrella effect, as discussed above. In addition, when the firms that are (more) affected by the cartel's price increase (F and G) pass-on the increased input costs leading to higher output prices, downstream market demand increases for rivals H and I that, instead have a preference for the good supplied by cartel outsiders. The resulting increase in the demand faced by cartel outsiders, which now works through downstream firms' competition, also triggers a price increase. It should be noted that these two effects should, however, not be considered as complementary or mutually reinforcing. Instead, when competition in the downstream market is more intense, as there is a relatively higher number of firms that remain unaffected by the direct effects of the cartel mark-up, the direct purchasers of the cartel will respond to this more intense competition by not passing-on as much of the cartel mark-up to indirect purchasers as they would otherwise do. It is intuitive that in this case also the cartel will have reduced incentives to raise prices, as this would trigger a larger reduction in demand.

The essential point is that the two reasons for why the demand for the product of cartel outsiders increases and for why cartel outsiders will increase prices have rather orthogonal implications for the consequences inflicted on firms purchasing their products. In fact, as discussed above, when the demand expansion works through the increased competitiveness of the respective direct purchasers (H and I) on the downstream market, the immediate effect should be that these firms benefit from the operation of the cartel. A simple empirical analysis that would merely determine the price increase of cartel outsiders (D and E), as compared to an actual or hypothetical counterfactual market, would fail to uncover this difference. On the other hand, a full analysis of damages, which

includes particularly changes in quantity and pass-on, would not face this pitfall.³³ Even when such a full-fledged analysis is not feasible, however, it should be clear from the preceding discussion that the determination of an overcharge, i.e. a mark-up and its multiplication with actual quantity, may provide a very poor reflection of the damages emanating from an umbrella effect.

As a final remark note that even when the firms that face higher input prices from suppliers that are not members of the cartel actually benefit from the operation of the cartel (firms H and I), their purchasers, i.e. consumers or firms operating at the next lower level of the vertical value chain, will still be harmed and should be able to claim damages. Even when they purchase from firms that are not purchasers of the cartel and that, at least in our extreme example, could not even claim that the cartel's price increase has deprived them of a cheaper alternative source of supply, they may still face a price increase caused ultimately by the cartel. This price increase may, to some extent, be triggered directly by the best response of firms when they see their rivals' price increase, following a cost increase due to the cartel. And it may then be further amplified by the considered price increase of the respective suppliers that themselves face a higher (derived) demand.

5 Umbrella Effects and Endogenous Cartel Formation

So far it was simply assumed that cartels exhibit only partial market coverage instead of this partial coverage being derived as an equilibrium within a theoretical model. This assumption could be justified in the case where besides the firms that constitute the cartel, all other firms in the market are each insignificantly small with respect to the market. In this case, it can be assumed that these fringe firms behave non-strategically as price takers. However, in many instances cartels are observed with relatively low market coverage³⁴ or where firms with a significant market share do not participate in the cartel.³⁵ In such cases, the assumption of non-strategic behaviour is unconvincing and economic theory has to explain under which conditions incomplete cartels may arise in equilibrium. Only if cartels with partial market coverage can be theoretically explained, can a consistent and convincing theory of umbrella effects be derived. In this context, it has been shown that the incentives to form cartels depend on the type of competition in the market and on the

³³ See Maier-Rigaud and Schwalbe (2013) or Inderst *et al.* (2013) for a discussion of quantification of antitrust damages.

³⁴ See case COMP/39396 – Calcium carbide and magnesium based reagents for the steel and gas industries, Commission Decision of 22.7.2009, C(2009) 5791 final, where in recital 37 the Commission notes that in addition to the cartellists there were seven other producers/suppliers with an estimated combined market share of 15% for calcium carbide powder and 31% for calcium carbide granulates. A 50% market share of the cartel was identified (see recital 89) in case COMP/38543 – Services de déménagements internationaux, Décision de la Commission du 11.3.2008, C (2008) 926 final. See also Case COMP/38.628 - Nitrile Butadiene Rubber (also known as synthetic rubber), Commission Decision of 23.1.2008, C(2008)282 final, recital 15, where the cartellists Bayer and Zeon have respective market shares of 36% and 19% leaving 45% to competitors whose names and shares were considered confidential information. Note that Commission decisions will identify as cartellists only those cartel members for which an infringement could be proven. This implies that using the market coverage identified in decisions will tend to underestimate cartel coverage at least on average.

³⁵ This was the case for instance in case COMP/39482 – Exotic Fruit (Bananas), see Commission Decision C(2011) 7273 final, of 12.10.2011, where the Commission identified a cartel between two of the four big multinational companies active on the market, namely Chiquita and Pacific who had combined market shares of 30% and 40% for the two relevant years in Portugal, the only country with a 25% market share of fringe players in addition to the big four. The market shares of the cartel were 50% in Italy and 65-70% and 60% in Greece. (see recital 22 and 326). See also case COMP/39188 – Bananas, Commission Decision of 15.10.2008, C(2008) 5955 final, recital 457 where the combined market share of the undertakings for which an infringement could be established is estimated to be at least around 40-45%. More general studies include the following. Griffin (1989) reports the cartel's market share for a sample of fifty-four international cartels: 35% of the cartels in his sample have market shares of at least 75%, while 17% (9 cartels) have market shares of at least 90%. Suslow (2005:12) reports that, for 39 of the 71 cartels in the sample with market share data, the average cartel had at least 50% of the market. In their paper on U.S. price-fixing cases, Hay and Kelley (1974:22-23) report estimates of industry concentration that are roughly comparable to what we find: "In thirty-eight of fifty cases for which estimates could be made the concentration ratio was greater than 50 percent."

related question whether the strategies employed by the firms are strategic complements or substitutes. With price competition, strategies are strategic complements and cartel outsiders always have an incentive to join the cartel.³⁶ With quantity competition, however, quantities are strategic substitutes and, provided the cartel is not very large compared to the overall market, partial cartels are unstable as outsiders are better off free riding on the higher prices induced by the cartel's quantity reduction.³⁷

The basic theoretical approach to analyse cartels is a repeated interaction model where a cartel is considered stable if the short-run gains from a deviation from the cartel agreement are smaller than the long-run gains of remaining in the cartel.³⁸ This implicitly assumes that the cartel breaks down as soon as only one member deviates from the cartel.³⁹ To thoroughly analyse umbrella effects of cartels, economic theory has to provide an answer to the question of why it is in the interest of some firms not to participate in the cartel or, stated otherwise, why the cartelists would not prefer to include the other firms.

The central questions addressed relate to the internal and external stability of a cartel. Here, internal stability refers to the question whether or not a member of the cartel faces an incentive to stick to the cartel. This will be the case if the profit gained by an additional fringe firm is lower than that of a cartel member. External stability refers to the incentives to join the cartel in the first place, i.e. a cartel will be externally stable if no fringe firm has an incentive to enter the cartel. This condition is satisfied if the increase in price due to entering the cartel is not sufficient to increase the profit of a cartel member compared to what a fringe firm currently receives. A cartel is stable if it is internally and externally stable.

An important factor with respect to umbrella-effects is the size of the cartel. The latter is determined by the impact of an additional cartel member on the market price. If this impact is small, then the cartel will be small with respect to the industry. Also, the size of the cartel has an impact on the induced price increase, i.e. the smaller the cartel with respect to the market, the less effective it will be, i.e. in case of a small cartel, the market outcome is not substantially different from that of a competitive market. A similar result holds in the case of quantity competition, as the quantity produced decreases monotonically in the size of the cartel, starting from the competitive quantity and ending up at the quantity supplied by a monopolist. Of course, this is not surprising as the external competition either by a larger group of non-cartelized price-taking firms or a larger group of Cournot-competitors increases when the cartel becomes smaller in relation to the market.

In line with the comparison made above with the HMT, this relationship not only applies to the size of the cartel relative to its market coverage but also to the types of products supplied by these firms. While coverage is important, it will also be important to include the firms producing the closest substitutes. The products or those firms that would be included already in early candidate markets are more relevant than those only included towards the end just before the relevant market is found *ceteris paribus*.⁴⁰

³⁶ See Davidson and Deneckere (1983).

³⁷ This has been demonstrated for the linear case by Salant *et al.* (1985).

³⁸ There is, however, also an older strand of the literature, based on a static, one-shot game analysis, which goes back to the contributions of Selten (1973) and d'Aspremont *et al.* (1985).

³⁹ This does not imply that the cartel breaks down forever – a deviation might lead to a finite punishment phase and a return to the cartel arrangement (see e.g. Perry and Porter (1985)). However, the assumption is maintained that all firms in a market participate in the cartel.

⁴⁰ This issue does, however, not arise in models where only homogenous product Cournot competition is considered.

A recent strand of literature on partial cartels employs a repeated-interaction framework. This literature has analysed several aspects of partial cartels in a homogenous good framework, including cartel formation, cartel behaviour and industry structures that make partial cartels particularly likely.⁴¹ If firms differ with respect to their capacities and if cartel formation is costly, a cartel will not include all firms in the industry provided that the costs of cartelization increase in the number of cartel members. The actual size of the partial cartel depends on the cost of cartelization – the larger the cost, the smaller the number of firms in the cartel. The market price is shown to be an increasing function of the cartel's joint capacity. Stated otherwise, the cartel mark-up is smaller when the market coverage of the cartel decreases. This implies that umbrella effects increase in the degree of market coverage. This literature also demonstrates that larger firms have a stronger incentive to join a cartel. Thus, an equilibrium consists of a partial cartel that contains the largest firms in an industry. The problem of multiple equilibria may, however, arise. In addition, it is shown that in industries where the size distribution of firms is asymmetric, partial cartels are more likely than in markets where firm size is more evenly distributed.⁴²

Thus, the literature that analyses homogenous product cartels with partial market coverage as an equilibrium outcome seems by and large in accordance with the results derived above, i.e. the degree of market coverage and the magnitude of the umbrella effect are positively correlated. The analysis of partial cartels is, however, not very well developed and focusses exclusively on homogenous products. Further analysis could be able to describe this relation in more detail including the effect of differentiated products.

6 Conclusion

Our analysis of umbrella effects reveals several insights. First and foremost, we show that umbrella effects can occur in a wide range of circumstances, most notably both when the respective cartel outsiders act merely as price-takers and when they strategically adjust their prices in a response to higher demand as cartel members raise prices or restrict output. Also, we show how umbrella effects arise both when firms compete in quantities (capacities) or prices and when products are more or less differentiated. That said, all these factors together with others such as cost functions, affect the size of umbrella effects. For a given price increase of a cartel, umbrella effects should depend positively on the degree of substitutability, as this increases the extent to which demand is diverted away from cartel members to outsiders, and likewise on the size of the cartel. Interestingly, whether outsiders strategically react or not can both dampen or increase the overall effect of a cartel and thereby also the size of an umbrella effect, i.e., the impact that the cartel has on the purchasers from cartel outsiders. We work out the relationship between umbrella effects and market definition. Sizeable umbrella effect may occur, at least theoretically, also when the respective firms are not in the relevant market, as it is commonly defined in antitrust analysis. In particular, when the cartel has led to a persistent and sizable price increase, products become substitutes that are not substitutes under effective competition and the then prevailing lower prices. On the other hand, when cartel

⁴¹ See Bos (2009), Bos and Harrington (2010) and several contributions by Escrihueta-Villar (2003), (2004), (2008a), (2008b), (2009a), (2009b) for models of partial cartels in repeated interaction frameworks.

⁴² As discussed before, this literature is focusing on homogenous products and therefore does not treat differences in substitutability between firms' products. It may be perfectly reasonable to expect that a smaller cartel in terms of market coverage is stable when a cartel with a larger market coverage, exhibiting a different composition of firms is not under differentiated products. This will in particular be a possibility when the former is made up of firms with relatively close substitutes whereas the latter has a more representative set of firms in terms of substitutability characteristics of the products in the market.

outsiders (with sizable capacity) are in the relevant market, then the cartel's price increase can only be significant and profitable at the same time when cartel members can expect a sizable umbrella effect. Our analysis thus points out that cartel size and market coverage, the size of the cartel's price increase and umbrella effects are all closely interlinked. A thorough analysis should thus treat them jointly and has to consider to what extent the respective findings are mutually consistent (akin to an equilibrium analysis). Finally, we also show that demand substitution towards non-cartel members, which then triggers an increase in their respective prices, may, in fact, work through two different channels: Either a direct substitution effect away from cartel members or an indirect effect that works through downstream competition of firms that are purchasers from the cartel and rival firms that end up purchasing, instead, from non-cartelized suppliers. While also the latter channel leads to a price increase, rivals that are not purchasers from the cartel may overall benefit from the cartel. To identify the actual damage it is thus key to take into account the overall adjustments among cartel members and outsiders as well as their respective, potentially competing, purchasers.

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