The “Hold-Up” Problem in Vertically-Related Industries

An economic analysis

Prepared for

Sky

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Date: 5 June 2015

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1. INTRODUCTION AND OVERVIEW

This report responds to a request from Sky for an overview of the main insights from an economic analysis of the so-called "hold-up problem", and ways in which this can be resolved. In very stylised terms, a "hold-up problem" arises between two trading partners when one of them, for instance the "upstream firm" in a vertical trading relationship, carries out investments that become *sunk* and are *specific* to the downstream firm. In the absence of enforceable complete ex ante contracts, downstream firms might then be able to reduce their payment for the upstream input *after* the investment has been carried out, and as a result the upstream firm ends up getting lower profits or even incurring a loss. Knowing that it could be "held up" in this way, the upstream firm is then reluctant to invest – and in the extreme, it may not make the required investment.

The report focuses on two questions:

- What market characteristics make it more likely that a hold-up issue may arise?
- What solutions exist to hold-up, and in particular, how do contractual solutions between vertically separate firms perform against the solution of vertical integration?

The first important observation is that *this is not a novel issue.* It is, in fact, a very well-established question which has spawned a vast economic literature (generically described as dealing with the "hold-up" problem) with well-established answers. This should not be surprising: the problem of creating organisational structures that are incentive-compatible in terms of favouring productive investments is clearly central to economics and has therefore been considered *and addressed* for a very long time in *many* industries. There is nothing really 'different' or 'special' about telecoms and the investment challenges the telecoms industry faces for the provision of fast broadband services. Every industry has characteristics that arguably make it 'special' and 'different' from others in some respects, and in many of these industries vertical separation of downstream and upstream assets does not impede investment activity. It is important for the discussion to understand that, in spite of the hold-up problem, investments occur in a variety of circumstances.

In the first part of our analysis we set out the key insights from the economic literature on the relationship between vertical structure and incentives to invest. We then consider the experience of a number of industries where firms operating at one level of the value chain must make large sunk investments that produce inputs to another part of the value chain – and discuss how the issue has been addressed in practice. This review confirms that this is a routine question that has been addressed multiple times *not* through vertical integration, but through a variety of contractual solutions. Moreover, we find that even industries where vertical integration has been important historically are progressively moving away from integration and are increasingly relying on contractual solutions. This evolution seems to reflect both a move towards more modular technologies and the increased sophistication of the contractual solutions which have become available. In the final part of our report we briefly also consider how specific solutions to the "hold-up problem" that are discussed in the economic literature could be adopted to deal with hold-up concern (if any were indeed to exist in the first place) around the prospect for structural separation of Openreach from BT.

Specifically, the report is organised as follows.

Insights from the economic analysis of hold-up

We start in Section 2 with a discussion of the hold-up problem, which adopts a simple bilateral setting (one upstream firm and one downstream firm) as a benchmark. We then extend it in a number of directions to capture what we believe are, in practice, important factors affecting investment decisions. We explicitly discuss (a) the impact of investment specificity on the hold-up problem; (b) the importance of enforceability of ex ante contracts between the upstream and the downstream firm (i.e. contracts written before the investment takes place); (c) the impact of downstream competition; (d) the role of investments carried out by the downstream firm; and (e) the role of repeated interaction between upstream and downstream firms. We also discuss the role of demand uncertainty upstream and downstream in the context of the economic literature on principal-agent, transactions costs and property rights.

The severity of the hold-up problem increases with the proportion of investment costs that become sunk before enforceable agreements can be entered into. The hold-up problem also increases when it is more difficult to enforce ex ante contracts. In contrast, the hold-up problem is mitigated by downstream competition, downstream investments and repeated interaction. We further explain that the economic literature does not provide any basis for a conclusion that vertical integration is an efficient response to mitigate uncertainty.

Vertical integration vs. contractual solutions to the hold-up problem

In Section 3 we contrast vertical integration with contractual solutions to the hold-up problem.

The downside of vertical integration is that it increases the risk of foreclosure; thus, while investment may be higher with vertical integration, this may essentially reflect a gain from foreclosing competitors through the exercise of market power upstream – in which case the benefits of the additional investment are questionable. In other words, *even if vertical integration offered a complete solution to the hold-up problem* (which is not necessarily the case), the associated foreclosure incentives suggest that contractual solutions to the investment problem, which do not create incentives to foreclose, should be preferred. In practice, the benefit of vertical integration as a solution to the hold-up problem depends on how much of the investment is sunk, on the relative share of the downstream operation, and on whether, in practice, an integrated firm truly behaves as a single unit.

Hold-up can also be addressed through contractual means. Contractual features that are useful to address hold-up are co-investment, ex ante commitments by the downstream firm, long contract durations and quantity discounts, and pre-agreed rules for re-negotiation in case of a dispute. In addition, the timing of investment also matters: investment that is gradual and modular is less prone to hold-up. An interesting contract form that can help against hold-up is to allow the upstream firm to refuse supply to downstream firms if they do not carry out their own investments. Such contracts are more likely to be effective if both parties must make relationship-specific investments.

We specifically also discuss "anchor tenancy" as an approach to addressing the hold-up problem. The "anchor tenant" is generally thought of as a separate third party. The prevalence and success of "anchor tenant" solutions should therefore be seen as additional evidence that solutions that involve significant amounts of vertical integration are often not needed. Anchor tenancy can assist the hold-up problem in various ways: it can relax financial constraints for the upstream firm, it can create positive externalities for other

tenants, reduce the cost of uncertainty, and provide effective monitoring and certification of the upstream supplier. Certain of these functions, such as the relaxation of a financial constraint or monitoring and certification, would actually not work so well if the anchor tenant were an integrated downstream division of the upstream supplier.

Empirical evidence: lessons from various industries on the effectiveness of contractual solutions

We then draw on the existing empirical evidence, in two ways. First, in Section 4 we briefly review the results of existing cross-section empirical studies on various aspects of the hold-up problem, and the relationship between uncertainty and vertical integration. In particular on the latter, the empirical literature does not find strong evidence of a positive link between uncertainty and vertical integration.

In Section 5 we further set out a few brief case studies of investment, industry structure and contractual solutions in a number of industries – including car manufacturing as an early but standard reference, aviation, commercial real estate, submarine cables, the semiconductor industry, ports, aircraft, and natural resources exploration. This review confirms that multiple contractual solutions have been in place for considerable time to deal effectively with the hold-up problem, and vertical integration is by no means sought for or required in the vast majority of cases. It also suggests that vertical integration solutions to potential hold-up have been losing ground as technologies have become more modular and more sophisticated contracts have emerged.

Implications for the structural separation of Openreach from the remainder of BT

In the final section of this report (Section 6) we use the main insights from the theoretical and empirical literature to briefly consider claims that the separation of BT's network and retail arms would create insurmountable hold-up problems. BT argues that without vertical integration with its downstream operations, its network operations (Openreach) would be reluctant to make significant new network investments, such as upgrading its network to deliver fibre-based broadband services, and this would be highly detrimental to the development of communications in the UK.[1]

First, we find that the investments contemplated in the case of Openreach are not particularly large relative to the "downstream" investments that industry participants must themselves undertake. Second, we consider the specific case of Openreach against the insights we have developed on factors that should be expected to create or worsen a hold-up problem (asset specificity, absence of downstream competition, absence of downstream investments, one-time bilateral interaction, uncertainty). We show these factors to be either not applicable, or to be of limited significance. Finally we explain that – in particular with an active regulator like Ofcom – contractual solutions are available to address any remaining concerns about hold-up of Openreach investments.

1 See for example BT Consumer John Petter's statement at an Enders conference in London, as reported by the Telegraph on 17 March 2015 "Those who argue for [structural separation] ignore the importance of having a key anchor tenant to underpin the big investments."

2. INCENTIVISING INVESTMENTS: AN OLD ISSUE IN ECONOMICS

2.1. The basic hold-up problem

The concepts of "hold-up" and "opportunism" grew out of the debate about the nature and boundaries of the firm. The classic work of Coase (1937) raised the issue of why some activities are carried out inside firms, while others are carried out via market transactions between separate legal entities. Coase's answer was that there are costs associated with both of these organisational modes and firms choose the boundary of their activities by efficiently minimising these transaction costs. For the costs of internalising a transaction within a firm, Coase essentially *assumed* that managerial efficiency starts to decrease as the set of transactions that are organised within the firm increases beyond some level. These increasing costs would have to be traded off against the costs of using the market mechanism which he identified as mainly due to uncertainty: discovering prices, negotiating contracts, and specifying contractual obligations that will depend on uncertain (and possibly unforeseen) future events.

The "hold-up" problem is a particular manifestation of the latter type of costs from contractual incompleteness, which has come to occupy a central role in the literature – first with the more institutional approach of Williamson's "transaction cost economics", then with the more formal game-theoretic work of Grossman, Hart and Moore's "property rights theory".[2] The nature of the problem is best understood in a simple context where there is a single upstream firm, and a single downstream firm. We will use this as our benchmark for the analysis that follows.

Consider an upstream firm U, and a downstream firm D. The upstream firm can make an investment that would increase the profits of the downstream firm. In an ideal world, the two firms would reach an agreement whereby U would undertake an investment and D would pay U an amount that is sufficient to make this investment worthwhile but also leave some additional surplus to the downstream firm. However, once the upstream firm has made this investment, the downstream firm has an incentive to renegotiate the terms of the initial contract. This can be a risk particularly when, once the investment has been made, the upstream firm may be unlikely to find an alternative use where this investment would be as valuable as in the relationship with the downstream firm. In other words, the investment is somewhat *relationship-specific*. Equivalently, one can say that the difference between the cost of the investment and the best alternative deal that the investor could find ex post represents the part of the investment that is now *sunk.* The greater the proportion of the investment that is sunk, the weaker the ex post bargaining position of the investor.

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2 See Williamson (1971) for his earliest references to asset specificity and his 1985 treatise for a full book-length treatment including extensive discussion of hold-up issues. Shavell (2005) credits the first use of the term "hold-up" in the present sense to Goldberg (1976). Possibly the most influential paper in promoting the importance of hold-up issues is Klein, Crawford and Alchian (1978). The seminal papers on the Property Rights Theory are Grossman and Hart (1986), Hart and Moore (1988, 1990). Interestingly, Coase had already considered the possibility of hold-up problems as a source of market transaction costs. However, conversations with industry managers during his visit to the US in 1932 convinced him that this was not a major concern and that contractual solutions were typically able to address the problem. He thus avoided mentioning the issue in his 1937 paper and later vociferously opposed the prominence given to hold-up problems in determining firms' boundaries (see the discussion of the General Motors-Fisher Body case in section 5.1 below).

Thus, unless the upstream firm is confident that the terms of the ex ante contract can be enforced ex post, it will anticipate that the downstream firm will want to renegotiate the terms of the transaction once the investment has been undertaken. Anticipating the lower reward that would emerge from such ex post renegotiation, the upstream firm might decide not to invest in the first place, or at least not to invest as much as if ex ante contracts were known to be fully enforceable.

2.2. When is the hold-up problem important?

How serious the negative effect of "hold-up" on investment is likely to be depends on a number of factors. It will be useful to consider the following example to illustrate the relevant effects (formal derivations of the results discussed in the main body of the text are provided in the Annex). Suppose that, if the upstream firm U invests 100 to improve the quality of the inputs that it supplies to D, then profits in the downstream market increase by X > 100. As the increase in surplus created by the investment is larger than the investment cost, efficiency demands that the investment be carried out. But will it be?

2.2.1. Investment specificity (sunk costs)

Let us contrast two situations. In the first situation, U and D can bargain *before* the investment is made. The agreement that they reach involves a contractual promise from D to make a payment F to U if U does indeed make the investment of 100. Since D wants the investment to take place, it will make sure to agree on a fee that makes it worthwhile for U to invest.[3]

Let us now assume instead that, for some reason, the firms cannot contract before the investment expenses have been sunk. Assume further that, if the parties cannot reach an agreement, then U could get some "salvage" revenue payment $S < 100$ for its investment. This reflects the (partially) sunk and "specific" nature of the investment: outside of the relationship between U and D its value is reduced below its original cost. Because part of the investment has been sunk before negotiations take place, the upstream firm is in a weaker bargaining position: in ex ante negotiations, threatening not to invest was a serious threat since it saves the firm an expense of 100 but, ex post, the same threatened action would only "save" the salvage value S. Therefore, if S is large enough, ex post negotiations will give U a reward that does not cover the initial investment cost. Anticipating this outcome, U would not invest in the first place, to the detriment of both firms[4].

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3 It is readily shown that, if the two parties are equally able negotiators, the Nash Bargaining Solution (NBS) to their negotiation would involve a payment equal to

$$F = \frac{X + 100}{2} \geq 100$$

Since this payment covers at least the cost of investment, investment takes place whenever it is efficient (X > 100).

4 The Nash bargaining solution gives us

$$F = \frac{X + S}{2}$$

So the investment project is only undertaken if $X > 200 - S$. Hence, as long as some of the investment is sunk (S < 100), then there are values of X for which the investment should be made, but will not be.

The first insight is thus that *the severity of the hold-up problem increases with the proportion of the investment cost that becomes sunk before enforceable agreements can be entered into.*

2.2.2. Can contracts be easily designed and enforced?

Not surprisingly, if we consider a more realistic situation where ex ante contracts are possible but their enforceability is uncertain we also find (second insight) that *the severity of the hold-up problem increases as the probability that ex ante contracts would be enforceable decreases.*[5]

The lack of enforceability should not be interpreted in an overly narrow sense. For example, it may also arise from changes in the economic environment that require the parties to act in ways imperfectly specified in the contract, and which thus create the scope for opportunistic renegotiation even if the original contract may be legally enforceable in its original formulation. Conversely, courts can sometimes force interpretations of the "spirit" of the contract even when its "letter" is not applicable and thus protect the parties from hold-up.[6]

2.2.3. Is competition in the downstream market intense?

So far we have neglected the role of competition in the downstream market. Let us therefore now assume that there are two downstream firms, D_1 and D_2. If they both get the improved input supplied by the upstream firm, following its investment, then these firms share the market evenly. If only one of the two firms takes advantage of the new technology, then it captures a proportion $\alpha > 0.5$ of the value X, while the other firm actually loses profits since it would be facing a more efficient downstream rival. As shown more formally in the Annex (third insight),

the expected payment of the investing firm increases in the degree of downstream competition.

The intuition is fairly simple. When there are several firms competing downstream, the investor can still "play those firms again each other" when it comes to selling access to the new facilities, even when the investment cost has been sunk. This is because, when bargaining with one of the downstream firm, the alternative of that firm is not simply to not

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[5] Assume that the parties can agree on an ex ante contract but there is only a probability P that the contract can be enforced once the investment has been undertaken. The NBS is

$$Max_F \left[PF + (1-P)\frac{X+S}{2} - 100\right]\left[X - PF - (1-P)\frac{X+S}{2}\right]$$

Notice that we assume that, absent agreement the investment is not made. We get

$$F = \frac{P(X+S) + 100 - S}{2P}$$

This means that the reward that the investor can expect ex ante is equal to

$$E(C) = P\left[\frac{P(X+S) + 100 - S}{2P}\right] + (1-P)\left[\frac{X+S}{2}\right]$$

[6] See Shavell, S. (2005).

have access to the improved facilities – as was the case without downstream competition – but it is not to have access *while its rivals do*, which is a much less attractive situation. Since competition makes it more costly for a downstream firm not to get access to the new facilities, the investor can extract higher payments even in the absence of ex ante contracts.

2.2.4. Do both sides need to make specific investments?

Frequently, an upstream-downstream relationship requires both sides to make relationship-specific investments. For example, device manufacturers involved in standard setting undertake research which is of little value if it is not eventually embedded in a popular standard, while implementers of such standards also make product design decisions whose value depends on economical access to the standard. As explained in Williamson (1983), *hold-up tends to be less severe in situations where each side of the relationship holds some of the other side's specific investments "hostage".*[7] The basic insight is that, since both parties are vulnerable to ex post renegotiation, neither party finds it worthwhile to open the Pandora's Box.

2.2.5. Do the parties need to invest repeatedly over time?

In the standard hold-up setting, the initial investor is particularly vulnerable to hold-up because "the world ends" after a single investment episode. In practice, though, firms involved at different levels of a vertical chain are often called to interact repeatedly over significant periods of time. In such a context, the upstream firm's *next* specific investments can be used as a threat to contain the downstream firm's incentives to opportunistically renegotiate the terms of access to the most recent investment completed by the upstream firm.[8]

2.3. Uncertainty about market conditions

Claims are sometimes made that having a significant presence in the downstream market helps the upstream arm deal with uncertainty about the demand for the upgraded facilities that result from the new investment. There is a large literature on the relationship between uncertainty and vertical integration. We begin by reviewing the reason why downstream uncertainty might – or might not – make vertical integration more appealing. We then look at the corresponding empirical literature. As the quality of the theoretical literature is rather poor, the emphasis will be on the empirical side.

The current state of economic knowledge about vertical integration revolves around three main theories of the firm: principal-agent theory, transaction cost theory and property rights theory.

2.3.1. Principal-agent

The Principal-agent literature examines the relationship between an agent who wants something done (the Principal) and another one who actually carries out the task (the Agent). The Agent is better informed about his own level of effort and/or the downstream market environment than the Principal. The framework revolves around the fundamental

7 See Williamson (1983).

8 For empirical evidence on the effect of repeated business on vertical integration, see Table 6 in Lafontaine and Slade (2007).

trade-off between motivating agents to expand effort on their tasks (and/or use the information they are privy to efficiently) and the sharing of risks.

For the Agent to exert effort and/or use his better knowledge of the downstream environment efficiently, his reward must be tied as closely as possible to the outcome of his actions. However, doing so means exposing the Agent to a large share of the risk stemming from the fundamental uncertainty of the economic environment. If the Agent is risk averse he must be compensated for taking this risk. If, as commonly assumed, the Agent is *more* risk-averse than the Principal, then compensating the Agent for bearing more risk is costly to the Principal. This makes an arms-length relationship with the Agent less attractive for the Principal who is therefore more likely to decide to integrate forward into the downstream market. The prediction of the theory is therefore that *greater uncertainty about the downstream market makes vertical integration more efficient and therefore more likely*.

2.3.2. Transaction costs and Property rights

As explained very lucidly in Whinston (2003), the transaction cost theory and the property rights theory are intimately related. Both start from the premise that some investments are relationship-specific and imply the existence of “quasi-rents”. These are the ex post difference between the value of the investment within the vertical relationship and the value that the upstream firm can obtain for it if the relationship breaks down. It is because each party would like to appropriate these rents that opportunistic behaviour arises. And it is this opportunistic behaviour that adversely affects ex ante incentives to invest. This is where the transaction cost theory stops. Its main conclusion is therefore that *vertical integration will be more prevalent where quasi-rents are large*. As we have seen above though, contracts are often a credible alternative to vertical integration. This means that vertical integration is also more likely to occur if the environment in which the parties operate is more uncertain. This is because contracts find it difficult to fully specify all of the possible contingencies that arise from a volatile environment. The transaction cost theory thus also predicts that *greater uncertainty should be associated with a greater prevalence of vertical integration*.

Contrary to the transaction cost literature, the property rights literature recognises that vertical integration is not a panacea: since the investment and usage decisions tend to be decentralised even within a given organisation, quasi-rents arise even within the same organisation, also resulting in opportunistic behaviour that must be reined in through contractual means. So, in the property rights literature, whether or not vertical integration makes sense depends on a thorough comparison of the incentives for opportunistic behaviour in various possible organisation forms. For that reason, the property rights literature does not offer easy predictions for a link between uncertainty and vertical integration.

3. VERTICAL INTEGRATION VS. CONTRACTUAL SOLUTIONS TO THE HOLD-UP PROBLEM

3.1. Does vertical integration eliminate the hold-up problem?

The fact that hold-up could have a significant negative effect on relationship-specific investments does not mean that industries where upstream investment tends to be quite

specific to either the industry or to a particular bilateral relationship will necessarily be characterised by a large degree of vertical integration. There are two reasons for this.

First, vertical integration does not necessarily improve upstream incentives to invest either because vertically integrated divisions still fail to behave as a single firm or because the degree of integration required to address the hold-up issue is quite large. If the degree of vertical integration required to address the hold-up problem is high, then the many costs associated with integration (e.g. lack of flexibility, bureaucratic in-fighting between divisions for control of corporate resources) are also high. Secondly, relationship-specific investments can typically be handled quite effectively through a combination of contract design and the appropriate timing of investment.

3.1.1. Do vertically integrated firms truly behave as a single unit?

At the heart of the hold-up problem is one party’s desire to exploit the weaker bargaining position that the investor finds himself in once part or all of the investment has been sunk. This ex post (re)negotiation shifts rents away from the investor and towards the other party, weakening incentives to invest. If both the upstream and downstream units are part of the same firm, they should in principle both strive to maximise the overall profit of this firm. The downstream unit would therefore have no incentive to “ambush” the upstream unit since this would lead to sub-optimal levels of investment.

In practice, however, vertical integration is not necessarily a fool-proof warranty against hold-up. This is because, for a multitude of reasons ranging from compensation policies to promotion prospects to simply human nature, different parts of a single company do not necessarily work in perfect unison. The very need to integrate different parts into a single firm creates scope for internal conflicts over corporate resources that may result in inefficient rent-seeking behaviour.[9] Moreover, integration of the ownership of tradable assets cannot solve the problem if the source of potential hold-up is control of human capital as employees can also hold-up their employer. For an illustration, see the discussion in section 5.1.1 of the case of the Fisher brothers after they sold their car body company to General Motors.

3.1.2. The downstream market share of the integrated firm matters

The extent to which vertical integration might help preserve investment incentives also depends on the *degree* of vertical integration, and what part of the downstream market is accounted for by the downstream unit of the vertically integrated firm (and more generally the environment in which the integrated firm operates[10]).

For simplicity, let us consider the simple case where ex ante contracts are simply not enforceable. Negotiations therefore only take place after the investment has been made. Returning to our running example – and neglecting for now competition between downstream users – let us ask how the expected pay-off of the upstream investor changes as we progressively increase the market share of its downstream subsidiary. Define this market share as Y (which is therefore a number between 0 and 1). Because of this market share, the upstream firm would get downstream profits equal to XY from using the

9 See Milgrom and Roberts (1990).

10 See, for example, Harrigan (1986).

technology in its own subsidiary. However, this profit does not have any direct impact on the pay-off of the investor: vertical integration does not increase the total surplus generated by the investment and does not therefore affect the pay-off of each of the two bargaining parties *unless it modifies the disagreement pay-offs of one of the two parties*. In essence, if vertical integration does not modify the bargaining strength of the parties, then the investment-related profits of the downstream arm of the vertically integrated firms are just part of the payment obtained by this firm, which is unchanged; and the effective payment made by the independent downstream firm is reduced accordingly, leaving the total unchanged.

So, does vertical integration affect the relative bargaining positions of the parties? For the independent downstream firm, the answer is clearly no: if there is no agreement, it simply does not get to use the technology. Its disagreement pay-off is therefore the same whether or not the upstream firm is vertically integrated.

Now consider the integrated firm. Assume that the firm does not reach an agreement with the independent downstream firm. It then has two options: it can decide to dispose of the newly built infrastructure and get the "salvage" value S, or it can decide to only use the infrastructure for its own subsidiary, therefore capturing an additional value XY[11]. The bargaining position of the vertically integrated firm is therefore only changed if the "vertical exploitation" option dominates the "salvage" option. In our example, we have X = 130. If we assume the downstream share of the integrated firm to be Y = 30%, then XY = 39%. It is therefore only if the salvage value of the investment is less than 39% of its investment cost that vertical integration would matter *at all*.

To give a better idea of the order of magnitudes involved, Table 1 contains a tabulation of the percentage increase in the reward of the vertically integrated investor with a downstream market share of 30%, as the proportion of the investment that is sunk at the time of negotiations increases from 0.25 to 1. As just explained, vertical integration does not generate any additional incentives to invest as long as the proportion of the investment that is sunk is smaller than or equal to 0.61 (i.e. the complement to 0.39). For a higher proportion of sunk cost, vertical integration would only increase the reward from investment by 9%. The table below reports the percentage increase in investment-related revenues as a function of the degree of specificity of the investment. We see that *vertical integration has no effect on investment revenue – and hence on investment incentives up to the threshold of sunk cost which we have just defined*. *Beyond this threshold, the additional investment incentive due to vertical integration increases as the proportion of sunk cost increases. It is only if the whole investment is sunk that the vertically integrated firm's investment-related income would increase by a percentage equal to its downstream market share.*

11 If we did allow for competition downstream then the downstream firm would capture XY plus an additional pay-off equal to the value of the market share which it could steal from its rivals because it is the only one to have access to the new infrastructure. Notice, however, that this additional effect would come from de facto discrimination against unintegrated rivals, and is not therefore an effect that should be put on the "positive" side of vertical integration. Put differently, it would seem odd to give credit to a strategy that essentially gets better terms from downstream rivals by threatening them with facing a more competitive downstream harm of the integrated firm.

Table 1. Investment Incentives and vertical Integration

	Percentage of Investment Cost Sunk					
	0.25	**0.5**	**0.61**	**0.75**	**0.9**	**1**
Increase in investment revenue	**0 %**	**0 %**	**0 %**	**+ 9 %**	**+ 20.7 %**	**+ 30%**

So we see that, *unless the quasi-totality of the investment can be considered as sunk, the current level of vertical integration would not increase the reward to investment very substantially.*

3.1.3. Remark on the time dimension of sunk costs

When judging what might be a realistic value of the salvage value of investment, S (relative to the whole investment cost of 100), it is important to realise that sunk costs have a significant time dimension. After the upstream firm has completed a given infrastructure investment, it might well be that most of this investment is of little value if downstream companies decide not to use it. Some of the equipment might be redeployed for other uses but such alternative opportunities might be rather limited, suggesting a low value for S. This, however, would not be the right approach.

The correct approach is to ask how much of the total investment would be sunk *by the time solid contracts can actually be written and signed.* The whole hold-up issue stems from the parties’ inability to write sufficiently complete contracts that they can be confident to enforce. A major reason that makes writing such contracts difficult is that, at the start of the process, it is rather difficult for companies on both sides to know and describe exactly what kind of facilities the investment will lead to. However, as the upstream company proceeds with the investment, there comes a time where this ambiguity is mostly resolved so that proper contracts can be entered into. What matters for the hold-up argument, then, is the *proportion of the investment that has already been sunk once this stage of the process is reached.* So, for example, if parties can sign enforceable contracts when the upstream firm has invested 60 of the total cost of 100 and the salvage value of the 60 already invested is 20, then the relevant measure of sunk cost is 60 – 20 = 40 (i.e. 100- S = 40). Once this is understood, it becomes clear that, in our numerical example where the upstream firm has a 30% share of the downstream market, the degree of vertical integration would only significantly increase investment incentives under rather extreme assumptions.

3.1.4. A remark on vertical integration and hold-up

Does the effect of the upstream firm’s integration on its investment incentives go hand-in-hand with the risk of anti-competitive conduct that this vertical integration raises? In other words, does more vertical integration mean greater anti-competitive concerns, but also a better picture on the investment side?

In fact this is not straightforwardly the case. It is true that, as we have just seen, greater vertical integration tends to increase the upstream unit’s incentives to invest – though such increases are material only under certain conditions. On the other hand, because the vertically integrated firm has an incentive to disadvantage all of its downstream rivals, its downstream arm would “collect” most of the diverted customers even if it does not hold a dominant share downstream. The integrated firm’s incentives to disadvantage downstream

rivals are therefore not directly linked to its market share downstream. Our discussion thus shows that, under realistic conditions, *the additional investment benefits that might accrue because of vertical integration are likely to be rather small compared to the potential harm.*

3.1.5. Further insights from the property rights theory

The role of asset ownership

Although the property rights theory also looks at the issue of “hold-up” in a context where complete enforceable contracts cannot be written, it differs from transaction cost theory in important respects. Most importantly, instead of defining the firm as the set of transactions that are carried out internally, the property rights theory defines it in terms of asset ownership: a firm is simply a set of assets under common ownership/control.

The importance of asset ownership is that the asset owner becomes the “residual claimant”, i.e. the party that gets to decide when issues or events not specified in the contracts arise. Because of this right to decide on anything that the initial contract did not foresee, the asset-owner has greater bargaining power than the other party in any ex post renegotiation situation, ensuring that asset-owners get a larger share of the rents. This means that it is efficient to allocate asset ownership to the agent whose actions (e.g. investment) have the largest impact on the joint surplus of the parties, and/or whose actions are the most susceptible to non-contractible events.

The property rights theory therefore paints a significantly more complex picture of the relationship between conditions that are favourable to hold-up and vertical integration. For example, it would predict that *forward* vertical integration (i.e. acquisition of downstream assets by the owner of upstream assets) would be optimal if the upstream assets create the bigger part of the joint vertical surplus, are more specific than downstream assets and/or are more difficult to describe contractually than downstream assets. Indeed, the wrong kind of vertical integration (say backward rather than forward) might hurt the joint performance of the parties rather than improve it.

Overall, *the property rights theory does not support the broad proposition that an upstream firm should acquire a downstream firm simply because the upstream firm must make relationship-specific investments*.

3.2. Do contracts provide effective solutions to the hold-up problem?

The hold-up literature tells us that, in the absence of credible ex ante contracting, an upstream firm would have insufficient incentives to invest in projects which have limited value outside of a specific sector or outside of a specific vertical relationship. As we have just seen, this does not mean that vertical integration would necessarily be helpful, especially if the downstream share of the vertically integrated firm is limited. In this section, we review another crucial condition that must be satisfied for hold-up to call for any amount of vertical integration, namely that *effective ex ante contracts cannot be found.*

3.2.1. Theory

There is a very large theoretical literature proposing a variety of schemes that can either eliminate or seriously reduce the negative effect that hold-up issues might have on the level of investment undertaken.

On the theoretical side, Rogerson (1992) shows that, quite generally, the hold-up problem can be solved contractually if sufficiently complex contracts can be enforced and there are no externalities between parties.[12] The contracts required *do not* need to specify the level of investment and the corresponding reward for the investor in a complete manner. In that sense, once contractual possibilities are taken seriously, the hold-up problem does not necessarily have a substantial effect on investment incentives. In a sense, this paper and its followers show that one cannot simply start from the premise that the hold-up issue is large and can only be solved through vertical integration.

Less general, but simpler, solutions to the hold-up problem have been investigated in a more recent literature. The general gist of this literature is that the hold-up problem can be reduced by co-development, the use of long term contracts, shifting a significant proportion of the user's payment upfront and/or providing significant quantity discounts.[13] In a co-development agreement,[14] the upstream firm shares the ex ante cost of investment with one or more of the downstream firms. This can be in exchange for access to a certain share of the resulting infrastructure (freely or at a pre-specified price). In a sense, such an agreement effects some form of investment-specific "vertical integration" between the upstream party and downstream firms. However, as long as the upstream firm retains the right to set the conditions for access to firms that chose not to take part in the co-development agreement, this arrangement does not create incentives for vertical foreclosure, as actual integration between the upstream firm and some downstream competitors would.

A variant on co-development – which involves some joint steering of the investment project – are long-term contracts where a significant proportion of the lifetime payment is made up-front. Since this portion of the payment is therefore "sunk", such an approach "levels the playing field" by making both the upstream investor and the downstream user(s) subject to hold-up (see section 2.2.4. above). There are however two potential competition policy issues with such contracts. First, they lock users in for significant time-horizons, which would have a negative effect on rivals aiming to produce inputs that compete with those provided by the upstream firm. Secondly, shifting payments towards the beginning of the contract might create an entry barrier for smaller users. A possible solution to this second problem would be to require that a proportion of available capacity be reserved to firms that do not sign long-term contracts. The price of access for these firms would be left to the (non-integrated) upstream investor.[15]

The literature has also shown that the timing of investment matters. For example Pitchford and Snyder (2004) show that the first best level of investment can be reached if investment takes place gradually over time. In the same vein, De Fraja (1999) also shows that the hold-

12 These are *horizontal* externalities, i.e. externalities between upstream firms or between downstream firms. The issue of externalities between downstream firms is discussed further in the section on "Anchor Tenancy".

13 In some cases a sequence of short-term contracts can be a good substitute for a long-term contract. For a theoretical study of the conditions for the equivalence of the two approaches see Fudenberg *et al.* (1990). They show that the equivalence holds exactly if the relevant public information is verifiable, parties have equal access to capital markets and have common knowledge about technology and preferences when they re-negotiate the short-term contracts.

14 See Santoro and McGill (2005).

15 See Inderst and Peitz (2014) for a related scheme.

up problem disappears if both parties need to make specific investments and must do so sequentially. The general idea behind these papers is that with investment spread out over time, investors can rely on the threat of not continuing the investment program unless they get an appropriate remuneration for the part of the investment already carried out. In situations where investments are on both sides and there is no "once and for all" discrete investment, these papers would be the most relevant.

More drastically, maybe, Noldeke and Schmidt (1995) show that the hold-up problem disappears entirely if the parties can agree on *option contracts*. Such contracts give the seller the right (but not the obligation) to deliver a fixed quantity of the good, and make the buyer's contractual payment contingent on the seller's delivery decision. To the extent that the mechanism probably generalises to situations where the contracts specify conditions of access rather than the simple sale of a "unit" considered by the authors (which seems likely), such option contracts would also be a reasonable approach in our context. Notice, however, that for such a solution to work well, one would have to be sure that the upstream firm is *effectively* separated from any of the downstream competitors. Otherwise, since the option contract gives the upstream firm the power to effectively veto access to the inputs resulting from the investment ex post (i.e. the option contract does not *oblige* the upstream firm to deliver), there would still be an incentive and ability to foreclose or at least disadvantage some downstream firms.

Finally, Aghion, Dewatripont and Rey (1994) show that the underinvestment problem due to hold-up can be solved if the initial ex ante contract between parties can specify some minimal (enforceable) rules for any subsequent renegotiation. In their precise mechanism, those rules include the allocation of all the bargaining power for renegotiation to either one of the parties and the specification of a pre-determined outcome if such renegotiations break down.

These are just a few of the contractual arrangements that help avoid the underinvestment generally associated with specific investment and the ex post renegotiations to which they are vulnerable.[16] Taken as a whole, *what the theoretical literature implies is that one should not necessarily expect hold-up problems to require <u>any</u> amount of vertical integration.* Contracts are very flexible as to their scope, time horizon, timing and payment schemes and are therefore well-armed to deal with most asset-specificity problems. Moreover, contrary to the "textbook" presentation of the hold-up issues, contract enforcement is generally robust even beyond the letter of formal contracts, and reputational concerns are typically able to discipline firm behaviour quite effectively. The behaviour of car parts suppliers in the automobile industry discussed in Section 5 below is especially revealing in this respect: their control over the supply of critical automobile parts would appear to give them strong ex post leverage over the car manufacturers they serve, but typically they do not try to exploit this power as they would then be shunned by all car manufacturers; it is only when a parts supplier goes bankrupt (and thus can no longer care for long-term reputational benefits) that we observe attempts to renegotiate contracts opportunistically and, even then, the courts may prevent them from getting away with it.

16 For example, McLeod and Malcomson (1993) look at the role of "elevator clause" and "take or pay" contracts with both single-sided and multi-sided hold-up. Edlin and Reichelstein (1995) also obtain reasonable conditions under which standard remedies for breach of contract can ensure optimal investment levels with one sided or two sided hold-up

In this perspective, we provide in Section 4 below a review of the existing empirical literature on hold-up and vertical integration. While vertical integration is sometimes observed in extreme cases (e.g. Bauxite ore and aluminium mill) vertical integration as a response to hold-up is actually *not* prevalent. Indeed, the available literature strongly suggests that non-vertical integration solutions work well enough to be preferred in practice. For example, Joskow (1987) looks at the market for coal and finds that both buyers and sellers make stronger contractual commitments to future terms of trade and rely less on repeated bargaining (use longer contracts) when specific investments are important. This shows that, while specific investments do indeed matter, parties are often satisfied with contractual solutions that fall well short of vertical integration

3.2.2. The "anchor tenant" argument

It is useful to go back to the origin of the term "anchor tenant". This originally reflected the desire of property developers to obtain a commitment to one or more sizeable tenants at an early stage in the property-development process. The main idea behind "anchor tenancy" has thus nothing to do with vertical separation or integration: the "foundation" tenants sought by property developers are not owned by the developer himself. On the contrary, the very fact that anchor tenants are indeed common – but are not owned by the corresponding upstream firm – proves that contracts can often handle investment issues in vertical relationships perfectly well without any need for integration.

There are four main types of reasons for seeking anchor tenants: relaxing financial constraints, attracting other tenants, sending a positive signal to financial markets and ensuring adequate monitoring of the venture. We consider each briefly below.

Relaxing a financial constraint

If the developer/investor does not have access to sufficient finance on its own, obtaining partial pre-payment from significant potential clients may be a necessary condition for the investment to be carried out at all. Note, however, that this rationale applies as well to a number of small tenants (private buyers purchasing their apartment "on paper") as to large users. In other words, this is not an argument for the presence of a single anchor tenant of significant size. A variant of this argument relies on the fact that, as the advances received from tenants can be used as collateral, they usefully lower the borrowing costs of the investor even if full funding could have been raised without early tenants.

This argument does not of course apply when the firm planning the investment is adequately self-financed and/or can already raise capital at attractive terms. Moreover, this argument actually goes against using a downstream subsidiary as an anchor tenant since such a subsidiary would not add to the firm's overall access to funding.

Attracting other tenants by creating positive externalities

It is well-known that commercial malls need to attract a few well-known "names" early on if they want to succeed. This is because "footfall" at the mall depends on the overall attractiveness of the local offering. Having well-known brands on sites guarantees a minimum level of consumer traffic, and therefore helps convince other stores to also locate there, starting a positive snowball effect.

Support for such "footfall" benefit can be found in the vast literature on network externalities as well as in the related literature on the local "agglomeration" of (related or unrelated) businesses. For example, Schulz and Stahl (1996) examine the optimal pricing policy of

“mall” developers attempting to attract tenants. There is also a very large number of papers dealing with agglomeration effects and how to foster them in the field of Economic Geography. The network externality version of the “Anchor Tenant Hypothesis” has also been studied empirically in a number of industries other than real estate.

A key feature of this mechanism is that the very fact that some downstream firms would use the infrastructure that would result from the proposed investment increases the likelihood that others would as well. This effect should be direct, i.e. it should not be confused with the normal effect of downstream competition which we have already discussed, where the fear of being at a competitive disadvantage with respect to other downstream firms who get access to the facility increases a downstream firm’s incentive to pay for access as well.

Reducing the cost of uncertainty

Large real estate projects – just like most significant investment projects – face significant uncertainty. Will the demand for the amount and type of accommodation provided really materialise? The presence of anchor tenants might, under some conditions, help alleviate such demand-side uncertainty.

1. Credible transmission of private information

This uncertainty is especially acute for lenders who have little expertise in the real estate market and/or in the business in which potential tenants are involved. Landing one or more major tenants helps alleviate this uncertainty. Since these users are likely to be better informed about the state of the relevant demand, their participation credibly reveals that demand conditions are likely to be favourable.

2. Further considerations on uncertainty

A recent paper by Inderst and Peitz (2014) analyses a situation where an investor who will provide access to third parties faces two types of uncertainty: (i) whether it will be able to pass on investment costs to downstream firms that seek access to its infrastructure; and (ii) whether the products offered on the basis of new technologies will be successful with consumers, thus creating sufficient demand to make the investment profitable. While the first type of “uncertainty” refers to the traditional “hold-up” problem, which is discussed below, the second source of uncertainty is precisely of the type for which an anchor tenant might help. However, the authors present potential contractual solutions (from quantity discounts to prepayment for reserved capacity or option contracts) that help deal with such uncertainty, suggesting again that the mere presence of an investment-related problem should not automatically lead to the conclusion that vertical integration is needed.

Certification/monitoring

Just like small shareholders trust larger ones to monitor the actions of management, smaller tenants *might* be comforted by the knowledge that a few large tenants will be keeping a close eye on the development of the property/investment project. However, just like the financial constraint argument, this line of reasoning explicitly goes *against* the desirability of vertical integration since a subsidiary cannot be trusted to effectively monitor the actions of the upstream arm of the same firm.

4. INSIGHTS FROM THE EMPIRICAL ECONOMIC LITERATURE

There is unfortunately no broad measure of the prevalence of vertical integration – such as for example the share of national output produced by vertically integrated firms. The reason for this is simple: every firm which performs more than one simple narrow task is vertically integrated to some extent. Taking an extreme case, a car manufacturer is vertically integrated if it produces not only a chassis but attaches wheels to it. This makes it impossible to broadly define which firms should count as "integrated" and which firms should not, at least at the level of the economy as a whole. This is why empirical research on vertical integration has been conducted at the level of specific industries, where sufficiently clear measures of integration can be obtained. In this section we briefly review the insights form this theory.

4.1. Vertical integration, asset specificity and complexity

The existing body of empirical work analyses both *forward* integration and *backward* integration. For our purposes, one should think of integration being "forward" when it is motivated by the upstream firm's desire to guarantee itself a downstream outlet for its own output/infrastructure, while we speak of "backward integration" when the main concern is for the downstream firm to ensure a supply of some specific input(s) (or access to some specific infrastructure).

A large proportion of the literature on forward integration has relied on the use of franchising in service and retailing businesses. As franchisors can own any proportion of their franchisees (from owning all of its branded retail outlets to none), it is possible to obtain a continuous measure of the degree of vertical integration and relate it to various factors that economic theory has identified as important determinants of the integration decision.

This literature unambiguously finds that factors that tend to give rise to hold-up have a positive impact on the degree of vertical integration. In particular, the following two tables – adapted from Lafontaine and Slade – show that greater capital specificity and greater complexity are systematically associated with more vertical integration. So, if we assume that this association actually reflects a causal effect of specificity and complexity on vertical integration and that firms make efficient integration decisions, this literature does provide evidence that vertical integration can be an effective response to conditions that tend to exacerbate the hold-up problem.

The empirical strategy for the study of backward integration is more varied. One strategy, pioneered by Monteverde and Teece (1982) and Masten (1984) considers a single firm but distinguishes between a large number of inputs needed by the firm. Classifying these inputs in terms of specificity and complexity, these authors can then relate these characteristics to the firm's decision to buy the input at arm's-length or to produce it internally. The second strategy consists of exploiting the variation across firms in terms of the degree of asset specificity and complexity that they face. This literature also finds strong evidence that the degree of vertical integration is linked positively to asset specificity and complexity – and hence to the likelihood that separate units would face significant hold-up issues – as shown in the tables below (adapted from Lafontaine and Slade, 2007).

Table 2: Vertical Integration and Physical Capital Specificity

Authors	Date	Industry	Relationship
Masten	1984	Parts & Aerospoace	+*
Masten, Meehan and Snyder	1989	Parts & automobiles	+
Lieberman	1991	Inputs into Chemicals	+*
Masten, Meehan and Snyder	1991	Ship-Building	+
Lyons	1995	Inputs into Engineering Firms	+*

(*) indicates statistical significance.

Table 3: Vertical Integration and Complexity

Authors	Date	Industry	Relationship
Monteverde & Teece	1982	Parts & Automobiles	+*
Masten	1984	Parts & Aerospace	+*
Masten, Meehan & Snyder	1991	Ship-Building	U shaped*
Woodruff	2002	Footwear & Sales	+*
Forbes & Lederman	2005	Airlines	+*
Acemoglu, Aghion, Griffith & Zilibotti	2005	Manufacturing Plants	Upstream -* Downstream +*
Gil	2007	Movie Distribution	+*
Hartacsu & Syverson	2007	Manufacturing Plants	+*

(*) indicates statistical significance

4.1.1. Weaknesses of the available empirical evidence

The sets of empirical evidence on both forward and backward integration reviewed above suffer from similar drawbacks.

Measurement issues

The first problem is one of *measurement.* On the left-hand side of the regression, the measure of vertical integration itself is an issue as where one draws the line between vertical integration and a strong web of long term contracts is ultimately rather arbitrary. Right-hand side (explanatory) variables are even more problematic. For example, as discussed by Bresnahan and Levin (2012), many authors use measures of technological complexity, where measures of contractual complexity would be more appropriate. As the authors mention, mainframe computers are very complex items, yet they trade readily

between unconnected entities. The degree of specificity of various components or investment is of course itself quite difficult to measure precisely.

Interpretation

The second issue is one of *interpretation*. There are several difficulties. First, most of these studies ignore the broader market context in which the firms operate. This creates possible bias due to omitted variables, i.e. to market equilibrium features that might also be responsible for the observed pattern of trade between firms and their input suppliers. For example, many studies fail to control for the availability of alternative suppliers or the degree of competition between potential users. Socio-cultural context also matters: faced with the same objective “specificity” and “complexity” factors, Japanese firms do not choose the same organisational forms as US firm, making it difficult to get a clear idea of what can actually be attributed to the threat of hold-up.

Secondly, as we mentioned above, the empirical implications of the property rights theory are rather different. Rather than predict a coarse relationship between “factors that favour hold-up” and “vertical integration”, the property rights literature has more precise predictions that link these factors *as well as other elements of the contractual and economic environment* to *either* forward or backward integration. From the point of view of this theory, then, the broad correlations obtained between vertical integration and factors favouring hold-up do not tell us much as to whether vertical integration is indeed a (good) response to hold-up.

Thirdly, the positive correlations which are obtained do not actually tell us much about the *relative performance* of vertical integration and contracts designed to deal with hold-up. It might be that when factors related with hold-up are present, some firms which would otherwise have used neither vertical integration nor complex contracts designed to handle hold-up choose to vertically integrate, while others choose to go the contractual route. Indeed, we would still get a strong correlation between likely hold-up and vertical integration even if a relatively small proportion of firms facing a risk of hold-up decided to react by integrating.

The relevance of this drawback is reinforced by a related strand of the empirical literature which looks at the link between factors that can reasonably be associated with the likelihood of hold-up and *contractual features* – such as contract length, upfront payments or option contracts – which, according to the theory, could also be effective solutions to the hold-up problem. For example, the classic study of Joskow (1987) shows that the relationship between electrical utilities and nearby coal suppliers is handled through long-term contracts with a variety of clauses aimed at dealing with potential hold-up issues. More recently, Barthélémy and Quélin (2006) also find a strong link between measures of complexity and specificity and contractual clauses designed to handle the hold-up problem. Since the empirical literature only tells us that both vertical integration and more complex contracts seem to be natural responses to hold-up, it really does not say much about the conditions where contractual solutions alone would not suffice.

Order of magnitude

As emphasised by Bresnahan and Levine (2012), most of the empirical literature does not give us any idea of the *magnitude of the effects involved*: firms presumably integrate because it is profitable to do so, but how large are the benefits reaped? Unfortunately, few papers look at this issue. Moreover, those that do find that the gains from vertical integration

are mainly linked to factors, such as greater coordination or the leveraging of intellectual assets, which are not related to the hold-up problem.[17]

Interestingly, we are aware of one experimental study of contractual response to the hold-up problem.[18] The authors of this paper conclude that "option contracts significantly improve incentives" suggesting that vertical integration might not in fact be needed.

4.2. Econometric studies on upstream and downstream uncertainty

As we saw in Section 3, what we know about a possible link between vertical integration and uncertainty comes from three different strands of literature. The empirical work on the topic partially reflects this. Empirical works organised around Principal-Agent models tend to focus on forward integration, while work based on Transaction Cost theories or on Property Rights theories mostly focus on backward integration.

4.2.1. Principal-Agent

We have seen that the Principal-Agent literature predicts that *greater uncertainty about the downstream market makes vertical integration more efficient and therefore more likely*.

Lafontaine and Slade (2007) review the empirical literature on the relationship between downstream market uncertainty and the extent of vertical integration. The following table, summarising existing empirical studies, is adapted from their paper:

Table 4: Effect of downstream uncertainty on the extent of vertical integration

Authors	Year	Industry	Impact of downstream uncertainty
Anderson & Schmittlein	1984	Electronic Components & Sales	-
John & Weiz	1988	Industrial Goods & Sales	+
Martin	1988	Retail & Services	-*
Norton	1988	Restaurants and Motels	Restaurants +, Motels -*
Lafontaine	1992	Retail & Services	-*
Lafontaine & Bhattacharyya	1995	Retail & Services	-*
Woodruf	2002	Footwear & Sales	-*

(*) Indicates statistical significance

We see that, contrary to the predictions of the Principal-Agent theory, the only significant results are those for which greater uncertainty downstream is associated with *less* vertical integration. Lafontaine and Slade also review the empirical literature on backward vertical

17 See Atalay et al.(2012), Jortacsu and Syverson (2007).

18 Hoppe and Schmitz (2011).

integration. This part is based on both the transaction cost and the property rights approaches to vertical integration.

4.2.2. Transaction costs and property rights

We saw that the transaction cost theory also predicts that *greater uncertainty should be associated by a greater prevalence of vertical integration* while the property rights literature offers no such unambiguous prediction. The results of relevant empirical studies are summarised in the following table, which is again adapted from Lafontaine and Slade (2007).

Table 5: Effect of Uncertainty on (mostly backward) Integration

Authors	Year	Industry	Relationship
Walker & Weber	1984	Parts & Automobiles	+*
Lieberman	1991	Inputs to Chemical Products	Upstream uncertainty +* Downstream Uncertainty -
Hanson	1995	Apparel Manufacturers & Suppliers	+*
Gonsalez-Diaz, Arrunada & Fernandez	2002	Construction Fiirms & Contractors	-

(*) indicates statistical significance

While the empirical literature appears to confirm the theoretical prediction, this support is weak. We also note that, in the single case where upstream and downstream uncertainty were treated separately, greater uncertainty in the downstream market was not associated with a greater tendency to vertically integrate.

We also saw that the property rights literature does not offer easy predictions for a link between uncertainty and vertical integration arguing that the link between the two variables should depend on a number of factors that might be difficult to measure. Of course the absence of predictions does not mean that the property rights literature is irrelevant. Indeed, the very fact that that literature suggests that vertical integration should be influenced by a number of more subtle factors that are not accounted for in existing empirical work might explain why this work has remained so inconclusive as to any potential link between vertical integration and uncertainty.

Overall, then, *both theory and empirical work produce ambiguous results about a potential relationship between vertical integration and uncertainty. Indeed, when it comes to forward integration and uncertainty on the demand side (i.e. in the downstream market), the weight of evidence is that greater uncertainty is not associated with greater vertical integration. The claim that uncertainty about downstream markets can be best alleviated through integration is not therefore remotely supported.*

5. INSIGHTS FROM THE EXPERIENCE OF MULTIPLE INDUSTRIES

In this section we now consider a number of "mini case studies" on a range of industries and markets, with the objective of evaluating how concerns about hold-up and underinvestment have been dealt with in practice. As will become apparent, in the real world, a plethora of contractual solutions have been devised and put in place as an alternative to vertical integration.

5.1. A classic study of hold-up: car manufacturing and GM-Fisher Body

A version of the hold-up issue is the so-called "make vs buy" problem: should a manufacturer purchase an input which is specific to its product from an outside source – exposing himself to hold-up – or should the input be made inside the firm? The car industry has featured most prominently in discussions of the relative merits of alternative solutions to this "make-vs-buy" problem. The classic reference in the economic and business literature is the relationship between General Motors (GM) and Fisher Body Corporation (FB) in the early part of the 20th century. For many years since the classic Klein, Crawford and Alchian (1978) paper,[19] the 1926 acquisition of FB (a car-body manufacturer) by GM has been seen as the paradigmatic case of vertical integration as a solution to a hold-up problem. However, more recent scholarship has fundamentally changed this view, challenging the relevance of hold-up problems for that case.[20]

After a brief summary of the main facts, we discuss the various interpretations of those facts found in the recent literature. In sum, it appears that efficient contractual solutions for hold-up problems in this industry *are* typically available and that vertical integration was mainly motivated by other factors, such as the need to coordinate production and information flows. Finally, we briefly discuss contractual issues in the automobile industry in general.

5.1.1. A brief history of Fisher Body

At the beginning of the 20th century, car manufacturing required the assembly of three major components:

> *"First, there was the chassis, a rigid frame on which was attached the front wheels and steering mechanism. The second major component was the drive train. It consisted of the engine, transmission, and a drive shaft connected by a differential gear to the rear wheels. The third component, the car body, was mounted on the chassis. In the early part of the century, the car body could be anything from an upholstered seat anchored on wooden floorboards to a closed body made of sheet metal." (Baird (2003), p. 3)*

The Fisher Body Corporation (founded in 1916 and owned by six Fisher brothers) was the largest producer of car bodies in the US, especially of closed car bodies which were soon

19 See also Klein (1988a).

20 See Freeland (2000), Casadesus-Masanell and Spulber (2000), Baird (2003). The strongest critic of the hold-up interpretation of GM-FB (and more generally of asset specificity and hold-up theories of vertical integration) has been Nobel laureate Ronald Coase – see Coase (2000, 2006) as well as his 1987 lectures published as Coase (1993). For the evolution of Klein's view on the GM-FB case, see Klein (1988b, 2007).

to become the standard design in the industry).[21] FB specialised in "composite" car bodies (i.e., wooden frames covered with sheet metal that did not require expensive specialized dies and presses) and served all major car manufacturers, including GM which bought all their closed bodies (and some of the open ones) from FB.

In 1919 GM took a 60% ownership share in FB. This investment in FB was part of a wider contractual arrangement in which GM committed to an exclusive dealing with FB for practically all its car bodies requirements, and agreed to a cost-plus pricing formula in which GM would pay a mark-up over all FB costs, including fixed costs, depreciation and interest in proportion to GM's share of FB's business. FB could sell car bodies to other manufacturers, but GM was granted "most favoured customer" status (i.e., if FB sold comparable car bodies at lower prices to any other car manufacturer, the lower prices would also apply to GM).[22] The contract was for 10 years and included a provision for GM's 60% share to be held for 5 years in a trust where the Fisher brothers and GM had equal voting powers, thus *de facto* ensuring that the Fisher brothers retained control of the company.[23] As part of the 1919 deal, all Fisher brothers joined GM and signed up to employment contracts which included bonus payments of 5% of FB's (not GM's!) profit.

Around 1922 relations between FB and GM suffered a setback when a dispute over plant locations arose. As GM's sales of its (closed body) Chevrolet brand increased dramatically in 1921-22 FB was asked to build additional plants near the Chevrolet ones, but FB wanted to expand its capacity in Detroit. Eventually GM agreed to pay all the cost of building several FB plants in the desired locations – a very favourable deal for FB whose mark-up over costs for those plants became pure profit. In 1924 – the year when both the trust provisions for GM's 60% and the Fisher brothers' employment contracts with GM expired – the GM-FB contract was renegotiated and the pricing formula was modified to reflect internal GM transfer price principles (see Freeland, 2000). The employment contracts of the Fisher brothers were also renegotiated, with bonuses tied to GM's performance (rather than FB's) through 1929, and with the two senior brothers leaving FB to work fulltime for GM.

New tensions appeared in 1925 when GM sales fell by about a quarter while Chrysler and Hudson (both using FB closed bodies) increased their sales significantly. This prompted GM to reassess its marketing and production strategy (e.g., moving to synchronized yearly versions of its models, stronger focus on closed body cars) that put FB's capacity under strain. Location choice continued to be a thorny issue, especially in relation to GM's request for a new plant in Flint, Michigan, to produce car bodies for the local GM-Buick operations. Once again FB was reluctant to make the investment near a GM plant, even though it was at the time expanding its Detroit capacity to serve growing demand from Chrysler.

Finally, GM acquired the remaining 40% of FB shares in May 1926 and dissolved FB which became the Fisher Body division of GM. The Fisher brothers nonetheless preserved a tight grip on Fisher Body. While formally a mere GM division, they had "purposely kept the Fisher Body organization more or less apart and independent of General Motors with regard to its

21 Baird (2003) cites Alfred P. Sloan's autobiography for these shares.

22 Coase (2000) provides further information and claims that the exclusivity deal and the pricing formula were already present in a 1917 contract. See Appendix A of Klein (2007) for the text of the pricing clause in the 1919 contract. Goldberg (2008) reports parts of the contract related to GM's and FB's obligations.

23 See Friedland (2000) and Coase (2000).

management, so much so … that the others in General Motors were none too familiar with the body end of the business".[24] This allowed them to credibly threaten to leave GM *en masse* in 1934 and obtain a large payout in the form of options on GM stock – something that GM considered as "almost a hold-up" and led it eventually to take closer control of the Fisher Body operations.

5.1.2. Hold-up stories for Fisher Body

The economic and business literature has debated the case extensively, with much of the controversy arising from factual errors in Klein et al. (1978) and Klein (1988).

Justifications for the 1919 deal

Klein claimed that the 1919 contract was meant as an attempt to solve the problem of a potential hold-up of FB by GM:

> *"In order to produce automobile bodies for General Motors, Fisher Body had to make an investment in stamping machines and dies that was highly specific to General Motors. Fisher Body's investment could not be used to make bodies for any other automobile manufacturer. As a result, a significant potential was created for General Motors to hold-up Fisher. In particular, after Fisher Body made its specific investment, General Motors could have threatened to reduce its demand for Fisher produced bodies, or even to terminate its relationship with Fisher completely, unless Fisher reduced its prices. In most cases involving specific investments, transactors attempt to control the hold-up problem by designing their contracts before any such investments are made. In this case the contract adopted by General Motors and Fisher Body included a ten-year exclusive dealing clause which required General Motors to buy all its closed metal automobile bodies from Fisher for a period of ten years. This prevented General Motors from appropriating the rents from the Fisher investment by threatening to switch suppliers of its bodies" (Klein, 1988)*

The initial premise of this account is incorrect, however: there was no need for significant investment in stamping machines or GM-specific dies. Klein (2007) acknowledged this mistake in later papers, but continued to claim that the 1919 deal was "designed to protect significant GM-specific investments made by Fisher Body", namely "the very large expansion in capacity Fisher Body undertook in 1919 to handle the expected General Motors business". While the large cash injection from GM's 60% share acquisition surely facilitated FB's investments, there is no evidence that FB would have had any difficulty in obtaining alternative sources of financing or outlets for any planned capacity increase (or that hold-up considerations were in either FB's or GM's minds). In fact, FB was already in discussions with Cleveland financiers for a new car body company to serve rival car manufacturer Willys-Overland. GM simply outbid the Cleveland group and conditioned the 1919 deal to the discontinuations of negotiations with them (Freeland, 2000).

A more convincing explanation of the 1919 deal is that GM wanted the Fisher brothers to work for GM and not for rival car manufacturers: the (temporarily non-controlled) 60% equity share provided not only funds for FB's investments, but also prevented rivals from acquiring controlling stakes in FB; together with the employment contracts and the "most favoured customer" clause, it guaranteed that GM would not be left behind other FB customers. Far

24 William du Pont, cited by Freeland (2000).

from being an “anchor tenant” that allowed the creation of new capacity that would then benefit other market players, GM stepped in to keep capacity away from them. The other main features of the 1919 contractual arrangement, namely the cost-plus pricing formula and the exclusivity clause, may have been just a natural complement to the long-term (ten years) nature of the deal: they were a *contractual* means to allocate price and cost risks between the parties in the face of the considerable uncertainty facing the industry at the time.

Justifications for the merger

Klein argues that the exclusivity clause in the 1919 contract and the subsequent evolution of the market created another hold-up problem, linked to the location of plants, that was eventually solved by the 1926 acquisition:

> *“Fisher took advantage of the contractual incompleteness in the face of the large demand increase for automobile bodies to adopt an inefficient, highly labour-intensive production process. From Fisher's point of view there was no economic reason to make capital investments when, according to the contract, they could instead hire a worker and put a 17.6 percent upcharge on the worker's wage. In addition, Fisher used the contract to locate its body-producing plants far away from the General Motors assembly plant. There was no economic reason for Fisher to locate their plant close to the General Motors assembly plant when, according to the contract, they could profit by locating their plant far away from the General Motors plant and put a 17.6 percent upcharge on their transportation costs. The result was automobile bodies that were highly profitable for Fisher to produce, but very costly for General Motors to purchase.” (Klein, 1988)*

The claim that FB had an incentive to use inefficient techniques (either from insufficient capital/labour ratios or by inflating transport costs) because of the 1919 contract is incorrect: as admitted in Klein (2007), the contract did include sufficient safeguards against this. Nonetheless, Klein maintained that FB’s reluctance to build new plants next to GM’s Chevrolet plants in 1922 (and next to Buick’s in 1924) was still an example of hold-up that allowed FB to extract significant value from GM in the contract renegotiations.[25]

The hold-up interpretation of the 1922-1924 events is subject to several criticisms.

25 Klein correctly argues (e.g., *contra* Coase) that the fact that FB did eventually co-locate its car-body plants is not evidence against the occurrence of the hold-up: ex post negotiations are likely to be efficient in any case and it is the threat of withholding cooperation that defines hold-up. One might argue that, even if it had been a hold-up (which, as discussed in the text, is dubious), there was no inefficiency involved: ex post because negotiations reached the efficient outcome; ex ante because the problem was not anticipated and thus could not have affected GM’s investments. However, the experience of such hold-up – and the desire to avoid its repetition – could have then motivated the later vertical integration. More generally, firms’ ex ante investment may be suboptimal in similar circumstances because firms anticipate that there may be some unforeseen contingencies that could not be dealt with contractually and that would lead to hold-up situations. Note, however, that unforeseen contingencies are not enough to generate contract incompleteness problems: Maskin and Tirole (1999) show that the relevant payoffs to the parties must also be unverifiable, e.g., because it is too difficult to distinguish between the profits originating from different parts of the business.

First, FB's reluctance could have been a genuine desire to develop its capacity in Detroit and keep it open to customers other than GM – which might even have been a socially more efficient outcome.[26] This has nothing to do with "hold-up".

Second, the concessions obtained by FB in the contract renegotiations may have simply reflected a compensation for operating the new plants at a closer level of integration with the GM ones. Baird (2003) describes how William Knudsen, the new manager in charge of Chevrolet production, pushed for more complete integration with FB:

> *"Fisher could continue to stamp the different pieces of sheet metal at its own factories. These stamped parts, like other auto components, could be shipped at low cost. But assembling the pieces into the automobile body was a different matter. Like a finished car, a completed car body is expensive to ship and more subject to dents and other damage en route. Moreover, storing an inventory of assembled car bodies was a nontrivial problem. […] Fisher could stamp the sheet metal anywhere, but the bodies themselves had to be welded together at a factory adjacent to the auto assembly plant. The two plants were to be connected with a system of dollies and conveyers. […] At each location, Fisher and Chevrolet had to coordinate minute-by-minute operations. A stranger visiting any site would likely not see any separation between Fisher's operations and Chevrolet's."*

This suggests that the desire for integration had more of a Coasean explanation (avoid the need for negotiating and pricing minute-by-minute adjustment to production plans) than a hold-up one. In fact, Baird (2003) provides further evidence that hold-up problems could not have been a major concern:

> *"The cost of shifting the location in Fisher's car body assembly plants required a capital investment of about $5 million. This is a trivial sum compared with Chevrolet's annual operating expenses of half a billion dollars. Body assembly plants, like auto assembly plants, require little more than open factory space and a conveyor system. There is almost no asset specialization. Moreover, it was easy enough for GM to pay for building the facility and then lease the space to Fisher. In short, with Knudsen's arrival at Chevrolet what changed was not asset-specific investment by Fisher in Chevrolet, but rather the way Fisher conducted its day-to-day operations."*

Third, the concessions may have reflected the scarcity value of the Fisher brothers' human capital, i.e., their "natural" market power independently of the exclusivity clause that bound GM. The continued GM interest in tying the Fisher brothers ever closer to GM even post-merger suggests that this was an important factor.

Fourth, it is not clear whether the exclusivity clause would have really prevented GM from having another car body manufacturer co-locating with the Chevrolet plants (assuming there had been one with the required capabilities) if FB had refused to provide the same level of operational flexibility.[27]

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26 Doing both investments in Detroit and next to the Chevrolet plants at the same time might have been beyond FB's managerial capabilities.

27 Goldberg claims that the exclusivity clause was unenforceable in general on the basis that "Fisher did not promise to do anything". This does not seem very convincing (e.g., FB did promise to charge GM no more than its rivals) and is, in any case, contrary to FB's and GM's understanding of the contract – see the response in Klein (2008).

5.1.3. Beyond Fisher Body

It may be useful to contrast the evolution of GM-FB relations with those between GM and its car frame supplier A. O. Smith. As noted by Coase (see his lectures in the Williamson and Winter volume), A.O. Smith used "expensive and highly specific equipment" to serve GM with prices determined by annual contracts and yet this did not appear to pose any significant hold-up problems and did not lead to any form of vertical integration. What was the difference between A.O. Smith and FB then? For Baird (2003),

> *"The answer is straightforward: Completed car bodies (which Fisher supplied) were expensive to ship and hard to store, but automobile frames (which A.O. Smith supplied) can be shipped and stored easily. Efficient manufacture requires coordination of the assembly of the body with the rest of the car. The assembly of the frame requires no such coordination."*

Contractual solutions to the problem of investment in specialised assets by parts suppliers thus worked well for A.O. Smith and appear to have also worked well for the industry in more modern times. In some cases, the solutions may be simple ones, like those governing GM-FB relations in 1919 (e.g., cost-plus pricing formulas); alternatively, car manufacturers can pay for (and own) the specialized tools required for their car models and/or resort to a variety of other contractual provisions.[28]

Moreover, reputational concerns may overcome many of the limitations of contract incompleteness and consequent risks of hold-up: a firm that holds up and exploits its commercial partners may find it very hard to find partners in the future.[29] An indirect evidence of the importance of reputational concerns can be found in the few documented cases in which some suppliers tried to hold-up car manufacturers: these were suppliers who had been put into receivership – hence no longer cared for long run reputational concerns.[30]

The overwhelming conclusion from a careful examination of GM's relationships with its suppliers in the first third of the 20th century is therefore that any hold-up problem – including those linked to A.O. Smith's high level of specific investments – were handled through contractual solutions. The eventual vertical integration between GM and FB had most likely nothing to do with hold-up. Instead it was motivated by an increase in production (not investment) stemming from better daily coordination of part use and delivery and the efficient exploitation of the Fisher brothers' human capital.

5.2. Airports and airlines: an example of contractual solutions to hold-up

A classic rendition of the hold-up problem is often made with reference to the relationship between airports and airlines in the building or expansion of capacity. An airport is a long-

28 See White and Ben-Shahar (2006).

29 White and Ben-Shahar (2006) also stress the role of reputational concerns.

30 Roberts (2004, p. 208) cites the case of "UPF-Thompson, a small British firm that was the sole supplier of the chassis for Land Rover's Discovery model […] KPMG, the accounting firm, [that] was appointed to run the company while exploring a possible sale […]" asked for a massive payment and price increase stating that "Land Rover's reliance on the company is an asset and we need to obtain the best value on the asset". Land Rover eventually obtained a court injunction forcing UPF-Thompson to continue supply. White and Ben-Shahar (2006) cite similar cases involving Delphi with GM and Collins and Aikman with all three major US car manufacturers where the parts supplier was more successful.

term asset which is very specific to the relationship between airport developer (a private or public investor) and airlines. Absent appropriate commitment devices, this relationship can be open to opportunistic behaviour by the airlines if, after the completion of the investment, they renege on their promises, e.g. by reducing the number of aircrafts based at the airport (if there are no other airlines ready to fill the gap). However, hold-up can also occur in the opposite direction: once an airline incurs sunk costs in establishing a base at the airport, the airline's bargaining power is reduced because of the high cost of redeploying assets to a new base. Opportunistic behaviour could then arise after the hub has been deployed: for example, the airport might increase charges or impose schedule restrictions.

The industry has developed a variety of *contractual* models to deal with these issues. Consistent with the theories discussed in Section 3.2.1, forms of anchor tenancy, long-term contracts and co-financing seem to be the most prevalent. There are only a few cases where vertical integration occurred – and then mostly in the form of joint ventures in which airlines own a minority of shares and get partial control of dedicated terminals.

Commercial solutions to the hold-up problem

Long-term vertical agreements are commonly adopted in the industry. The long-term nature of these contracts provides the security that the airport developer needs to sink costs in additional infrastructure, thus reducing the risk of hold-up by airlines. However, long-term contracts can be equally beneficial to airlines because they can lock-in favourable terms and stipulate the quality of service that the airline can expect from the airport. Typically these agreements take the form of "anchor tenancy" contracts, which can cover any or all of the following terms:

- tariffs: airports may offer special rates for handling or landing to their anchor tenants, often to encourage growth of traffic;
- usage guarantees by the airline, usually in return for reduced tariffs;
- commitments about capital spend; and
- terms about various passenger policies: for instance, the "one bag rule" applied by most low cost carriers (LCCs) reduces the retail revenues of airports, and is typically a subject of negotiations in this type of contracts.

In the last decade, LCCs have used these contracts extensively, particularly with secondary airports, which have offered favourable terms to attract their traffic and encourage the airline to invest in airport facilities. Recent examples include a five year agreement signed in June 2013 between Manchester Airports Group (MAG), owner of Stansted since 2012, and Easyjet allowing the airline to more than double its passenger numbers at Stansted. In September 2013, MAG and Ryanair announced a similar agreement for ten years, allowing Ryanair to grow its traffic by more than 50% in return for reduced tariffs and more efficient facilities usage at the airport.[31] Easyjet also has similar agreements in place with

31 CAA, *Market power determination for passenger airlines in relation to Stansted Airport, Appendix C: The business of Stansted Airport Limited*, 10 January 2014.

Luton (the most recent agreement, announced in October 2014, will last for ten years) and Gatwick (seven years).[32]

Besides anchor tenancy contracts, other types of agreements that are often observed in practice are:[33]

- **Signatory airlines**: after privatisation, in many countries airports are required to be financially independent and operate without government subsidies. In many cases, airlines sign use-and-lease agreements which effectively make them guarantors of the airport's finance. These can range from "residual" agreements, whereby the signatory airlines pledge to cover the full cost of airport operations required for the airport to break even, to other types in which the main contribution from signatory airlines is service guarantee and usage commitment. This reduces uncertainty over future airport revenues, thereby allowing the airport to reduce financing costs. In return, signatory airlines are given varying degrees of influence over airport planning and operations, including slot allocation, terminal usage, capacity expansion and exclusive or preferential facility usage;
- **Airport revenue bonds**: some airports (e.g. Boston-Logan International Airport, Orlando International Airport[34]) have chosen in recent years to issue Special Facility Revenue Bonds (SFRB) to finance specific capital improvement programmes. In these arrangements, airports retain ownership of the assets but transfer the right for exclusive usage to a project sponsor. The airport does not face any obligation to SFRB bondholders in case of default. In this way, much of the risk associated with the project is transferred from airports to airlines. In turn, SFRBs give airlines preferential or exclusive rights over key airport facilities.

We have also found a few cases where airlines hold (minority) shares in airports or directly control some airport facilities. For example, Terminal 2 of Munich Airport was developed as a joint venture between the airport operating company, FMG (60%), and the dominant airline at the airport, Lufthansa (40%). Lufthansa has also invested in Frankfurt airport, and holds a 29% share of Shanghai Pudong International Airport Cargo Terminal; other examples include Qantas, which owns terminals in both Sydney and Melbourne airports, and the consortium formed in 1994 between Air France, Japan Airlines, Korean Air and Lufthansa to invest in Terminal 1 of JFK International Airport in New York.

Other examples of hold-up issues

Hold-up in aviation is not limited to airports and airlines. External agents can also experience hold-up: for instance, an industrial site may have based its locational decisions on the development of an airport, and may find it difficult to relocate to another area. Similarly, residents might have invested in properties and have built a network of relationships, upon the promise that the airport will not be extended; however, they may be

32 The Telegraph, *EasyJet to help put Luton Airport back on the map*, 31 March 2014, and *Gatwick agrees seven-year pricing deal with EasyJet*, 27 March 2014.

33 OECD, *International Transport Forum Round Tables: Competitive Interaction between Airports, Airlines and High-Speed Rails*, 2009.

34 https://www.massport.com/media/8130/MAPortAuth01a-OS%2006%2008%2011.pdf

http://www.orlandoairports.net/finance/os/2010A&B.pdf

exposed to opportunistic behaviour if promises to prevent capacity extensions are not kept, and, as a result, they may have to leave their houses and networks or bear negative externalities such as noise and pollution.

In these circumstances, the solutions are typically *contractual* agreements between airports and public bodies such as the Government or local authorities. An example is the agreement signed in 1979, when the North Terminal was opened at Gatwick, between BAA and West Sussex County Council. The agreement, which lasts for 40 years, provides that no new runways will be built at Gatwick until 2019. Obviously the credibility of this type of agreement, and whether they are sufficient to reduce the risk of hold-up, depends entirely on the reputation of the parties.

5.3. Real estate: anchor tenancy in commercial developments

A successful commercial development such as a shopping mall requires the cooperation of two parties: the developer, who is responsible for the realisation of the project, and the stores that rent out a space in the mall. The potential for hold-up arises because the developer has to incur significant sunk cost in the early phases of realisation of the project before searching for potential tenants: a developer has to perform, in broad terms, a market analysis, a site suitability analysis and a regulatory review, which can be very costly in terms of time as well as money (up to hundreds of thousands of pounds).[35] In order to have incentives to undertake this investment, the developer needs some form of guarantee that the shopping mall will draw sufficient retail traffic to ensure a minimum return to the investment.

The typical solution, adopted in the sector since the planned shopping mall format was developed in the early to mid-1950s,[36] are tenancy agreements with "anchor" stores. Anchor stores are typically one of the larger stores in a shopping mall, usually a high-profile department store or a major retail chain. Securing the presence of larger department stores is necessary not only for the financial stability of the project, but also because anchor stores generate positive externalities,[37] in that they not only attract retail traffic, but they also attract non-anchor stores, in the anticipation that the retail traffic drawn to the anchor store will result in visits to smaller stores as well.[38]

Bearing many similarities with aviation, anchor tenancy contracts generally stipulate heavily discounted rents for anchor tenants, which may even receive cash inducements from the mall to remain open. The more favourable treatment may be seen as restricting competition

35 Kramer (2008)

36 See the Wikipedia definition of anchor stores.

37 As modelled by Brueckner (1993), Benjamin et al. (1992) and Gould et al. (2005)

38 Note, however, that anchor tenancy contracts may not always ensure the recovery of the entirety of sunk costs incurred by the developer, and in particular the exploratory costs incurred before the negotiation with anchor tenants. At the point of negotiation, anchor tenants have no incentive to share these costs, therefore when deciding to make the investment a developer must anticipate sharing the profits from a commercial development with anchor tenants, but bear the pre-negotiation costs alone. This is also a form of hold-up that arises when one party must pay the cost while others share in the payoff. If the developer is unable to recover pre-negotiation costs, even a commercial project which generates positive profits may, in extreme cases, not be profitable and may therefore not be undertaken. This situation is more likely to happen in low-income communities where the profitability of a commercial project is limited to start with. See Zhou (2014).

against anchor stores, and may in some jurisdictions attract competition scrutiny. However, in UK law such agreements could be exempt from competition law if the parties can demonstrate that the agreement brings economic and consumer benefits, that the restrictive effects are no wider than is indispensable to achieving those benefits, and that it does not substantially eliminate competition.[39] The rationale for exemption lies precisely in the elimination of the hold-up problem: the development of the shopping mall brings economic and consumer benefits, and the restriction is indispensable in that the shopping mall would not be able to attract enough tenants or rental to justify the investment in its establishment without an anchor tenant, and would not be able to attract an anchor tenant without the restriction.

A problem with these contracts sometimes observed in practice is that they significantly increase the bargaining power of tenants, particularly if they are allowed to participate in the planning of any expansion or redevelopment plan of the mall. The empirical evidence suggests that, in certain cases, these contracts effectively give tenants the power to block any alteration, modification or change in the architectural design or the appearance of the mall, or change in the number of floors, size or location of the buildings. Often, anchor tenants use their power to block investments in a certain shopping mall to secure a space in another shopping mall owned by the same developer. This is both another form of hold-up, which arises after the initial investment in a commercial development has been made (limiting the investor's ability to obtain a further return on investment) and an example of foreclosure occurring even in the absence of full integration. However, there might also be an efficiency rationale for this pattern: having branches of the same store in different malls from the same owners reduces transaction costs (e.g. mall owners do not need to draft separate contracts for different companies or to search background information on each company, and it is easier to predict from existing stores whether a given mix of tenants will be successful or not).

The bottom line is that the potentially severe hold-up problems that arise within the relationship between a mall and its major tenant are routinely handled through anchor tenancy *contracts* which fall well short of vertical integration.

5.4. Submarine cables: the progressive rise of contractual solutions

The construction of submarine telecommunications cables requires significant upfront capital investment, while operating costs are generally very low (usually less than 6% of the CAPEX per year).[40] As a result, any new submarine cable project will require significant funding well before generating any revenues. There is therefore significant scope for hold-up from telecommunications companies with significant market power at either end of the cables as these companies would of course realise that, by the time ex post negotiations take place, the huge investments required have already been sunk and are of very little value without their cooperation.

The solutions to this hold-up problem often do involve a degree of vertical integration, but only in the form of joint ventures between the various private and public stakeholders. In recent times, possibly due to the increased level of competition in telecommunications

39 For a useful summary, see Norton Rose Fullbright, "Under scrutiny: UK Competition Act and property contracts", September 2010.

40 Salience Consulting, *Submarine Cables: Structuring and Financing Options*, January 2015.

markets, several other models of independent private ownership of cables have been developed, e.g., requiring only the sale of shares of capacity or frequencies in the cable.

Stakeholders in submarine cable investment projects

The first step in a submarine cable investment project is the search for stakeholders, which in turn depends on the objectives to be achieved through the investment. Project initiators seek to involve stakeholders to either secure additional financing (passive equity financing) or political and commercial influence (strategic partnership). While a passive investor may require, once convinced about the feasibility of the project, a seat on the Board of Directors, this would hardly interfere with daily operations. By contrast a strategic partner would demand some level of operational control. The agreements that are typically more relevant in the hold-up context are those with strategic partners. Examples of strategic partners include:

- **Landing partners**: these are licensed telecom operators that operate a landing station in one of the countries at either end of the cable. Landing stations are an important partner in the context of avoiding opportunistic behaviour, as shown by the Australia-Japan cable case.[41] While project sponsors could easily buy and install the $500 million submarine cable, they were obliged to provide connections into the local phone networks through landing stations to on-shore telecommunications firms. Landing stations, however, are typically in very short supply and it is extremely difficult to get permission to build new ones near major cities. To prevent the possibility of hold-up by landing station owners, the lead sponsor (Telstra) expanded the ownership group to include landing station owners along the route (Australia, Guam, and Japan). Telstra created the joint ownership structure even though it could and did sign long-term "landing party agreements" with each party. A further advantage of a partnership with landing partners is that the lead time for establishing a fully operational landing station, including obtaining permits and buildings, would significantly decrease. The partnership is generally in the form of a commercial agreement; however, as in the Australia-Japan cable case mentioned above, landing partners may on occasion become equity partners, and contribute to the project not only via landing facilities, but also some level of financing;
- **Cable users**: these are telecom service providers (ISPs, mobile and fixed telecom companies, international telecom operators needing transit) operating in the countries where the submarine cable lands. Sometimes these agreements take the form of equity partnerships, whereby cable users are entitled to a share of the cable capacity; however, typically agreements are of commercial nature and take the form of pre-sale of capacity, which enables the project initiator to gain early cash inflow that significantly decreases the need for additional financing;
- **Public or semi-public bodies**: these partners typically provide significant political influence and some level of financing to the project, in exchange for equity; and
- **Investment funds**: certain investment funds with strong telecom expertise may have an interest in contributing to equity in exchange for a share of the management control. These stakeholders are valuable to project initiators for their

41 See for example Esty, *The Economic Motivations for Using Project Finance*, January 2003. Mimeo.

executive experience, and can bring the benefit of potential synergies with their existing assets.

Traditional ownership structures of submarine cables

Depending on the nature of the stakeholders involved, there are three possible ownership structures that can arise in the submarine cable industry: consortium ownership, public-private partnership (PPP) and private ownership. These usually differ in nature and in the specific commercial objectives that are to be achieved.

a) Consortium

Historically, this type of arrangement for building and operating submarine cables was established to help interconnect the incumbent state-owned telecommunications networks in order to enable international voice and data services. More recently, however, consortia have been created by operators across different countries, with a view to either owning international broadband access for their own operations (e.g. MTN in the WACS project), or to be able to offer competitive wholesale solutions across continents (e.g. TTCL in EASSy).

Consortia typically form when a group of operators establishes a need for data links between a number of international points and then group together to satisfy that need by jointly building and operating a submarine cable. Capital costs are entirely borne by consortium members, in accordance with their ownership agreement. Each member is then allocated units of capacity in Minimum Investment Units (MIUs) depending on their participation. In addition to the initial investment, each operator also contributes to the running expenses according to its personal share of capacity. Consortia mostly represent a cost sharing agreement whereby each member owns part of a major asset, and they are generally not formalised as independent legal entities. As a consequence, consortium members have to seek financing separately, but the consortium itself cannot incur any debt.

A feature of this structure is that landing stations are generally not included within the total cable investment. Instead, consortium members in their respective countries are usually landing partners, and they bear the total cost of building and operating the landing stations. These costs are then retrieved from the consortium either as a lump sum when the cable becomes operational, or along the lifetime of the cable, in which case each connected operator is charged a monthly contribution towards the landing station it uses.

b) Public-Private Partnership (PPP)

A PPP is an agreement between public and private organisations to develop, operate, maintain and market a network by sharing risks and rewards.[42] The involvement of public entities within private projects – in particular complex international telecom projects requiring large sunk investments – generates benefits for the whole value chain. Typically, the involvement of public bodies tends to enable higher risk projects with lower return expectations, and often results in a shorter lead time and critical project speed. Also, the involvement of private players tends to ensure a higher quality of service and the availability of anchor customers.

Two of the most common PPP types are:

42 World Bank ICT organisation.

- Consortium type, where one or more government entities take direct part in the consortium. For example in the ACE cable public contribution reached more than 50% of the total cost; and
- Pre-sale commitment, in which a public entity commits to buy in advance a major chunk of the available capacity. This generates some initial positive cash flow, and facilitates further financing.

c) Private ownership

Under this structure, the investment is made by one or more strategic investors (such as sovereign funds) to extract profits from the commercial opportunity created by underserved growing demand in a specific region or country. Often, the investment is made with a view to enabling wider strategic development of other vertically-related sectors (e.g. telecoms, ICT, education), which in turn depends on the availability of reliable international connectivity. The investors involved usually have a wider portfolio of regional investments and are looking at a cable investment to support some of their other interests.

In the case of the direct shareholders being Investment Funds, the cable does not generally allow for direct investment by an operator nor provide exclusivity to specific operators. The investment vehicle might also be directly owned by an operator or telecom group that sees direct synergies in owning a subsea cable, such as the possibility to offer network services across different continents. This is the case with Orascom's MENA cable, and Reliance's Flag. As the business case for the deployment of these cables is typically based on overall demand projections and underserved market needs, they do not require any customer pre-commitment (e.g. pre-sale of capacity). The initial cost is borne by the capital raising agent and cable access will be offered to all operators in destination countries without (usually) exclusivity given to any specific entity.

Agreements emerging in recent years

Due to the unprecedented increase in demand for data, recent years have seen a renewed levels of investment into the submarine cable sector, especially in emerging markets such as Africa and the Asia-Pacific region. Some of the agreements implemented have taken relatively innovative forms. For example:

- **Sale and leaseback**: in 2013, the Brazilian investment bank and asset manager BTG Pactual purchased the GlobeNet submarine cable network (22,500km of infrastructure) from Brazilian telecoms operator Oi. The acquisition, valued in the region of US$ 750m, was one of the largest ever submarine cable acquisitions ever realised. The original feature of the contract was that it included a central "take or pay" arrangement that involved the supply of capacity by GlobeNet back to Oi and its subsidiaries through a fixed-price long-term contract with volume guarantees. This model is effectively a sale-and-leaseback arrangement taken from project finance deals, and typically used in, for example, large energy projects.[43]
- **Sale of spectrum instead of capacity**: under this type of agreement, increasingly common in the industry, customers buy the rights to use a particular and allocated range of frequencies and they can use the allocated lots in using their preferred equipment to turn that spectrum into capacity. The decision on how to use the

43 DLA Piper, *Legal Innovations in Submarine Cable Projects*, September 2014.

spectrum (e.g. whether to equip it for 10Gb/s wavelengths or latest generation 100GB/s wavelengths) is entirely up to the customer, without reference to the seller of the cable system or to any other user of the infrastructure.

Overview

The potential for hold-up in the submarine cable industry is large, since massive specific investment must take place before "production" can occur. In the past, the organisational models that were used did often involve some degree of vertical integration as, for example, landing station owners or cable users would typically take an equity position in the cable venture. Even in this context, however, the observed arrangements fell well short of vertical integration. Moreover, as we would expect based on our discussion of the economics literature on hold-up, recent increases in the degree of competition between cable users has progressively led to more reliance on purely contractual solutions which do not involve ownership stakes.

5.5. The semiconductor industry: moving away from vertical integration

The semiconductor industry provides a rather different lesson in how large sunk investments, the need for technical coordination between the parties and significant demand uncertainty affect organisational choices, namely moving the industry *away* from vertical integration.

Over the last two decades, the semiconductor industry has gradually been shifting from an integrated design and manufacturing model to a separated "fabless design" and "foundry" structure. More and more integrated chip designers have selected the fabless business model. [44] A number of factors have affected this shift. First, the significant costs of setting up a semiconductor manufacturing facility make it necessary to ensure a high capacity utilisation in order to lower unit costs. Focusing on a single product is unlikely to ensure full capacity utilisation, especially in view of the shorter and more uncertain product life cycles of semiconductor products. Secondly, the skills required for the design versus the manufacturing of semiconductors are distinct. The design of semiconductors requires highly educated (MSc, PhD) employees, a close cooperation between universities and industry and an environment friendly to innovation, whereas the semiconductor manufacturing industry is a capital intensive industry. Thirdly, vertical specialisation has been facilitated by improvements in design software that fabless designers can use to design and simulate the operation of novel chips.[45]

Whereas the need to achieve economies of scale and specialisation favours vertical separation, there are a number of coordination issues between vertically separate fabless and foundries that need to be resolved via contracts. An early paper by Chaterjee et al (1999) discusses the coordination problems between fabless and foundries. These include

44 In 2009 AMD spun-off its foundry business and created GlobalFoundries. Three years later, in 2012 AMD divested its remaining 9% share in the business. http://www.extremetech.com/computing/121069-the-dream-is-dead-amd-gives-up-its-share-in-globalfoundries

In late 2014 IBM sold its semiconductor manufacturing business to GlobalFoundries. http://www.anandtech.com/show/8631/globalfoundries-acquires-ibms-semiconductor-manufacturing-business-ibm-bows-out

45 See Macher and Mowery (2004).

the matching of demand and supply, where temporary mismatches can result in oversupply and low prices or shortages and high prices, yield management and the need for coordination in order to determine the root of poor yield performance and make improvements, e.g. systematic yield loss is more likely the result of faults in the design and manufacturing, whereas sporadic yield loss is more likely due to manufacturing only. The authors develop a framework for analysing issues related to yield information sharing and find that contracts based on a fixed number of good dies[46] and better yield information are more profitable.

A more recent paper by Yang & Chang (2008), analyses what the authors describe as an increasingly popular contract between a fabless and a foundry based on purchase commitments on shared yields in light of demand uncertainty. This involves the commitment by the fabless to purchase a share of the foundry’s output in an environment of demand uncertainty. The authors describe a common practice in the industry whereby foundry customers in advance of placing firm orders (which commit them to buy a certain amount of units), place ‘soft orders’ which reveal their intent to buy and serves as guidance for the foundry’s capacity decisions. Foundry customers have an incentive to inflate their soft orders in order to ensure sufficient supply in an uncertain demand environment, knowing that they can lower or cancel their soft orders later. The authors model a supply chain of a risk-averse fabless and a risk-averse foundry with uncertain downstream demand (modelled as price variability) and show that the optimal share of yields depends on the parties’ expectations about the final price and their risk aversion.

Cohen et al (2003) analyse the problem of inflated ‘soft orders’ and the corresponding holding, cancellation and delay costs for the supplier in the context of semiconductor equipment supplies. Studying the orders for semiconductor equipment by a large chip maker, they find that soft orders tend to be inflated: of the 143 orders analysed 43 were cancelled and another 76 experienced changes with regards to the delivery date. Equipment manufacturers faced with this situation have a trade-off: they can either start ordering inputs and start producing early in order to deliver on time, or they can wait until they receive more information regarding the ‘firm order’. In the former case the supplier faces the risk of either an order cancellation, in which case he bears the cost of the inputs already purchased (which, if specialised, could be largely sunk) or a delivery delay, which affects the suppliers’ cashflow. In the latter case, where the supplier waits for more information, he faces the risk of delay in the order fulfilment. The authors estimate these imputed costs and find that the supplier perceives the cost of cancellation to be two times higher and the holding costs three times higher than the delay cost. In light of these findings the authors consider possible measures to reduce the delay in delivery, including a delayed delivery fee, and buyer sharing of cancellation and holding costs.

Some foundries, such as Samsung, Intel or IBM, have their own downstream operations, while others, such as TSMC and GlobalFoundries, do not. Even foundries that have their own downstream operations seek outside customers for their semiconductor products to ensure full capacity utilisation. With or without their own downstream operations, foundries need to continually invest very significant sums into equipment for smaller transistor sizes

46 A die is a small block of semiconducting material on which a functional circuit is fabricated.

and strive to be the first to market in order to gain an advantage over rivals.[47] As the size of the chips has fallen, the costs of developing smaller and smaller chips has increased, and only a few companies can afford to remain in the race. In 2014 Intel, the largest semiconductor chip maker for computing, was the first to introduce the 14 nm[48] process technology (the previous standard for Intel was the 22 nm process technology).[49] Samsung and GlobalFoundries were next with the 14nm process technology.[50] TSCM's next generation 16 nm process technology is expected to start production during 2015. TSCM, having fallen behind its competitors on the production of the 14/16nm technology, is reported to be racing to close the gap with Intel for the 10 nm process technology, which TSCM says it will start producing in 2017.[51] The top chip makers are therefore spending significant sums investing in smaller and smaller transistor sizes.

On the other hand, fabless chip designers such as Qualcomm, NVidia, Apple or AMD, also invest significant amounts in new chip designs and then select foundries for their manufacturing. The choice of foundry depends on a number of factors including ability to manufacture required chips in the quantity and quality needed. In developing new products, fabless chip designers work closely with foundries that will end up supplying the chips for their products. Having more than one supplier increases the coordination problems but could also be desirable in order to ensure security of supply.

Apple, one of the largest buyers of chips worldwide, relied for many years on Samsung as its main chip (and other parts) supplier for iPhone and iPads. Since Samsung's move into the smartphone market, the two companies have been involved in lawsuits on various technology licenses and design features of their smartphones. As a result, in 2012 Apple started rethinking its sourcing strategy for chips and worked with TSMC in order to develop 20 nm chips for use in Apple's products.[52] Delays due to technical issues that prevented the chips from meeting Apple's standards resulted in the first supplies occurring in 2014.[53] By that time the new generation of 14/16 nm chips were coming to market. Apple was reported to be working both with TSMC on developing the 16nm chips for the new iPhone and with Samsung on the 14 nm chips.[54] Apple decided to work with both chip suppliers to

47 In the industry the continuous trend towards smaller size of transistors is called Moore's law, named after Gordon Moore, a founder of Intel, who in the 1960s noted that the number of transistors per a unit of area of an integrated circuit had doubled every two years and that this trend would continue in the future.

48 One nanometer (nm) is equal to 1 billionth of a meter and measures the length between connections in a chip. The smaller the length, the more advanced the technology and the more efficient the semiconductors.

49 Intel does not report the amount of money spent on developing the 14 nm technology. According to Intel's Form 10K, its total R&D investments amounted to $11.5 billion in 2014, $10.6 billion in 2013 and $10.1 billion in 2012

50 GlobalFoundries entered a licensing agreement with Samsung, allowing it to use Samsung's 14 nm processing technology. It is unclear how much Samsung invested to develop its 14 nm process technology. However according to UBS estimates, Samsung's capex on its processor business amounted to $3.7 billion in 2014 and $4.9 billion in 2015, and the company is also spending $15 billion in a new chip plant in Taiwan. *Ibid* footnote 55.

51 In 2015 TSCM has budgeted a capital expenditure of $11.5-12.0 billion and plans to invest an additional $15.9 billion in a plant expansion in Taiwan. http://www.eetimes.com/document.asp?doc_id=1325787

52 http://www.cnet.com/uk/news/apple-rethinking-samsung-chip-partnership-say-sources/

53 http://www.wsj.com/articles/SB10001424127887324682204578513882349940500

54 http://www.techtimes.com/articles/10149/20140710/apple-cuts-samsung-cord-tsmc-shipping-apple-chips.htm

reduce the risk of delays in delivery or poor yields. Whereas initial reports suggested that Apple would use Samsung/GlobalFoundries' 14 nm chip for the major part of its new generation iPhone[55], more recent reports suggest that due to yield problems from these suppliers Apple decided to use TSMC for a third of its chip supplies.[56]

The example of Apple's sourcing of its chips highlights the coordination issues between fabless chip designers and foundries which are exacerbated when high-investment new generation products are launched. Despite these coordination issues, vertical separation is still preferred to vertical integration. Contracts and sourcing strategies, including multi-sourcing, have been developed to reduce the coordination problems, which do not appear to have affected investment incentives in what is one of the most innovative industries.

5.6. Ports: dealing with multiple stakeholders

Similarly to the case of airports, hold-up problems can arise in the relationship between shipping lines, port operators and port authorities in the building or expansion of capacity. The provision of port services requires significant and lumpy sunk investments. The port authorities are usually public bodies that own the land of the port and are responsible for long-term investments such as fairways, berths, and access roads, as well as dredging to ensure access for larger boats. Port operators (stevedoring firms, cargo handling firms, terminal operators) are private firms that receive concessions to operate the various aspects of port infrastructure (e.g. handling, stevedoring, storage etc.) and are responsible for investing in their infrastructure (e.g. specific cargo handling, storage). Shipping lines may also invest significant sums in vessels and other assets that must be adapted to the port infrastructure for efficient loading and unloading.

Absent credible commitments, the hold-up problem can arise in the relationship between port operators and port authorities on the one hand, and shipping lines on the other. Port operators face the risk that following investments in infrastructure facilities, large shipping lines will threaten to use alternative harbours or reduce shipping volumes and thus exploit the sunk nature of the investments to negotiate lower fees. Similarly, port authorities who have invested in transport links to help move the goods brought in by new giant container ships can be held up by large shipping companies which have not yet converted their fleet or which have a choice of harbours. The hold-up problem could also arise in the relationship between port operators and port authorities, if following investments by the port operators in the superstructure of the port (terminals, storage etc), the port authority decides to raise concession fees or in other ways renege on the contract.

Nonetheless, the market relies mostly on long-term contracts usually specifying minimum throughput volumes, though in the last years there has also been vertical integration or share ownership by shipping lines in terminal operations

55 http://www.bloomberg.com/news/articles/2015-04-03/samsung-said-to-win-apple-a9-chip-orders-for-next-iphone

56 http://appleinsider.com/articles/15/04/15/apple-makes-last-minute-decision-to-use-tsmc-for-30-of-a9-chip-orders-for-next-iphone

5.6.1. Commercial solutions to the hold-up problem

Shipping lines and port operators

Shipping lines aim to achieve maximum utilisation of their vessels at sea, and minimise the time spent at ports, where congestion may result in significant delays to loading and unloading of cargo. Moreover, shipping lines depend on logistic services available at ports, namely the terminal infrastructure and access to hinterland transport facilities for the quality of service offered to their end customers (speed of transit). Port operators, on the other hand, rely on the custom of shipping companies – especially larger ones with significant volumes – in order to make a profit and earn a return on their investment in facilities at the port.

A number of structures have been developed to overcome the problem of providing port operators with sufficient incentives to guarantee a good service to shipping lines without giving hold-up opportunities to the latter:[57]

- **Contracts** between terminal operators and shipping lines. The details of contracts between terminal operators and shipping lines are confidential and therefore difficult to observe. However, according to a European Commission competition report on terminal handling charges, contracts between shipping lines and terminal operators tend to be multiyear contracts with break clauses and commit the carrier to a minimum guarantee volume in exchange for which the carrier is usually provided with guaranteed slots for vessel berthing and number of containers handled by the hour.[58] This is confirmed by a 2014 Australian Competition and Consumer Commission (ACCC) monitor report on stevedoring, which notes that contracts between shipping lines and terminal operators are negotiated on a multi-port basis and may contain rebates and discounts based on volume guarantees.[59] Soppe et al (2008) based on 2006 data estimate that only 14% of shipping lines' capacity is handled at dedicated terminals compared to terminals of local and international terminal operators, though they acknowledge that there is significant variation among shipping lines.[60] The inclusion of clauses on minimum guaranteed volumes in the contracts between terminal operators and shipping lines in return for lower charges and/or guaranteed slots and time to handle containers, as well as contract length, reduces the hold-up and incentives problems discussed above.
- **Minority shareholdings** by shipping lines in port terminal operations. A number of shipping lines have invested in minority shareholdings in port terminal operations. An example of this strategy is Maersk's 30% shareholding in Seaport Terminal (the holding company of the port of Tanjung Pelepas in Malaysia), which resulted in Maersk shifting almost all of its volumes from the port of Singapore to the Pelepas

57 Francesco Parola & Enrico Musso (2007) Market structures and competitive strategies: the carrier–stevedore arm-wrestling in northern European ports, Maritime Policy & Management:, 34:3, 259-278.

58 European Competition Commission, Terminal handling charges during and after the liner conference era, October 2009 Competition Report.

59 ACCC Container stevedoring monitoring report no. 16, October 2014.

60 Martin Soppe, Francesco Parola, Antoine Fermont (2008), Emerging inter-industry partnerships between shipping lines and stevedores: from rivalry to cooperation?, Journal of Transport Geography.

port, thereby causing a significant increase in throughput.[61] Through minority shareholdings, shipping lines can be involved in the long-term planning of the port operations, including decisions on investments in which shipping lines may have an interest to the extent that they improve the service offered without having to be involved in the day to day operations of the terminal. In return, port operators benefit as a result of increased throughput from the shipping companies and reduced hold-up risk from the (partial) commonality of ownership – though it is unclear what the importance of the latter is in the adoption of these organizational structures.

- **Joint ventures** between shipping lines and terminal operators, in return for dedicated terminal capacity. Joint ventures involve larger financial participation by the shipping line in infrastructure investments (though shipping lines are not involved in the day to day operations), which increases its incentives to commit volumes to the port.
- **Dedicated terminals.** Shipping lines, especially those with high transport volumes may invest in dedicated terminals.[62] This is done either directly or via port operator subsidiaries of shipping lines. For example, APM Terminals is an independent business unit of Maersk Group. Similarly Terminal Investment Ltd is a subsidiary of Mediterranean Shipping Company (MSC) and operates MSC's dedicated terminal in Antwerp (MSC Home Terminal). Investments in dedicated terminals give shipping companies access to busy ports. Moreover shipping lines can invest in capacity expansions and other infrastructures that are relevant to their fleet size and operations. Port authorities on the other hand, by offering concessions for dedicated terminals to shipping lines, secure the volume of the shipping lines. According to press reports MSC accounts for 50% of Antwerp's total container throughput.[63] The larger the volume, the greater the incentive of the port authority to offer a dedicated terminal concession for fear of losing business, especially in the presence of alternative competing ports. In 2000, the port of Singapore lost significant business from Maersk, one of its largest customers, after it resisted Maersk's requests for a dedicated terminal. Following this, as mentioned above, Maersk invested in the development of the nearby port of Tanjung Pelepas, which, as a result, experienced significant growth in throughput. The port of Singapore (through its affiliate port operator PSA) subsequently posted a 9% decline in profits in the following year.[64]

Port authorities and port operators

A hold-up problem may also arise in the relationship between port authorities and port operators if port authorities, following investments by port operators, offer the concession

61 Port Reform Tooklit, 2nd edition, Module 3. http://www.ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Portoolkit/Toolkit/module3/port_functions.html

62 See Meersman *et al*. (2001), Cooperation and competition in international container transport strategies for ports, University of Antwerp Research Paper.

63 Port of Antwerp agrees to MSC Terminal transfer and prepares for P3 July launch, The Load Star, 13 May 2014. http://theloadstar.co.uk/antwerp-agrees-msc-terminal-transfer-gets-ready-p3/

64 http://www.singapore-window.org/sw02/020406aw.htm

contract to other port operators (via tenders or other means). One way to solve this problem has been through the provision of long-term concession contracts. The duration of the concession contract typically depends on the level of the investment by the operator. There are considerable differences in the duration of concession agreements, but a number of ports allow for a base duration of 15 years followed by options to renew every 5 years.[65]

On the other hand, long-term concession agreements can prolong the tenure of a potentially inefficient operator. This points out that long term contracts are not a panacea and can themselves lead to insufficient investments if they are not well-specified. An example of this is the legal dispute between MBZ, the port authority of the Belgian port Zeebrugge, and the terminal operator Katoen Natie. Katoen Natie had a long term concession agreement to operate the Flanders Container Terminal but had never managed to achieve significant utilisation of the terminals. After a long litigation, Katoen Natie pulled out of the container terminal activities in Zeebrugge, and in 2004, MBZ awarded the contract to another terminal operator, APM Terminals. The award of the contract was based on investment commitments by APM Terminals aimed at increasing the volume in the port.[66] With this better designed contract, port authorities can protect against this risk by including conditions such as minimum throughput for existing berths and terminals in the concession agreements. Failure to reach the minimum cargo throughput results in penalty payments to the port authority.

In the case of greenfield investments in ports, as for many other types of infrastructure investments, one method used to attract private investors is the Build, Operate, Transfer (BOT) contract. Under such a contract a private entity or consortium is granted a concession by the government to build via its own financing, operate and at the end of the contract term, transfer the facility back to the state. The concessionaire will be responsible for the design, financing and construction of the project (via a contract with a construction company). Following construction, the concessionaire has the option to find a private operator (via tendering procedures) to operate the port and is free to set the fees. Alternatively, if the concessionaire is a port operator, it can decide to operate the port on its own. At the end of the period the assets are transferred back to the port authority or government either at book value or no value.

A private entity entering a BOT contract with a port authority faces the risk that post investment, the port authority may renegotiate the terms of the contract in ways that are detrimental to the concessionaire's interests. To avoid this risk BOT contracts are usually long term, having a duration of 30 years or more.[67]

The fact that the concessionaire can find a private operator – and hence use competition between potential operators to its advantage – and still retain the option of operating the facility itself if the deals available are not lucrative enough, provides significant protection about hold-up.

65 Brooks, M. and K. Cullinane, eds. (2007), "Devolution, Port Governance and Port Performance", *Research in Transportation Economics*, Vol. 17, Chapter 19.

66 *Ibid*.

67 PPIAF, Port Reform Toolkit, 2nd edition, Module 4. http://www.ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Portoolkit/Toolkit/module4/bot.html

The port authority or government may also face the risk that the concessionaire is not maximising the land's productivity, through e.g. poor investments or inefficient operations resulting in low throughput. In such cases, participation by the port authority as a shareholder in the Special Purpose Company set up by the concessionaire to build and operate the project, can give the port authority more control over the construction and running of the port. This is not a common occurrence, especially in ports with multiple port operators. Participation of the port authority in the operations of a port is considered potentially problematic in cases where there are multiple terminal operators and thus a potential for conflicts of interest.[68]

5.7. Aircraft manufacturing: the role of competition and pre-ordering in dealing with hold-up and demand uncertainty

The relations between aircraft and aircraft engine manufacturers provide another example of an industry in which vertical integration is not used, despite the presence of large co-specific investments and significant demand uncertainty. This may be due in part to the nature of the product – namely to the fact that the final decisions as to which engine to purchase for each aircraft order is left to the final consumers, i.e., the airlines, which fosters sufficiently intense competition despite the relatively small number of operators on both sides of the transaction. Under these conditions, producers of aircrafts and engines have an incentive to coordinate their technical decisions and design investments to maintain compatibility between components, but still retain ownership and control over their respective assets, therefore ensuring efficient management of these assets.

Aircraft manufacturing involves the assembly of a number of subsystems of an aircraft (e.g. engine, cockpit, avionics, fuselage, wings), each of which is manufactured by a number of specialised firms. The single largest such component is the aircraft engine which can account for a third of the cost of the plane.[69] Aircraft manufacturers invest significant financial resources and time to develop larger and more fuel-efficient aircraft. Unlike semiconductors where the development of new generation process technologies occurs every two years, the development of new generation aircraft takes significantly more time and requires significantly higher and more uncertain investments. Airbus' A380, the largest passenger aircraft, cost a reported $12 billion to develop (it was budgeted at $8 billion).[70] The program was first officially launched in 1994 but underwent a number of changes and was announced in its final form in 2000. The first delivery was in 2007, following a number of delays due to technical difficulties.[71] Boeing's 787 Dreamliner cost approximately $16 billion to develop (having been budgeted for $6 billion)[72], and it took seven years from the date the Dreamliner was announced (in 2003) to the date of first delivery of the aircraft (2011). The development of the aircraft was fraught with difficulties and delays, due to the

68 http://www.portstrategy.com/news101/port-operations/planning-and-design/hfw-concessions

69 http://www.airbus.com/company/aircraft-manufacture/how-is-an-aircraft-built/final-assembly-and-tests/

70 http://www.flightglobal.com/news/articles/airbus-a380-aircraft-profile-205274/

71 Airbus Giant-Jet Gamble OKd in Challenge to Boeing; Aerospace: EU rebuffs Clinton warning that subsidies for project could lead to a trade war, Los Angeles Times, 20 December 2000.

72 Boeing was reported to have spent $32 bn on the Dreamliner by 2011, half of which was on the development and half on manufacturing. http://business.time.com/2013/01/17/is-the-dreamliner-becoming-a-financial-nightmare-for-boeing/

problems that subcontractors faced in procuring the inputs needed. Airbus' response to Boeing's 787 was the A350. Airbus reportedly spent $15 billion on the development of this new aircraft and more than 10 years passed from design to its first flight.[73]

Usually, new generation aircraft require new generation engines that will be compatible with the aircraft. Engines are complex constructions made up of thousands of parts. Given this complexity, the assembly and manufacture of an aircraft engine takes approximately two years, while testing of each model can take up to 5 years.[74] Aircraft manufacturers prefer to have more than one engine supplier in order to provide choice to their end customers (airlines and aircraft leasing companies). However, this does not always occur. For example, Airbus' A380 had two suppliers: Rolls-Royce, with its new Trent 900, and Engine Alliance (GE and Pratt & Whitney alliance), with a new engine developed for Airbus A380. The Dreamliner also had two engine suppliers: GE, with its new GenX engines, and Rolls Royce, with its new Trent 1000. However, Airbus A350 only had one engine supplier: Rolls-Royce, with a customised new engine for the A350 family.[75]

Absent credible commitment devices, a hold-up problem may arise in the relationship between airlines on the one hand and aircraft and engine manufacturers on the other. Aircraft manufacturers may, following significant investments to develop new aircraft, face low demand for their aircraft by airlines at the time of launch. This could be due to cyclical factors as, during a downturn, airlines are less willing to invest in increasing their fleet. Due to the long development times (usually more than 10 years) aircraft manufacturers face significant uncertainties with respect to how demand will be at the time the aircraft can be produced. The recent drop in demand for jumbo jets is a case in point as the demand for both the Dreamliner and the A380 seem likely to be significantly below initial expectations.

5.7.1. Commercial solutions to the hold-up problem in aircraft manufacturing

A common industry practice that aims to overcome the hold-up problem faced by aircraft manufacturers is the pre-ordering of new aircraft very early in the development phase. For example, in 2000 at the time that the Airbus 380 program was announced, Airbus already had 50 firm orders and options for another 42 from six airlines.[76] Moreover, due to the significant costs of manufacturing the aircraft, even post-development aircraft manufacturers will only start producing based on firm orders from customers.[77]

The sales agreement for new aircraft typically specifies progress payments with the last payment occurring upon delivery. Moreover, for new aircraft, separate prices are quoted for the different parts of the aircraft, e.g. airframe, engines, airline specific customisations

73 http://www.bbc.com/news/business-22803218

74 http://www.madehow.com/Volume-1/Jet-Engine.html

75 http://www.flightglobal.com/news/articles/farnborough-airbus-a350-powerplant-race-ignites-as-rolls-royce-reaches-agreement-to-supply-trent-208086/

76 *Ibid.*, footnote 71.

77 For example in 2013 Singapore airlines placed a firm order for 30 A350 Airbus to be delivered in 2016-2017 with options for 20 more planes. http://www.theguardian.com/business/2013/may/30/singapore-airlines-orders-airbus-boeing

etc.[78] These contracts reduce the risk of hold-up compared to a situation where the aircraft manufacturer is responsible for the purchase of all inputs. Sales agreements may also include financing arrangements, especially during periods of low demand, performance guarantees, and options for discounts if additional aircraft are purchased.

Usually the orders are predicated on a certain delivery date, which acts as a safety mechanism for airlines that can face delays in delivery when planning their capacity expansion. Some airlines have cancelled orders as a result of delays in delivery. For example both FedEx and UPS in 2007 cancelled their orders of the A380 following reports by Airbus that it would temporarily halt works on the cargo version of the aircraft.[79]

When airlines decide on their aircraft orders, they also make a decision about which engines to buy for the new aircraft. Due to the time and cost involved in the assembly of aircraft engines, engine manufacturers only begin production after having received firm orders from the airlines. The contract will typically specify a delivery date for the order. For example, Rolls Royce in April 2015 announced a €8.5 billion deal to supply Trent 900 engines for 50 A380 aircraft, with first deliveries starting in 2016.[80]

5.8. Natural resources exploration and extraction: a smorgasbord of contractual and asset-allocation solutions

The natural resources industries provide a different – and, in a sense, the most radical – example of the contractual incompleteness problem. This is because national governments are typically the owners (or at least controllers) of land and resources, and have a strong incentive to renege on contracts. Moreover, neither international law nor reputational concerns may be powerful enough to counter those incentives.[81] Even leaving aside extreme cases of regulatory expropriation, the extractive industries are an interesting case study of contractual incompleteness where stakes are high, payoff streams are uncertain, time horizons are long and yet contractual solutions are often preferred to vertical integration – possibly because most States (especially those facing the commitment problems mentioned above) do not have the technical competence to run the business.

The investment required to undertake exploration and extraction activities for natural resources is highly specific in nature. An international company (e.g. an oil or gas company) generally incurs all the costs of exploration, drilling and extraction: these costs are not only substantial, but also sunk. In addition to the fact that these activities are necessarily specific to the field being explored, certain pieces of equipment used for exploration and extraction (e.g. drilling rigs) often cannot be redeployed somewhere else, because they are often designed and created for the specific location at which they will be

78 Pitt *et al.* (1999).

79 http://www.theguardian.com/business/2007/mar/03/theairlineindustry.travelnews

80 http://www.independent.co.uk/news/business/news/rollsroyce-lands-6bn-engine-deal-as-emirates-turns-away-from-the-us-10186350.html

81 In principle, this problem is not unique to the sector and may apply to all cases in which untrustworthy governments can seize large sunk investments (e.g., to all infrastructure investments). However the problem may be more severe in the case of natural resources due to the size of the potential gains from reneging on contracts and the fact that the government's counterparties are typically *foreign* multinationals rather than politically connected local companies.

placed.[82] Given these characteristics, if the exploration is successful, the investor is vulnerable to opportunistic behaviour by the host State – and possibly by the several States through which a pipeline may have to pass through in order to reach the markets.

In a typical case, the State offers generous terms to the international company (low royalties, fast investment recovery etc.) to encourage investment. Before significant reserves have been discovered, such terms are often necessary due to the high risk nature of these activities. As stated by Bindeman (1999):[83]

> *"Ventures of this nature are of a high risk nature in the physical, commercial and political sense as it is difficult to determine in advance the existence, extent and quality of mineral reserves as well as production costs and the future price in the world market".*

In oil and gas production, for instance, approximately eight out of nine wells are dry, and about 20% of drilled development wells turn out to be dry.[84]

Once a resource has been discovered and production has started, however, the State may renege on the initial agreement and prevent the international company from extracting the benefit of the investment. Often this occurs through alterations to the tax regime or allegations that the initial deal was obtained through corruption, but in some cases the State may go as far as recurring to outright expropriation of the investing company, as recently occurred in Venezuela and Bolivia. If there are no ex ante safeguards in place to prevent such an outcome, the international company may decide not to invest altogether.

5.8.1. Contractual solutions to hold-up problems in natural resource exploitation

There are several types of contractual structures that are used in the extractive industries. The main dimensions in which they differ are the allocation of control and/or ownership of the resources between the parties and the allocation of the risks of exploration and market price fluctuations. Both dimensions are important in finding the right trade-off between the hold-up risks and the provision of incentives for efficient exploration and extraction. For example, in oil extraction four main types of contracts are observed today:

- **Production Sharing Agreements***:* these contracts provide that the State owns the resource and all the installation and plants, and the investor is simply hired to explore, exploit and develop the resource in exchange for a share of production.[85] Following extraction, the costs and revenue are split between the two parties on the following basis:
    - Royalty: these are paid (as a percentage of revenues or output) by the investor to the State;
    - Cost oil: after the payment of the royalty, the investor is allowed to retain a percentage of the resource (usually between 30% and 50%) to cover its costs of exploration, drilling and production;

82 *Gulf Oil Corp. v. C. I. R.*, 87 T. C.324, 328 (1986).

83 See Bindeman (1999).

84 *Sun Co. Inc. & Subsidiaries (Consol.) v. C. I. R.*, 677 F .2d 294, 300 (3rd Cir. 1982).

85 Bindemann (1999)

  - Profit oil: after the investor has recovered its costs, the remaining production is split between the international investor and the State (represented by a national oil company) according to a pre-determined formula;
  - Tax: the investor generally pays income tax to the host State on its share of profit, as well as other taxes;

- **Concession Contracts**: these contracts grant exclusive rights to explore, develop and export the resource on a specific territory and for a specific period of time. In these contracts, the State transfers ownership of the resource to the investor as well as all risks over exploration and extraction activities;
- **Risk Service Contracts**: under this agreement, the investor supplies services and know-how to the State in exchange for an agreed fixed fee. The firm bears all the exploration costs; the State remains the owner of the resource once it is extracted, but in some cases the investor can buy the resource back at world prices; and
- **Joint ventures**: in this arrangement, ownership of the production is specified by the participation of the investor and the State in the joint venture. Both parties participate actively in the operation of the reserve, hence both bear a share of development and operation costs and both are entitled to a share of profits.

Looking in more detail at these organisational structures, we can see how several categories of contractual provisions are used to address various aspects of the hold-up problem: (i) provisions which reduce the degree of asset specificity of the investment; (ii) long-term agreements; (iii) safeguard clauses; (iv) renegotiation and dispute settlement rules. The effectiveness of these clauses will depend on the investor's ability to negotiate them with the State in the first place and also on their enforceability. Particularly for clauses (iii) and (iv), as well as for solutions based on the allocation of resource ownership, ex post enforcement may not be straightforward to achieve, as the State (particularly after a change in government) may contest the authority of the arbitrator.

Reducing the asset specificity of the investment

Certain agreements can be made between international companies and host countries to reduce the degree of asset specificity of the investment and the extent of sunk costs. For example, the host State may agree to make exploration costs deductible for tax income purposes; as noted by Brinsmead (2007), "*by foregoing its present tax revenues in the expectation of future tax income once oil is discovered, the host State is effectively sharing the risk of exploration with the oil company*". In other cases, the host State may agree to reimburse part of the exploration costs, thus reducing the extent of sunk costs that have to be incurred by the international firm. These provisions effectively aim at making the State a partner and share the risk of the exploration phase with the firm.

Long term agreements

Long term agreements are widely used between investors and host States, often in conjunction with one or more of the clauses presented below.

The academic literature has extensively studied the use of these contracts. Masten and Crocker (1985) find that long-term contracts may be used to avoid repeated bargaining in transactions supported by asset specific investment. Since long-term contracts may be

inflexible if market circumstances change, the authors argue that "take-or-pay" obligations in gas contracts can be viewed as a mechanism for providing appropriate incentives for contractual performance. Joskow (1987) tests empirically the importance of asset specific investment for the duration of contracts in the coal industry in the US. His study supports the hypothesis that as asset specific investments become more substantial, the parties rely on longer term contracts rather than relying on repeated bargaining. Saussier (1999) analyses contracts for coal transportation in France and shows that contract duration was positively correlated to the value of asset specific investments (as measured by the value of start-up investments and guaranteed contract quantities) and negatively correlated to the level of demand related uncertainty over time.

Safeguard clauses

Companies often seek to include safeguard clauses to protect the terms of the original agreement with the host State. An example of such clauses are stabilisation clauses, which prevent the State from unilaterally changing the agreement with the international company or changing its laws in ways that negatively affect the operation of the contract.[86]

Other instruments are convertibility and profit repatriation clauses, which allow the investor to convert the revenues it may receive from the extraction of the natural resource from the local currency into US dollars or its own currency, and clauses that allow the investor to sell its share of the resource on the international market to prevent the host country from trying to expropriate rent through its exchange rate policy.

Renegotiation and dispute settlement rules

As discussed in 3.2, a suitable choice of default options and of the allocation of bargaining power between the parties in case of renegotiation may provide a solution to the underinvestment problem.[87] Renegotiation clauses are sometimes used to address the risk of opportunistic behaviour by making explicit the conditions under which renegotiation of the initial contract may occur. Dispute settlement rules instead seek to establish that any dispute arising in relation to the agreement with the host State will be resolved by means of international commercial arbitration rather than being subject to the local judiciary system which may be unduly controlled by the executive power.[88]

6. IMPLICATIONS FOR THE POTENTIAL SEPARATION OF OPENREACH FROM THE REST OF BT

In this final section of the report we seek to apply the main insights of our review of the theory of hold-up, and practical solutions to address it in various industries, to consider whether structurally separating Openreach from the rest of BT would have a negative impact on Openreach's investment incentives.

86 See Asante (1979). Such clauses are at the heart of the current controversy regarding the North Atlantic Free Trade Agreement between the US and the EU.

87 See Aghion *et al*. (1994).

88 See Bishop *et al*. (2001).

Let us first deal with the question of the extent to which BT and Openreach can be legitimately regarded as vertically integrated today. With the 2005 Undertakings, Openreach was functionally separated from BT[89] with an obligation to follow the principle of "Equivalence of Inputs" for many of its products (a requirement that is intended to prevent discrimination against 3rd parties).[90] Is there an argument that the Equivalence of Inputs condition is sufficiently strong for Openreach to be considered a separate entity from BT when it comes to analysing deployment of Fibre-to-the-Cabinet (FTTC)?

To answer that question it is important to note that what constitutes "functional separation", as well as how Openreach is regulated, have both been modified for FTTC. First, a variation of the Undertakings was agreed between Ofcom and BT in June of 2009 allowing Openreach to operate the "electronic equipment necessary to provide super-fast broadband services using FTTC". Before this variation came into effect, Openreach was not allowed to control and operate electronic equipment in BT's access network".[91] With the variation, the demarcation line between what should constitute Openreach and the rest of BT has become more blurred. Second, the prices of Openreach's wholesale FTTC products are not subject to any control and will only be subjected to a margin squeeze test following a recent Ofcom decision of 19 March 2015.[92] The weaker regulation implies that BT can set an access price for FTTC that is above cost and make profits above its cost of capital, as long as BT Consumer makes a positive retail margin. Compared to cost-based access on standard broadband, this allows BT to effectively circumvent the Equivalence of Inputs condition and increase access prices to 3rd parties. Internally within the BT Group, the price paid to Openreach is only a transfer price. Thus, while BT Consumer formally faces the same price to access the Openreach wholesale SFBB product GEA-FTTC as third parties, in its economic pricing behaviour BT Group can behave as if the Openreach price were set at the efficient marginal cost level and maximise profits over the whole firm accordingly. The posted price effectively only applies to 3rd parties.

With margin control only, the constraint implied by the "Equivalence of Inputs" principle is therefore much weaker than with cost-based access. It essentially imposes an obligation to interconnect, but does in fact allow for discrimination between BT Consumer and 3rd party access seekers as long as a margin squeeze is formally avoided. Given this background, in the rest of our discussion it is legitimate to consider BT as 'vertically integrated' as regards the specific issue of upgrading of local loop infrastructure.

We now proceed in three steps. In Section 6.1 we first discuss the estimated size of new investments in local loop upgrades that Openreach has carried out. Particularly when viewed against the size of investment by "downstream" communications providers in content and applications, the investment that Openreach is expected to have to make is not exceedingly large. Further, investment upgrades have increased Openreach's capital expenditure in small steps, and by amounts that do not create an excessive exposure to investment risk. Therefore the estimate we use for the investment Openreach is to

89 See Ofcom news release of 22 September 2005 *Ofcom accepts undertakings from Board of BT Group plc on operational separation*

90 https://www.Openreach.co.uk/orpg/home/aboutus/equivalence/equivalence.do

91 See Ofcom Statement of 11 June 2009, http://stakeholders.ofcom.org.uk/consultations/fttc/statement/, ¶1.2

92 See Ofcom Statement of 19 March 2015, http://stakeholders.ofcom.org.uk/consultations/VULA-margin/statement/

undertake is at most, in any event, an "upper bound" for any potential hold-up problem – much investment is indeed deployed gradually, and therefore at any point in time only a fraction can be regarded as sunk and unsupported by a specific customer contract (and therefore potentially liable to hold-up).

In Section 6.2 we then set the economic circumstances in which Openreach operates against the product and market characteristics that we identify in Section 2 as determinative of the seriousness of hold-up. We find that, in practice, the circumstances in which Openreach operates significantly mitigate any hold-up concern.

Finally, in Section 6.3 we explain that any remaining hold-up concern could be easily offset by appropriate contracts. The evidence from our case studies in Section 5 shows that, in practice, hold-up problems which are much more severe than anything that could arise in the case of Openreach, are dealt with in this way.

Overall, we conclude that the relevant investments are not especially large, and in any event, only a limited share of these investments is potentially subject to hold-up; that the risk of hold-up is mitigated by a number of market characteristics; and that any residual hold-up problem could be addressed without preserving vertical links between BT and Openreach.

6.1. The size of Openreach's investment into infrastructure upgrades: an upper bound to the hold-up problem

Openreach owns and operates BT's fixed local access infrastructure. Note that while Openreach operates in several wholesale business segments, the "potential for hold-up" we discuss here is limited in any case to technology upgrades to the local loop for residential customers. Openreach also maintains and operates the existing network, an activity for which there is no risk of hold-up. Structural separation of Openreach cannot thus conceivably create any potential hold-up concerns for these activities – and to the extent that the performance of Openreach in this area has been weak,[93] separation can arguably also resolve the conflict of interest which is at the heart of that weak performance, without affecting investment incentives in network upgrades.

We also do not discuss here access links that are built on demand, for example for mobile backhaul or for businesses. Openreach has an obligation to construct links to mobile operators' base stations on an on-demand basis. While this part of Openreach's business involves significant investment to support the spectacular growth of mobile data services, most of this investment does not create either a hold-up problem or significant exposure to demand uncertainty. This is precisely because Openreach builds to order when demand has materialised, and construction cost reimbursements and access conditions are specified and binding ex-ante.

Potential hold-up concerns are limited in any case to technology upgrades to the local loop

Initially, access regulation to Openreach's local loop infrastructure was made simpler by the fact that the copper local loop was already in place. Ofcom could thus focus on creating a competitive xDSL market by obliging Openreach to give access to the local loop at costs as measured by LRIC+. While significant investments are necessary on an on-going basis

93 Sky submission, ¶20-43 and Annex A.

to maintain the network in a steady state, such replacement and maintenance investments do not create a hold-up problem since downstream demand is already present and committed to the local loop product. Any remaining investment incentives were addressed by Ofcom by regulating access at LRIC+, where the '+' refers to a mark-up over long-run incremental cost that would allow for full cost recovery and a sufficient return on capital.

This situation changed upon consideration of whether the residential consumer segment would require the deployment of more fibre in the local loop and related technological upgrades.[94] As a de novo investment with – at the time – potentially uncertain demand and no contractual commitment on the part of users, fibre deployment could potentially face a risk of hold-up and would be subject to significant uncertainty. At the same time, these risks should not be exaggerated. While the investment required to develop a full national fibre footprint might seem large, the upgrade of the local loop (which ultimately requires replacement of all copper lines with fibre), is gradual and likely to take many years if not decades. Over this span of time, most of the uncertainty about demand is likely to be resolved and a large portion of the fibre network will already be under contract.

BT has to date completed its roll-out of "Fibre-to-the-Cabinet" (FTTC) – upgrading around 1,700 exchanges which connect around 20m households (the size distribution of lines per exchange is highly skewed, so that 30% of exchanges cover around 70% of premises).[95] With a significant amount of public funds coverage will be extended to around 90% of UK households by December 2016. While that investment upgrade is largely complete, we focus our analysis on it rather than speculate over the costs of further upgrades to "Fibre-to-the-Distribution-Point" (FTTdp), "Fibre-to-the-premise" (FTTP) and related technologies. We note that BT itself has argued that the case of SFBB shows the benefit of the vertically integrated model.[96]

Size of the FTTC local loop investment upgrade

We use three sources to gauge the size of the cost of BT's investment upgrade: a report by Frontier Economics for Sky analysing BT's recent investments ("the Frontier Report");[97] a report by WIK on behalf of TalkTalk analysing the cost of FTTC-GEA to Ofcom ("WIK Reports 2013 and 2014");[98] and BT's own annual accounts.

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94 Such as, for example, connecting cabinets to the power grid and deploying vDSL routing equipment in cabinets.

95 There are essentially three segments in an access network:

- *Between the exchange and street cabinets* ("fibre to the cabinet", or "FTTC"): there are around 5,600 exchange locations in the UK linked to around 89,000 street cabinets over a typical distance of 3.5km;
- *Between street cabinets and distribution points* (on poles or underground): the 89,000 street cabinets link to around 4m distribution point locations with a typical distance of 350m;
- Between distribution points and premises: the 4m distribution points link to around 29m locations with a typical distance of 35m.

Figures taken from BT Presentation by Tim Whitley, Managing Director of Research & innovation and Adastral Park "The Future of Mobile is Fixed".

96 See, for example, J. Petter in an Enders Analysis conference as published in the Telegraph on 17 March 2015

97 Frontier Economics, *BT Access Network Investment*, June 2015

98 WIK Reports, *Estimating the cost of GEA*, March 2013 and update 13 August 2014

BT’s annual accounts show capital expenditure for Openreach as reported in Table 6. This shows that in FY 2009, which to our knowledge must be regarded as the last year before the FTTC investment programme, capital expenditure was around £951m. This decreased in 2010 to £907m, before increasing to between £1,050m and £1,150m. At first sight, this appears to suggest that FTTC deployment increased annual capex by between about £100m and £200m since 2011.

Table 6: Openreach capex in £m

2009	**951**
2010	**907**
2011	**1,087**
2012	**1,075**
2013	**1,144**
2014	**1,049**

Source: BT Annual Accounts 2011 and 2014

This figure is likely to be too small, however, since over the same period BT appears to have reduced investment in its existing copper and duct network – with associated deterioration in network quality and increased faults.[99] On the basis of BT’s 2012/13 reports and business updates, Frontier Economics estimates the annual run rate of capital expenditure for FTTC upgrades to be between £300m and £400m in May 2013.[100] Assuming that upgrade costs were similar over the 5 year programme, this would lead to total FTTC upgrade costs of between £1.5bn and £2bn.

WIK estimates the total cost of the FTTC roll-out to be in the region of £1.9bn (2014 sensitivity) and £2.25bn (2013 base case).[101] WIK appears puzzled by BT’s annual accounts as shown in Table 6 above. It states:

> *A cross-check with capex levels for Openreach reported in BT financial statements do not show significant variations over the period in which the FTTx investments occurred, compared with previous periods, although Openreach capex in FY2011/2012, a year in which there was substantial FTTx deployment was some £60m over previous years. We noted in the 2013 summary report that one possible explanation might be that FTTx investment replaced investment in other activities or may have included some investments such as duct renewals that may have occurred irrespective of FTTx. A further potential explanation could be the possible*

99 see Frontier report and Sky submission.

100 Frontier report, p. 8

101 The 2013 figure refers to the WIK base case (WIK Report 2013, p. 43); the 2014 figure refers to the scenario where duct reuse is at 80% (WIK Report 2014, Table 5, p. 15).

inclusion of retail investments or network operating costs within BT's stated £2.5bn fibre spend.[102]

WIK therefore notes that a part of the upgrade investments are not truly incremental, since they only replace old technology with new technology when a replacement was due in any case. What matters for hold-up is the *incremental* cost of the new technology over the costs that would have been incurred by the replacement of the existing technology, and this also reduces the size of the investment potentially liable to a hold-up problem.

The three sources we have reviewed together suggest a likely figure of under £2bn for total investment. In any event, this figure only represents an upper bound for the potential hold-up problem: as explained in Section 2 and discussed further below, hold-up only occurs when investments become sunk. In fact, BT has gradually developed its fibre network and indeed changed its roll-out plans various times: this gradual deployment suggests that BT's exposure at any point to a hold-up problem has been (and is) significantly smaller than suggested by the total capital outlay.

With the number of homes passed at around 20.5m, the capital cost per home passed is likely to be less than £100. WIK's long-run incremental cost model computes an "annual capex cost": the model runs over a period of 60 years with certain assumptions on penetration and roll-out costs; and once an asset has come to the end of its lifetime, it is replaced. In the model, which corresponds in its methodology to LRIC models used by Ofcom to compute regulatory charges, WIK estimates an annual real 2013 capex cost of £37.32 per line.[103]

WIK's estimated figures for capex costs can be placed into the context of retail prices on the one hand, and downstream capex on the other. As of May 2015, BT offers superfast broadband, including line rental and free weekend national calls, for around £350 per year,[104] implying that the annual capex cost for upgrading to FTTC as computed by WIK is between 10% and 11% of annual retail revenues. In comparison, BT Consumer's investment into premium sports rights for Premier League and Champions League football alone amount to around £550m per year for 2015/16, and around £620m per year for 2016/17 and 2017/18.[105] BT has a retail broadband subscriber base of around 7.7m, of which around 3m have been converted to superfast broadband. Around 3.3m have access to BT Sport, a figure rising to 5.2m when wholesale deals are taken into account.[106] The annual cost of football rights per BT Sport subscriber (retail and wholesale) is therefore around £100-120. In terms of broadband subscribers, annual costs are around £70 to £80 when considering the full subscriber base, around £160 to £187 when considering BT Sport broadband subscribers, and around £183 to £206 when considering only SFBB subscribers.

102 WIK Report 2014, p. 13; £2.5bn figure as quoted in BT's Annual Report 2013, p. 12.

103 WIK Report 2013, p. 43 shows a capex cost of £3.11 per month

104 See http://www.productsandservices.bt.com/products/options/new-customer.html, accessed on 10 May 2015

105 The figures correspond to £246m per season for Premier League rights through the 2015/16 season, increasing to £320m, and for Champions League rights of £299m per season from 2015/16 for three seasons.

106 All figures in this paragraph from BT Annual Report 2015, p. 66

Thus no matter how one looks at the content cost, it is far in excess of WIK's estimated annualised capex cost of upgrading the local loop. The investment risk and potential hold-up problem is therefore not excessively large relative to other investments that BT (and indeed other operators) make.

There is also public funding available for the extension of FTTC roll-out to 95% of households through government agency Broadband Delivery UK – which significantly reduces the investment potentially liable to hold-up for Openreach for that additional roll-out. In Phase 1, central government investment of £530m is intended to help bring coverage of fibre-to-the-cabinet to 90% of premises by 2016, and in phase 2 a further £250m are intended to extend coverage to 95% of premises by the end of 2017. These funds are supplemented by local authorities, so that current funding for all broadband upgrades is around £1.7bn. Broadband upgrades are organised through 47 individual projects.[107] This public funding has been notified as State Aid to the European Commission, with individual projects being tendered and the winner promising to top up the investment with its own funds. Further public funding is in place in the form of the UK Guarantees Scheme, which will support Virgin Media's own proposed £3bn investment[108] in the upgrade of its cable network.[109]

6.2. Could structural separation between BT and Openreach lead to a significant hold-up problem?

Having invested to build out FTTC to 70% of premises, BT is naturally considering whether to invest further to upgrade its local loop network. The next stage could be to lay fibre to the distribution point (FTTdp) and use xDSL technology that is highly effective over very short distances (such as G.Fast). However, other upgrades are also possible, such as, for example, a more selective roll-out of FTTP. Could this further investment be argued to give rise to a hold-up problem, in case BT were structurally separated from Openreach? And – retrospectively – would Openreach have been at the risk of hold-up regarding its almost complete upgrade to FTTC if it had been structurally separated?

Building on the framework developed in this report in Section 2, we consider first whether the conditions could be claimed to exist for a material hold-up problem, and then discuss potential contractual solutions.

6.2.1. Assessing the factors that determine the size of the hold-up problem

Our review of the literature around hold-up has identified a number of factors (product and market characteristics) that impact on the severity of the hold-up problem. For the details of these characteristics and how they influence the hold-up problem we build on Sections 2 and 3 of the report. For empirical evidence supporting our findings we refer to Section 4, while case studies on hold-up problems in a number of industries are found in Section 5.

107 https://www.gov.uk/government/policies/transforming-uk-broadband/supporting-pages/rural-broadband-programme

108 Virgin Media News Release of 13 February 2015 "Virgin Media and Liberty Global announce largest investment in UK's internet infrastructure for more than a decade"

109 Department for Culture, Media and Sport, HM Treasury, *The digital communications infrastructure strategy*, 18 March 2015, section 3.2

The most important characteristics that we find to influence the severity of the hold-up problem are (i) asset specificity (Section 2.2.1), (ii) intensity of downstream competition (Section 2.2.3), (iii) importance of specific investments by (downstream) counterparties (Section 2.2.4), (iv) degree to which investments are sequential or lumpy (Section 2.2.5), and (v) uncertainty (Section 2.3). We review briefly below how the circumstances of local loop upgrades by BT fare against these criteria.

6.2.2. Asset specificity

We recall that "asset specificity" refers to whether the salvage value of the investment the upstream firm makes is low relative to the cost it incurs. In contrast to copper cables that have a significant scrap value, once the fibre is in the ground, it is impractical to use it anywhere else. Indeed, the cost of the fibre cable is significantly lower than the civil works cost to bury it in the ground. The cost is therefore sunk. There are additional investment costs for activating the fibre, and while equipment can be relocated if needed, this represents only a small part of investment cost. The value of *S* used in the example presented in section 3.1.2. would therefore be assumed to be small compared to the value of *K.*

The *effective* specificity of assets can also be mitigated by sequencing the investment over time. This caveat applies with full force to fibre deployment since it is eminently modular (i.e. one does not need the whole network to be upgraded for fibre to have value). Overall then, the *economic* specificity of the investment should not be overstated.

In addition, "taking the fibre out of the ground" is not the only option open to Openreach, were it to be held up by a potential user. Fibre in the local loop can address different customer groups with different demands. Businesses demand fast fibre connections for different reasons relative to residential customers. To the extent that businesses share the same fibre or ducts, that fibre would have an alternative usage. In addition, most industry observers believe that the topology of future mobile networks will evolve to combining a so-called "small cell network" with a "macro-cell network". Fibre in the local loop is ideally placed to provide the fixed back-haul links to small cell networks, in particular when base stations are placed in street cabinets. We note that in October 2014, Openreach launched the "Mobile Infrastructure Infill Solution" (MIIS). Since Openreach owns telegraph poles, it can offer to place antenna on these poles and then connect the antenna to the nearest street cabinet which has fibre installed. It can be expected that this form of small cell backhaul will provide a significant amount of additional revenue that can be extracted from the Openreach FTTC deployment. Asset specificity is therefore significantly reduced.

6.2.3. Downstream competition

The downstream retail market for fibre-based broadband access has at least three active competitors with non-negligible shares: BT Consumer (around 39%), the vertically integrated downstream firm, faces competition from Sky (25%), TalkTalk (19%), EE (4%) and others (around 13%).[110]

110 The market share of Virgin Media is not included here since it does not bargain with Openreach over access. Virgin Media however plays an important role in providing incentives to invest in upgrades since the standard broadband technology becomes increasingly unattractive as Virgin Media moves

What matters for the question of hold-up is whether competition between those firms seeking access to the upstream input exists, as this changes the bargaining position between the access seekers and the upstream infrastructure provider. As explained earlier in this report (Sections 2.2.3 and also 3.1.2), the hold-up problem is *reduced* when there is downstream competition, because with more rivals, the bargaining position of each downstream firm is weakened. Essentially, a downstream firm has little ability to hold up BT Openreach: it would lose significant market share when it does not have access to the new fibre infrastructure, while its rivals do. Given how competitive the downstream UK market has become, it is clear that each downstream operator would be sensitive to losing material market share, and it is hard to imagine how any of them would have the ability to hold up Openreach to any material extent. Downstream competition is also important since the existence of significant 3rd party retail channels for the upgraded Openreach technology substantially reduces the benefit of vertical integration for investment (Section 3.1.2). It is also relevant that the downstream access seekers we have identified are in competition themselves with OTT services providers. The existence of OTT providers (such as in particular video or music streaming services) further intensifies the competition downstream which in turn reduces the ability of downstream access seekers to hold up Openreach.

We note that BT Consumer's share of SFBB far exceeds that of overall broadband by far. At the end of 2014, BT Consumer had in excess of 70% of all SFBB over fibre lines. While, as we show here, the conditions for structural separation are present, in fact the regulatory forbearance shown towards BT / Openreach as regards FTTC deployment weakens the constraint on the hold-up problem imposed by downstream competition.

6.2.4. Downstream investments

When discussing the extent of Openreach investment into local loop upgrades, we have already noted that downstream investments are high. For example, it is BT Consumer's stated aim to sell more broadband connections by providing premium content.[111] BT Consumer first started bidding for premium football rights in 2012, notably 2 years after launching its FTTC upgrade. For premium football rights alone, BT Consumer has annual fixed costs of almost £550m (rising to £620m in 2016/17), which it aims to recuperate to the largest extent from its broadband subscriptions, and in particular hopes to induce more subscribers to upgrade to SFBB.

It is not only BT Consumer which invests heavily in content. Sky has a significant broadband subscriber base (around 25% of copper/fibre subscribers) and offers increasingly hybrid services (such as box sets of TV shows on demand). TalkTalk now also offers television services. In addition, OTT content providers have invested heavily into their services. Other content providers offer services such as iPlayer, AppleTV, Netflix, Blinkbox, Now TV, LoveFilm, YouTube, Google Chromecast, Spotify, Deezer, Qobuz and so on. Lastly,

to faster broadband technologies; and further, Virgin Media reveals significant information regarding the nature of demand for high-speed broadband products.

111 BT Annual Report 2014, Strategic Report, p. 17, "Our strategy is to invest in broadband-based services that help consumers get more from being connected. This will help us to win new customers and keep existing ones in a competitive market."

equipment manufacturers create more and more connected products that require higher bandwidth. Ultra HD is a prime example of this development. The investment undertaking by these third firms provides a substantial increase in demand for broadband speed and to a significant extent requires the availability of fast broadband. We note that BT itself recognises the importance of third party services for broadband demand in its 2015 Annual Report:

> *Demand for superfast broadband continues to grow as more people consume media online through over-the-top services such as Netflix, ITV Player and BBC iPlayer. 59% of UK adults used video streaming services in 2014.*[112]

Investments in content may be partly dependent on the investment in fibre undertaken upstream by Openreach since such investment improves the quality – and hence the value – of delivered content. Firms that enter into long-term content contracts under the expectation that the fibre infrastructure would keep expanding might therefore be "held up" by Openreach network upgrades.

There are therefore good reasons to believe that a kind of mutual deterrence arises through hold-up occurring on both sides of the upstream-downstream relationship. This would help minimise the potential chilling effect of hold-up on both parties' incentives to invest.

There are however signs that BT as a group attempts to limit 3rd party downstream investments into technological differentiation. With standard broadband, 3rd party access seekers have the possibility to rent passive copper pairs (the "Metallic Path Facility"). This is currently not possible for SFBB. Instead, 3rd parties are required to act more like resellers of the Openreach product GEA-FTTC. Such resale allows for significantly less product differentiation and therefore induces lower downstream investments into technology. The technological limits on downstream investments could increase the size of the hold-up problem in the same way that regulatory forbearance on pricing has a negative impact on downstream competition. A solution to that risk would be to provide additional means of accessing the upgraded infrastructure, such as access to the passive elements only.

6.2.5. Sequential investments

A significant reason why hold-up problems are limited in the case of Openreach network upgrades is that the upgrades happen over a number of years, and therefore with repeated interaction between the upstream and the downstream firm.

While for SFBB BT might have announced a roll-out up to 70% of UK premises, in reality roll-outs are carried out by exchange area. For the potential upgrade to FTTdp, upgrades can be carried out on the basis of individual street cabinets. Also the BDUK rural broadband project is carried out in 44 local regions.

During a network upgrade, Openreach sequences its steps so as to address more profitable local areas first. The WIK report 2013 claims that Openreach first targeted areas in which Virgin Media was not active. It states that in 2011, 48% of Openreach upgrades were outside cable areas.[113] The investment was therefore carried out to maximise take-up by avoiding the main infrastructure competitor. Even within exchange areas, Openreach does

112 BT Annaul Report 2015, p. 64

113 WIK Report 2013, p. 6

not necessarily build out fibre to each cabinet. Instead, it appears to assess how many customers might be willing to upgrade to SFBB and then rolls out to the respective cabinets first. When accessing BT’s SFBB “Where and When” internet site,[114] four types of cabinets are listed for an exchange area: “accepting order”, “high demand” (cabinet is full), “enabled area” (cabinet not upgraded), and “under review” (whether cabinet will be upgraded). Such cabinet-by-cabinet segregation further limits any hold-up issue.

The time horizon of upgrades also shows that investment is gradual and therefore upstream/downstream interaction is repeated. As discussed in section 3, this allows the investor to react to any attempt to hold up a slice of its investment by modifying its future investment behaviour either to reduce his exposure to further hold-up or to “punish” any party that engaged in opportunistic behaviour. In this respect, we note that BT used this gradual progression of investment to repeatedly modify its roll-out plans. BT carried out trials of SFBB in 50 homes in Foxhall, Ipswich in January 2009 and launched the SFBB service commercially on 25 January 2010. In 2009 the plan for roll-out was meant to cover 45% of homes in the UK for a total investment cost of £1.5bn. In 2010, investment plans were upgraded to reach around 70% of UK households at a stated cost of £2.5bn (but see above that this cost could be inflated). The roll-out according to the 2010 plan was largely completed in 2014.

The interaction between upstream and downstream firms is therefore indeed long-term, and repeated. The repeated interaction allows for revisions of investments. In particular if hold-up problems occurred, new investment might be curtailed. In the Openreach case, investment was expanded from covering 45% to 70% of the population within one year. This would suggest that hold-up was not an issue. While we regard BT as integrated, we also note that BT had a retail market share of a size such that additional investment incentives from that vertical integration can be regarded as small (see Section 3.1.2).

6.2.6. Uncertainty is limited by the wealth of available information

As discussed in Section 2.3, it is sometimes argued that vertical integration assists the upstream part of a firm to gain better information regarding downstream demand. We note however that the results from the empirical literature on this issue are at best mixed (Section 4.2).

We do not believe that uncertainty poses a very significant problem for Openreach investment, however. From a technical perspective, bandwidth demand growth appears relatively predictable. It can be traced to downstream innovations (such as new streaming services) which are verifiable and for which data is generally available.

The presence of Virgin Media as a direct competitor relying on a different technology also means that data is available regarding the willingness to pay for new products. While Openreach operates upstream, it will be aware of the margin required by downstream firms and therefore can assess with significant accuracy if, taking the Virgin Media price as a benchmark, a certain expected penetration in a street cabinet area will make a build-out profitable.

Further, the geographic roll-out, which Openreach appears to carry out cabinet by cabinet also suggests that Openreach must be able to predict quite well how high the likely uptake

114 http://www.superfast-openreach.co.uk/where-and-when/

for SFBB for particular cabinets would be. This is even more so the case since Openreach itself offers the active product GEA-FTTC that allows it to measure the traffic consumed. Openreach therefore has significantly more direct consumption information from SFBB than, say, from unbundled local loops.[115] That additional traffic information, combined with the gradual investment approach, means that uncertainty is likely to be limited.

If Openreach were a separate entity, it could nevertheless observe downstream activities of its access seekers. For example, Openreach would be able to follow user numbers of BT Consumer's entry into TV (which occurred already in December 2006 under the brand of "BT Vision" and therefore significantly before the decision to upgrade the local loop) and would have access to investor information of BT Vision/TV, as it would for Sky, TalkTalk or other services that drive downstream demand.

As highlighted above in the discussion of downstream investments, within the same time period that BT established its TV service BT Vision (now BT TV) other 3rd party drivers of demand for fixed broadband (Netflix, Youtube, LoveFilm, iPlayer, SkyGo, HDTV Smart TV, smartphones, tablets) which are measurable and verifiable had emerged. In the case of those OTT services, the upstream provider Openreach has as much information as the downstream retailer BT Consumer. Both only see the traffic that OTT services generate but cannot see to what extent consumers are paying for additional content. Regarding the resolution of uncertainty for the demand of these services, it is therefore irrelevant whether BT Consumer and Openreach are vertically integrated.

6.2.7. Summary of factors that could lead to a hold-up problem for Openreach

The table below summarises the different product and market characteristics that influence hold-up for Openreach. Overall, we find that only the extent of technical asset-specificity would lead one to think that a hold-up problem might arise. However we also saw that there are several reasons to believe that the degree of *economic asset-specificity* - which is the relevant concept for assessing the risk of hold-up - is itself quite limited.

Moreover, one can observe significant mitigating factors for a hold-up problem: there is active downstream competition; downstream investment is high, observable, and carried out by the firms demanding broadband service and also by third party OTT providers. Uncertainty in fact appears to be contained very well through a gradual investment process.

Overall, therefore, there is reason to believe that the hold-up problem is small in the first place. Moreover, as we discuss below, it can be addressed by reasonable modifications to existing regulated contracts.

Table 7: Factors that may increase the risk of hold-up for Openreach

Factor	Findings
Asset specificity	Yes, but limited by modularity of investment and emerging alternative use of small cell backhaul
Absence of downstream competition	No – active downstream competition

115 Although,even with LLU, Openreach can ascertain detailed consumption data because it knows both the LLU operators' subscriber volumes and more often than not also provides dedicated and measurable backhaul capacity to the LLU operator

Absence of downstream investments	No - high downstream or 3rd party investments
One-time bilateral interaction	No – repeated interaction through local geographic decisions
Uncertainty	Limited - Addressed through the availability of significant own subscriber and market information and the gradual investment process

6.3. Any residual hold-up problem of Openreach can be resolved through contracts

The theme of this report is that in most situations, contractual solutions exist for the hold-up problem. What those solutions are in practice depends on the specifics of the case that one considers. We refer the reader to the wealth of industry case studies that are presented in Section 5.

In the previous section we have explained that, when applying to the case of Openreach the "grid" of criteria which we identified in Sections 2, 3 and 4 as "increasing" or "mitigating" a hold-up problem, it is clear that multiple factors tend towards mitigating the problem. There is active downstream competition, downstream investments are carried out by 3rd parties, there is repeated interaction between the upstream and downstream parties, and uncertainty appears to be contained through the gradual investment process.

But to the extent that a residual issue exists because investments are sunk to some degree, solutions other than vertical integration are available.

6.3.1. Would a persistent link between Openreach and BT materially address the hold-up Issue?

As seen in Section 3, vertical integration has no effect on investment incentives as long as the downstream market share of the vertically integrated unit is small relative to the "non-sunk" portion of the investments (Section 3.1.2). Indeed, the numerical example that we used to illustrate the point relied on a downstream market share (30%) that is of the same order of magnitude as BT's. We saw that, in that case, only extreme proportions of sunk costs made it possible for integration to have any effect on the upstream firm's incentives to invest.

We have already noted that business demand and small cell mobile backhaul are alternative uses that reduce the asset specificity and therefore the sunk nature of the investment.

The current level of BT's downstream integration is therefore very unlikely to increase its incentives to invest much, especially considering the wealth of contractual solutions that are available and have proved sufficient in many other industries.

6.3.2. The regulatory context of NGN investments helps deal with any issue

Openreach operates within the context of a regulated industry, which expands the number of solutions to any residual hold-up problem, as the regulator can potentially use its own commitment power to offer guarantees to Openreach (the upstream investor).

Ofcom’s presence as a regulator changes the interaction between the players. First, a regulator can provide a more stable framework for the enforcement of contracts and assist dispute resolution. Second, it can aim to achieve a socially efficient outcome rather than the market outcome that would arise. It does so by restricting or modifying contracts. While in a free market, firms’ bilateral bargaining can be represented by Nash bargaining (the concept we have used in our running example of Section 2), a regulator has no obligation to impose the Nash bargaining solution, but can instead mandate a contract that shifts the bargaining power from one party to another. Contracts imposed by a regulator are therefore not restricted to contracts that would arise in a free unregulated market.

The additional freedom gained in the design of contracts through the regulated environment allows for greater flexibility in addressing any remaining hold-up problem that would arise from the structural separation of Openreach.

6.3.3. Contracts can solve an Openreach hold-up problem while continuing to promote competition through 3rd party access

It would seem to us that – once the factors on which hold-up depends are specifically considered – this is unlikely to be a major source of concern for Openreach even if it were to be fully separated from BT. And because Openreach operates in a regulated environment, it should be possible to enhance the enforceability of contracts that would ensure an appropriate rate of return on investment.

But even leaving aside any reliance on regulatory oversight, residual hold-up concerns – if they exist - can be solved by contracts that address remaining issues. There are several possible contractual features that allow for setting access prices that minimise hold-up and therefore provide sufficient investment incentives. For the purpose of illustration, examples of these contracts are:

Fixed fee contracts. Such contracts require the payment by the access seeker of a fixed fee for the investment, irrespective of customer numbers. They are in a sense similar to spectrum fees in that they enable third party access seekers to access the technology but further costs are incurred when the technology is used.

Ex ante contracts. A payment is made before the attractiveness of the investment is known. Essentially, the investment is shared by the investing firm and the downstream firm. This form of contract could also be carried out selectively in the form of a true 3rd party “anchor tenancy”.

Ex post contracts with fees dependent on the success of the technology. Under standard access fee contracts, the investing firm does not benefit from an upside when the technology is successful but faces the risk of slow take-up when the technology fails to expand demand, since 3rd party access seekers have the option of not asking for access. That potential hold-up problem can be addressed by ex post contracts when these are modified to allow for varying returns.

6.4. Conclusion

Our discussion of hold-up in the earlier sections suggests that, both from the perspective of theory and that of industry experience, potential hold-up issues can be effectively addressed outside of a vertically integrated framework. In this section we applied these insights to the question of the structural separation of Openreach.

We found that the characteristics identified in the theory as determinative of the hold-up problem are either not present or well contained. Any hold-up problem must therefore be regarded as small.

Industry experience that we surveyed suggests that contracts can usually be found to address any residual hold-up problem. In the context of telecommunications as a regulated industry, hold-up issues are further minimised since the regulator can assist by providing greater assurance that contracts are enforced and by expanding the set of contracts that can be implemented.

ANNEX A: AN ILLUSTRATIVE SIMPLE MODEL OF HOLD-UP

We present a simple bargaining analysis which supports some of the points made in sections 2 and 3 of the main text. We use the following example throughout. There is one upstream firm U and one downstream firm D. The upstream firm can make an investment which would improve the profitability of the downstream market. If the upstream firm invests 100 to improve the quality of the inputs that it supplies to D, then D’s profits increase by X > 100. As the increase in surplus created by the investment is larger than the investment cost, efficiency demands that the investment be carried out. But will it be?

Let us contrast two situations. In the first situation, U and D can bargain *before* the investment is made. The agreement that they reach involves a contractual promise from D to make a payment F to U if U does indeed make the investment of 100. It is readily shown that, if the two parties are equally able negotiators, the Nash Bargaining Solution to their negotiation is

$$Max_F[F-100][X-F]$$

So that the agreement would involve a payment equal to

$$F=\frac{X+100}{2}\geq 100$$

Since this payment covers at least the cost of investment, investment takes place whenever it is efficient (X > 100).

Let us now assume that, for some reason, the firms cannot contract before the investment expenses have been sunk. Assume further that, if the parties cannot reach an agreement, then U could get some “salvage” revenue payment $S<100$ for its investment. This reflects the (partially) sunk nature of the investment: outside of the relationship between U and D, the investment would not be economically justified. The Nash bargaining Solution is

$$Max_F[F-S][X-F]$$

So that

$$F=\frac{X+S}{2}$$

Therefore, the investment project is only undertaken if $X>200-S$. Hence, as long as some of the investment is sunk (S < 100), then there are values of X for which the investment should be made, but will not be.

Finally, let us consider an intermediate solution where the parties can agree on a contract ex ante but there is only a probability P that the contract can be enforced once the investment has been undertaken. If the contract cannot be enforced, then the party must bargain all over again. In this case, the Nash Bargaining Solution is

$$Max_F\left[PF+(1-P)\tfrac{X+S}{2}-100\right][X-PF-(1-P)\tfrac{X+S}{2}].$$

Notice that we assume that, absent agreement the investment is not made.

The corresponding payment that the upstream firm can get is equal to

$$F=\frac{P(X+S)+100-S}{2P}$$

This means that the reward that the investor can expect ex ante is equal to

$$E(C) = P\left[\frac{P(X+S)+100-S}{2P}\right] + (1-P)[\frac{X+S}{2}]$$

As the previous example shows clearly then, the extent of the "hold-up" problem that might arise between the two non-integrated firms U and D depends on two main factors: the degree of "relationship specificity" of the investment, i.e. the difference between 100 and S, and the ability to enforce ex ante contracts.

Allowing for partial vertical integration

The extent to which vertical integration might help preserve investment incentives also depends on the degree of vertical integration. If the downstream unit of the vertically integrated firms only accounts for a proportion Y of the downstream market, the hold-up problem will be reduced less than if there is complete vertical integration between the upstream and downstream parts of the market. Returning to our ongoing example – and neglecting for now competition between downstream users – the Nash Bargaining Solution with partial vertical integration is

$$Max_F[F + YX - Max(S, YX)][(1-Y)X - F]$$

So that the expected payment that an upstream division, which is integrated with a downstream unit which accounts for a proportion Y of the downstream market, is given by

$$F = \frac{X - 2XY + Max(S, XY)}{2}$$

Of course, the integrated firm now also enjoys the benefits of using the investment itself, i.e. YX so that its total compensation for incurring the investment expenses is equal to

$$C = \frac{X + Max(S, XY)}{2}$$

This gives us an important insight: vertical integration only increases investment incentives if the downstream arm of the investing unit has a sufficient downstream market share, i.e. if

$$Y > \frac{S}{X}$$

This gives us an idea of how important the type of vertical integration that BT would enjoy in the absence of vertical separation might be for BT's incentives to invest upstream. BT's presence downstream would be approximately 30% (Y = 0.3). Consider an investment of 100 which would have a 30% rate of return (i.e. X =130) then BT does not get any additional incentives from vertical integration as long as the proportion of the investment that is sunk (i.e. 1- S) is smaller or equal to 0.61. For a higher proportion of sunk cost, vertical integration would only increase BT's reward from investment by 9%. The table below reports the percentage increase in BT's investment-related revenues as a function of the degree of specificity of the investment. We see that vertical integration has no effect on investment revenue – and hence on investment incentives up to the threshold of sunk cost which we have just defined. Beyond this threshold, the additional investment incentive due to vertical integration increases as the proportion of sunk cost increases. It is only if the whole investment is sunk that BT's investment-related income would increase by a percentage equal to its downstream market share.

Table 1.a. Investment Incentives and vertical Integration

(100 – S)/100	0.25	0.5	0.61	0.75	0.9	1
Increase in Investment Revenue	**0 %**	**0 %**	**0 %**	**+ 9 %**	**+ 20.7 %**	**+ 30%**

Hold-up with competition in the downstream market

We model competition by assuming that there are two downstream firms. If each firm gets access to the upstream investment, then the firms share the additional profits X equally. If only firm 1 gets access to the upstream investment then it gets a proportion $\alpha > 0.5$ of X while the profits of the other downstream firm actually decrease by βX. The precise relationship between α and β would depend on the nature of downstream competition. Clearly, the more intense downstream competition, the larger is β. To determine the equilibrium payment when both downstream firms do get access to the new facility, we look at the negotiation between the upstream firm and one of the downstream firms (firm 1), assuming that the other firm (firm 2) has reached an agreement for a fee equal to F_2. Since we are looking at a situation where ex ante contracts cannot be written/enforced, we consider the negotiations that arise once the investment has been made. This means that the upstream firm can only recover S out of the 100 worth of investment if it cannot reach agreement with the two firms. There are two cases to consider.

Firm 1 is not pivotal

A downstream firm is pivotal if, in the absence of an agreement with that firm, the upstream firm would prefer to pocket the salvage value of the investment S to making the facility available to a single downstream firm. In other words, Firm 1 would be pivotal if $F_2 < S$. For now, let us assume that firm 1 is not pivotal, i.e. that $F_2 \geq S$. Then the Nash Bargaining Problem that represents the negotiation between the upstream firm and firm 1 is:

$$Max_{F_1}[F_1 + F_2 - 100 - (F_2 - 100)][\frac{X}{2} - F_1 + \beta X]$$

So that

$$F_1 = \frac{X}{4} + \beta\frac{X}{2}$$

Since the upstream firm would collect the same amount from firm 2, its total reward is

$$F_1 + F_2 = \frac{X}{2} + \beta X$$

We can now check the conditions under which our assumption that firm 1 would not be pivotal is satisfied:

$$F_2 < S \leftrightarrow X > \frac{4S}{1 + 2\beta}$$

So it must be that the salvage value of the investment is small and/or downstream competition is intense (large β).

Without competition downstream, the investor could expect a revenue equal to

$$\frac{X+S}{2}$$

Hence downstream competition increases revenues if

$$\frac{X}{2}+\beta X > \frac{X+S}{2} \leftrightarrow X > \frac{S}{2\beta}$$

This condition is implied by the condition required for us to be in the “non pivotal” case if

$$\frac{4S}{1+2\beta} \geq \frac{S}{2\beta} \leftrightarrow \beta \geq \frac{1}{6}$$

In other words, when neither downstream firm is pivotal, then downstream competition increases the reward to the upstream investor if downstream competition is sufficiently intense. Notice that, if we increase the number of downstream firms, the likelihood that any single firm is pivotal becomes vanishingly small, so that this “non pivotal” case would be the relevant one.

Firm 1 is pivotal

This means that, if an agreement cannot be reached with firm 1, then the upstream firm will decide to get the salvage value for its investment. Hence the Nash Bargaining Solution is:

$$Max_{F_1}[F_1+F_2-100-S][\frac{X}{2}-F_1]$$

So that

$$F_1 = \frac{X}{2}+50+\frac{S}{2}-\frac{F_2}{2}$$

Using symmetry we get

$$F_1 = F_2 = \frac{X+S+100}{3}$$

And the total reward to the investor is

$$F_1+F_2 = \frac{2(X+S+100)}{3}$$

We now check the conditions for firm1 to actually be pivotal, i.e.

$$F_2 < S \leftrightarrow S > 50+\frac{X}{2}$$

Since we must have S < 100 < X, this condition cannot be satisfied. Hence, with two downstream firms at least, the only relevant case is the case where neither firm is pivotal.

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