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Separation Anxieties:
Structural Separation and Technological Diffusion in Nascent Fibre Networks

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September 2014

Paper presented at the Telecommunications Policy Research Conference, 14 September 2014 at George Mason University Law School, Arlington, Virginia. This version replaces the conference paper version of August 2014 available on SSRN.

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Abstract

Vertical separation of upstream network operations from downstream retail activities, as the most extreme form of access regulation, has long been considered a legitimate regulatory remedy against use of market power in upstream infrastructure markets to engage in price- and non-price discrimination to foreclose competition in downstream retail markets. However, the remedy is increasingly being mandated for new networks, sometimes before any investment has been made. This paper uses theories of General Purpose Technologies and regulatory economics to consider how vertical separation – compared to both access regulation and no regulation - poses challenges to the ability to maximise scale economies at the early stage of a network life-cycle. This suggests greater caution in its use at this stage compared to middle and mature phases of the life-cycle. The theories are examined via case studies of two markets where vertical separation has been mandated for Fibre-to-the-Home networks – Australia and New Zealand – and one where it has not – the Netherlands. The case studies suggest that mandatory separation imposes additional constraints on the network owner's ability to achieve scale economies arising from rapid uptake of a new network relative to access regulation when it fails to replicate amongst any retailers the vertically-integrated operator's incentives to engage in aggressive early-stage marketing. Analysis also suggests that contractual limitations may have greater effect on the ability to achieve scale economies than structural impositions and ownership limitations.

Vertical separation of upstream network operations from downstream retail activities has long been considered as a potential constraint on the abuse of extant market power by incumbent network operators engaging in price- and non-price discrimination to foreclose competition in downstream retail markets. Despite apparent costs and risks, separation of the incumbent's copper operations from retail activities has been adopted in several jurisdictions, both voluntarily and compulsorily as a regulatory remedy. Increasingly, separation is being proposed as a means of preventing the (potential or actual) accrual of future market power by the firms deploying Next-Generation Access Networks (NGANs) such as Fibre-to-the-Home (FTTH) and Fibre-to-the-node (FTTN). For example, it is mandatory for government-subsidised FTTH networks in Australia, New Zealand and Singapore.

As separation is the most extreme form of access regulation, and access regulation is coming under increased scrutiny for its effects on investment incentives, questions arise about the effects on investment incentives when 'preventative' separation is mandated for a nascent infrastructure that has yet to be built. These questions pertain not just to the magnitude and timing of investment in the network elements, but also in the downstream retail activities necessary to market the new technology and encourage existing subscribers to the legacy networks to substitute to the frontier technology. Specifically, what effects might arise for both upstream and downstream investment incentives when the co-ordinating activities internalised within a vertically-integrated firm are severed by separation? And how might these incentives play out differently during the early stages of a technology's life-cycle (as is occurring in the separated FTTH networks) relative to the later, mature stage, where recent analysis of copper network regulation has shown that access regulation per se, and vertical separation as its most extreme form, have had potentially significant effects on the likelihood, magnitude and timing of investment in new networks?

This paper addresses these questions.

Section One provides a literature review of vertical separation in telecommunications, in the context of access regulation. Section Two examines the theoretical implications for both network investment and retail incentives arising from vertical separation. This section utilises theories from the economics of General Purpose Technologies to identify the different stages of a technology's life cycle to create a case that the scale economies available during the early stages of the diffusion of a network with very high fixed and sunk costs will lead to different optimal industry structures than in the middle and later stages of the life-cycle when the early scale economies have been exhausted. Both access regulation and vertical separation create barriers to appropriating scale economies in order to maximise the welfare benefits of investment in frontier networks. However, vertical separation imposes further barriers as it prevents any retailer from facing financial incentives to sell as many connections to the new network as quickly as possible in order to appropriate the scale economy effects from a sharply-declining average cost curve. Where separation is not mandated, then the network's downstream retailer (at least) shares these incentives, so will invest in and undertake marketing activities aligned with rapid uptake of the new network. Thus, *ceteris paribus*, mandatory separation would appear to militate against rapid uptake (diffusion) of the frontier network.

Section Three uses case studies to explore the effects of structural separation on frontier network diffusion rates. Two countries where structural separation of the FTTH networks have been mandated in advance of investment – Australia and New Zealand – are compared with one where no separation mandates have been imposed – The Netherlands. In the latter case (within the confines of access regulation), the market participants have been free to allow the FTTH market structure to evolve in response to financial incentives. Section Four concludes.

1. Vertical Separation: Foreclosing Foreclosure

Vertical separation of upstream network operations from downstream retail activities has long been considered a potential constraint on the abuse of extant market power by incumbent network operators engaging in price- and non-price discrimination to foreclose competition in downstream retail markets (Laffont & Tirole, 2002; Xavier & Ypsilanti, 2004; de Bijl, 2005; Cave, 2006). In the telecommunications context it is an extreme measure, initially proposed as an ultimate sanction for an access-regulated firm denying a competitor regulated access to an essential good or service with the intent of extending its monopoly power from that segment into a potentially competitive segment (Rey & Tirole, 2007; Laffont & Tirole, 2002). In 2007, the European Commission allowed that functional separation, where the regulated firm is required to separate functions, employees and information, but may maintain common shareholding, but not ultimate ownership, "could therefore be considered where all other regulatory tools have proved inadequate to address market and competition failures" (European Commission, 2007, p. 43).

Despite its appeal in managing risks of downstream foreclosure, separation is not without costs and risks. Telecommunications networks have sizeable economies of scale and scope enabling cost synergies which arguably are lost when separation of a single vertically-integrated operator is mandated (Gonçalves & Nascimento, 2010; Howell, Meade & O'Connor, 2010). It is subject to many of the same concerns about potential diminishing of investment incentives for both incumbents and entrants as access regulation, of which (in the primacy given to the development of services-based competition over infrastructure competition), it is the most extreme form (Tropina, Whalley & Curwen, 2010; Brito, Pereira & Vareda, 2011). Furthermore, under certain circumstances, even though separation eliminates discrimination, it is not guaranteed to increase welfare (Chikhladze &Mandy, 2009; Brito, Pereira & Vareda, 2010; Heatley & Howell, 2010a; 2010b).

Notwithstanding, functional separation of the incumbent telecommunications operator has been adopted in several jurisdictions, including the United Kingdom (Cadman, 2010), and Italy (Nucciarelli & Sadowski, 2010; Mancuso, 2012), and is considered favourably in several others (Tropina, Whalley & Curwen, 2010). After briefly experimenting with functional separation, New Zealand mandated full structural separation of its copper incumbent in 2011, as a condition of its participation in the government-subsidised Ultra-Fast Broadband project (Howell, 2012; 2013).

Despite cautions about its status as an extreme and likely irreversible measure (de Bijl, 2005), separation has not always arisen from principled economic analysis. Regulatory theory posits that separation may be justified when the incumbent firm's market power in the relevantly-defined market has been established, other less-intrusive forms of access regulation have failed to bring about the desired competition in the downstream market, there is evidence of discrimination occurring, and a cost-benefit analysis confirms that network separation will be both of net benefit and more effective than any other regulatory remedy (Kirsch & von Hirschhausen, 2008; Gonçalves & Nascimento, 2010). However, no example appears to exist of separation being adopted as a regulatory remedy on the basis of a principled inquiry including a favourable empirical cost-benefit analysis. In the United Kingdom, functional separation was voluntarily adopted by incumbent as part of a negotiated arrangement with the regulator (Cadman, 2010). In New Zealand, both functional and structural separations were imposed via legislative fiat, bypassing the typical regulatory processes for assessing the implementation of such remedies, with minimal supporting policy analysis and no empirical analysis (Howell, 2009; 2010). Arguably, its use in these cases was motivated more by the desire to sanction an incumbent for past transgressions than from a principled analysis of future market structure options in a technologically-dynamic industry.

Increasingly, separation is also being proposed as a regulatory means of preventing the (potential or actual) accrual of future market power by the firms deploying Next-Generation Access Networks (NGANs) such as Fibre-to-the-Home (FTTH) and Fibre-to-the-node (FTTN) (Kirsch & von Hirschhausen, 2008; Huigen & Cave, 2008; Whalley & Henten, 2010; Cadman, 2010). In some countries – notably Australia, New Zealand and Singapore – structural separation has been mandated for FTTH networks as a condition of government funding (Given, 2010;

Given & Middleton, 2010; Howell, 2012). Whilst, arguably, separation of FTTN operators might be considered to continue the regulation of an incumbent operator (as FTTN investment enhances existing infrastructure), the same cannot be said of separation of completely new FTTH networks. This begs the question of whether separation of FTTH networks has been proposed for its economic merit in governing the development of emerging markets as the legacy copper infrastructure is replaced by frontier fibre technology or, as in past use of copper separation, it is primarily a means of constraining an incumbent firm exhibiting dominance and potentially discriminatory behaviour in the legacy markets from transferring that power into frontier markets. In the absence of empirical analysis, it cannot be excluded that regulatory focus is primarily on a specific firm rather than on the evolution of the market in which the new network will be deployed. The distinction is material because, for a transition period at least, the frontier and legacy networks will compete with each other for retail consumers. This is fundamentally different from the situation when ADSL as the frontier internet access technology superseded legacy dial-up (and indeed, as VDSL supersedes ADSL), as both were provided on the same copper network.

2. Regulation, 'Preventative' Separation and Market Evolution

'Preventative' separation, mandated before any investment has occurred in frontier infrastructures, and imposed upon all potential network operators, regardless of whether or not they have any presence in the relevant markets, is a very strong 'remedy'. It addresses a 'monopoly problem' in a theoretical 'monopoly market' which may not even eventuate, given that infrastructure competition (at least in duopoly, oligopoly or monopolistic competition form) is anticipated to be the predominant future internet access market structure (Hazlett & Weisman, 2011; Renda, 2010).

The motivation to prevent the development of a dominant position in the new market may be commendable. However, separation cannot be considered in isolation from existing regulation or market characteristics. If legacy regulation is predicated upon the 'ladder of investment' purportedly incentivising competitors to invest ultimately in competing networks (Cave, 2006a), then in addition to distortions in investment incentives from the 'ladder' (Bacache, Bourreau & Gaudin, 2014; Bourreau, Dogan & Manant, 2010), mandating separation for all FTTH networks militates against any competitor to the incumbent climbing the ladder to network ownership as all benefits acquired by amassing a retail customer base by leasing elements from the incumbent must be forfeited when building the FTTH network[1]. The effect is to reinforce the existing

[1] Howell (2012) identifies this as a potential explanation for none of the unbundling competitors to the incumbent tendering for the New Zealand government-funded FTTH subsidy programme. The two largest were significant network investors (in mobile and cable respectively) so would have had cost advantages

dominance of the copper network provider, as (absent any other infrastructure competition) it is the only (copper) market participant with an incentive to invest in a frontier fibre network. If the regulator's intention is simply to prevent the transfer of market power in the legacy network to the frontier network, then horizontal separation (either functional or structural) of (vertically integrated) copper and fibre networks is both less intrusive than vertical structural separation between network and retail, and has precedents in the competition law governing mergers and acquisitions[2].

2.1 A Pre-Determined Structural Prescription for a Dynamic Market

Furthermore, 'preventative' separation imposes a pre-determined market structure on a yet-to-be-deployed infrastructure in a rapidly-evolving and technologically dynamic environment that appears to close out any possibility of evolutionary market development in response to competitive interaction between the legacy and frontier networks. To be economically justified, the costs of downstream foreclosure must be so large that no other market structure could possibly be contemplated, despite the considerable uncertainty associated with new technologies. If this is not the case, then 'preventative' separation appears to signal a return to historic centralised market design, control and network planning reminiscent of an era dominated by government telecommunications ownership, which was characterised by the suppression of technologically-led market dynamism. Interestingly, to date, mandatorily vertically separate FTTH infrastructures feature more prominently when governments (either national or municipal) are substantial funders.

As a variant of access regulation, structural separation invokes inevitable trade-offs between the pursuit of static and dynamic efficiencies. Yet FTTH is a new technology that itself is contributing to Schumpeterian market dynamism where economic growth is driven by "imperfect" competition, "the competition from the new commodity, the new technology, the new source of supply, the new type of organizations (Schumpeter, 1975: p 85). In this context, the optimal market structure at any given point in time is not static and exogenously imposed, but fluid and endogenously determined. It is not evident ex ante that one specific market structure will be optimal over the entire life cycle of the technology. Imposing a predetermined structure overrides endogenous development of growth-enhancing institutions and relationships made possible by new information not available at the outset when the market structure is imposed (Guthrie, 2006). The exogenously imposed market structure even if initially optimal, will

over the successful non-incumbent tenderers (electric lines companies and a municipality) given existing access to rights of way and backhaul infrastructure.

[2] For example, between telephony and cable TV networks in the late 1990s.

inevitably be ‘wrong’ at some point of the life-cycle, necessitating changes if new benefits are to be appropriated. For example, integrated monopoly may have been optimal in the early stages of copper telephony, but not in the middle to later stages of its lifecycle, which required structural changes made possible by market liberalisation to enable both private and societal benefits (Wallsten, 2005).

It is both timely and apposite therefore to consider how a predetermined separated market structure might influence both the behaviour of FTTH market participants and outcomes relative to those in a counterfactual where no such limitations have been imposed (i.e. vertical integration is permitted) in the early stages of the technology’s life-cycle.

2.2 FTTH in a GPT Context

Internet access (i.e. broadband) is frequently claimed to be a General Purpose Technology (GPT). In this context, copper broadband access can be considered the legacy internet access GPT and fibre broadband the frontier (Bresnahan & Trajtenberg, 1995). GPTs exhibit three distinct ‘stages’ in their life cycle (Bresnahan & Yin, 2010). To capitalise upon the exploitation of increasing returns in the initial period of deployment, co-ordination on a particular technology direction is required. This reduces flexibility and choice, and potentially leads to the creation of bottlenecks, but is essential for the initial increasing returns to be generated. The benefits of allowing a period of market power for the first investor are outlined in the case for FTTN and FTTH operators to be given ‘regulatory holidays’ to incentivise investment (Gans & King, 2003). The second stage, where the bottleneck manifests as lower growth, is where reallocation of innovative resources around the bottleneck should occur in order to stimulate the third stage, where an alternative GPT competes the original one out of the market.

If FTTH is considered to be a GPT, then in the early stages of its deployment, maximising the potential of economies of scale is paramount. If co-ordination between the network and retail activities of an FTTH operator is critical to capitalising upon scale economies, then vertical integration will be the optimal initial market structure. Separation militates against this, so at best will slow the rate at which the dynamic efficiency gains from the presence of the new technology are realised, and at worst may prevent them from being accrued at all (e.g. by foreclosing investment in the first place). However, allowing an initial period of market power does not preclude the subsequent introduction of regulatory remedies (e.g. access regulation or even separation) to militate against the period of lesser contributions to growth that arises from an integrated provider as the market matures. Indeed, the need to vary the prices at which access is granted to an incumbent’s infrastructure relative to marginal cost across the middle and later stages of the life cycle of access-regulated copper networks in order to provide the appropriate balance between static and dynamic efficiency gains to promote stimulate investment in frontier FTTN and FTTH is already recognised (Lestage & Flacher, 2014).

2.3 Appropriating Scale Economies in Early-Stage FTTH

The crucial factor in determining the optimal market structure in the initial stages of FTTH deployment is capturing scale economies. Around 90% of the fixed and sunk costs of an FTTH network investment pertain to infrastructure elements (Layer 1 and 2), with only around 10% pertaining to (Layer 3) retail activities (Heatley & Howell, 2010). As with all infrastructures characterised by very high fixed (and sunk) costs and low marginal costs, the early stages of the deployment of FTTH is characterised by a steeply downward-sloping supply (average cost) curve. The more connections to the network that are sold, the lower is the average cost per connection (Figure 1 – it costs $P_B < P_A$ to sell $Q_B > Q_A$ connections). For this reason when an operator invests in a new network, there is an imperative to sell as many connections as quickly as possible to rapidly appropriate the gains from decreasing average costs.

2.3.1 Price Discrimination

Despite its common pejorative linguistic usage, discrimination does not necessarily imply a detrimental outcome. It derives from the Latin *discriminatus*[3] meaning to divide or separate based upon the ability to recognise and understand the difference between one thing and another[4].

Price discrimination is a classic means by which producers with access to economies of scale can sell more units in the early stage of a network's life. It is possible when the supplier has the means to distinguish between two (or more) different customer types – for example, early adopters with very high willingness to pay for a new good, and those who would not be prepared to pay a high price initially. As suggested by Bresnahan & Yin (2010), in the early stages of a GPT, price discrimination enables welfare gains to be appropriated by capitalising on economies of scale arising from the steeply-decreasing average cost curve. Given the black demand curve (Figure 2), the monopolist breaks even selling Q_A connections at a single price P_A (arguably, the price a regulator would set under access regulation, so that all retailers pay the same 'fair' price and the network operator covers costs). The monopolist could sell a further (Q_B-Q_A) units at P_C. The cost per unit of producing Q_B units (P_B) is less than the cost per unit of producing Q_A units (P_A), but exceeds the price at which the additional units are sold (P_C). The monopolist's profit increases because the surplus from selling Q_A units at P_A (the dotted blue rectangle) exceeds the losses from selling the additional units below cost at P_C (the wavy blue rectangle). There is a net

[3] http://www.etymonline.com/index.php?term=discriminate
[4] http://www.oxforddictionaries.com/definition/english/discrimination

gain in welfare (static efficiency gain). Consumers are better off. The higher-paying purchasers are no worse off than if there was just a single price. The lower-paying purchasers are better off – they have a connection that they would not have bought at the single price. And the monopolist is better off than the break-even regulated price, because profits are made.

This welfare-enhancing scenario is possible only when the average cost curve is steeply falling (scale economies exist) – such as in the initial stages of a network build - and most profitable when there is a wide variation in customers' willingness to pay (i.e. a steeply declining (inelastic) demand curve). This is almost certainly the case in the early stage of a new technology when a small number of early adopters are willing to pay a substantial premium to access the technology, but the vast majority of consumers will not be prepared to pay a large sum until the benefits have been demonstrated. It is not likely to be welfare-enhancing when the technology is widely diffused (a large number of connections have been sold) and the average cost curve is relatively flat – as occurs in a mature technology. At this stage of the technology's life cycle it is market power, and not cost structure, that primarily gives rise to the incentives to engage in price discrimination. However, even at this stage, careful analysis is required to ascertain whether the purpose is to transfer welfare from high-valuing consumers to low-valuing ones paying below cost (classic 'Ramsey Prices') or to maximise producer profits (Höffler, 2004).

Furthermore, price discrimination can lead to a network operator bringing the new technology to market sooner than if a single price is mandated, realising dynamic efficiency gains. Figure 3 shows the case of a cost curve sitting above the demand curve (D) for all possible quantities. Under this scenario, there is no single price at which it is economically feasible to produce. This is precisely what occurs in the early stage of a new technology when there are only a few individuals who know what it can do. In the fullness of time, demand will grow and the demand curve will push out to D', when it will be feasible to find a single price at which the operator will find it worthwhile to invest and produce. But with demand curve D, there will be no investment and no network if a single price must be charged. However, charging P_1 to the Q_1 highest-valuing consumers and P_2 to the remaining $Q_2 - Q_1$ consumers allows Q_2 units to be produced at a cost of P_3 each. If the profits from the first (area A) exceed the losses from the second (area B), then the monopolist will build the network earlier than if regulation requires access to be sold at a single regulated price. The welfare benefits of the new network are appropriated earlier than if a single price is charged. This constitutes the dynamic efficiency gain which exists in addition to any static efficiency gains arising from price discrimination increasing the total number of connections sold.

2.3.2 Access Regulation Impedes Price Discrimination Benefits

On the basis of this analysis, both structural separation and access regulation counter-indicate the accrual of welfare gains by precluding the network operator from engaging in retail price discrimination, as both require network elements to be sold at a single (common) price to all competing retailers. The literature on access regulation considers trading off static efficiency gains against dynamic efficiency gains arising from investment in network enhancements when regulating an existing network, which leads to optimal prices above long run average cost when future returns are uncertain (Lestage & Flacher, 2014). However, the preceding discussion shows that even regulating at average cost will prevent accrual of both static and dynamic gains arising from the particular scale economy effects prevailing in the early stage of network deployment where the strongest scale economies apply.

Analysis of Figures 1 to 3 suggests that a vertically-integrated network operator (or at least, one not precluded from engaging directly with end consumers) would seek to engage in welfare-enhancing price discrimination immediately after having deployed a new network, in order to rapidly grow connection numbers and gain the scale economy benefits. For example, cable television operators are frequently observed to offer free connections and substantially discounted 'trial periods' to consumers who did not voluntarily seek to connect when their networks were first deployed in a locality. Yet somewhat ironically, a vertically integrated, regulated telecommunications firm's retail arm offering such discounts for its new FTTH network exposes itself to accusations of discriminatory bias that could lead to separation being applied as a sanction, even though the firm's actions are welfare-enhancing. This reinforces the need to undertake case-specific cost-benefit analyses before imposing separation as a regulatory remedy.

2.3.3 Separation Disconnects Retailers from Scale Economy Incentives

Whilst access regulation alone limits the ability to engage in welfare-enhancing price discrimination, relative to a vertically-integrated access-regulated operator, a structurally-separate network operator faces greater impediments to rapidly accessing scale economies because no retailer faces the incentives provided by reducing average costs as the number of new connections to the new network increases. A vertically-integrated operator may engage in non-price activities (e.g. marketing effort) in order to accelerate network uptake, but retailers with no exposure to network investment face no particular incentives to prioritise marketing of the new network. This suggests that the retail effort exerted to sell connections to the new separated network will be less than that observed in an integrated counterfactual, where at least the integrated operator appropriates the benefits from rapid uptake.

Furthermore, whilst there may be many retailers potentially able to sell the FTTH connections, the new networks are being deployed in a market where the legacy copper and cable connections are widely deployed, retailers already have established relationships with consumers and fibre connections will be sold for the most part as substitutes for existing copper connections. Unless retailers get a higher margin from selling FTTH connections than copper ones, they face few incentives to invest in aggressive marketing campaigns for the new network. Indeed, the costs of marketing may actually lead to lower retailer returns from selling a substitute FTTH connection to an existing copper customer than taking no action and retaining the customer on the legacy connection. This leads to even more delays in the rate at which fibre connections will be sold.

Moreover, new FTTH networks are being deployed gradually, one neighbourhood at a time. In a market where access regulation has been in place, it is most likely that the customers of any one retailer will be scattered around and not contiguously located within a specific geographic area. Whereas the network owner's retailer faces strong incentives to market the new connections to every premise passed in a street (the 'door-knocking' common amongst cable sellers), a separated retailer may have only a handful of customers in any given street. There is no particular incentive for any retailer to co-ordinate marketing effort with the network operator's fibre-laying activities (e.g. by sending door-knockers into a locality) given that any or all of the other retailers may be doing the same thing. If they all invest in 'door-knockers', then (in the manner of monopolistically competitive markets where fixed and sunk costs must be expended before sales are made – Carlton & Perloff, 2005, p216-9) a risk exists that none can perfectly assess the marketing efforts of the other, too many will engage in the marketing exercise and inefficiently too much will be spent trying to persuade a fixed number of consumers to purchase a fibre connection. As each can anticipate this outcome, an equilibrium may emerge where none invests in marketing, awaiting information about what the others plan to do. If this occurs, then the FTTH network lays under-utilised, even though it has been deployed. As the separated network operator too can anticipate this eventuality, then network investment will be delayed to an even greater extent than would be anticipated under access regulation and integrated network and retail operations. That is, separation imposes even greater investment delays than access regulation alone.

In sum, therefore, the theory supports the contention that access regulation impedes the ability to obtain scale economy benefits available from price discrimination in a new FTTH network, and that structural separation further impedes the ability to maximise scale-related cost reductions relative to an integrated but regulated operator by impeding the ability to co-ordinate network deployment and marketing effort. In practice, this would manifest itself as (all else held equal) a slower diffusion rate of FTTH connections in markets where separation is mandatory.

3. *Case Studies*

The inability to set up control and treatment groups precludes empirical testing of the proposition that FTTH uptake will be slower in markets where FTTH is being deployed under separation mandates. Case studies allow the comparison of observations in different markets, albeit that institutional differences other than separation may also influence uptake rates. Nonetheless, case studies may, when taking account of known differences, provide evidence that is consistent with (or contradictory to) the proposition.

This section uses case studies to compare FTTH deployment and uptake in two markets where structural separation is mandated – Australia and New Zealand – and one where it is not – the Netherlands. FTTH deployment in Australia and New Zealand is occurring under the aegis of government funding initiatives – the National Broadband Network (NBN) in Australia and the UltraFast Broadband (UFB) initiative in New Zealand. Whilst some municipally-funded networks have been deployed in the Netherlands (Kramer, Lopez & Koonen, 2006), privately-funded major commercial operator Reggefiber accounts for over 90% of fibre connections sold[5]. All three countries have long histories of access regulation (albeit that New Zealand was somewhat slower to adopt it than the other two, implementing access regulation in 2001, bitstream unbundling in 2004 and full local loop unbundling in 2006), and New Zealand's copper incumbent has been required to structurally separate (this has not been required in the other two). The other major difference is that in Australia, the government policy requires copper to be decommissioned when fibre is installed in a locality, but in the other two countries, copper and fibre networks are assumed to compete with each other indefinitely.

3.1 Australia and New Zealand

FTTH network deployment commenced in Australia in 2010 and in New Zealand in 2011. The Australian arrangements are based upon a fully government-owned structurally separate network operator NBN Co intended to reach over 90% of the Australian population, whilst in New Zealand the government has subsidised around 25% of the cost of deploying FTTH to 70% of the country via four public-private partnerships (Howell, 2012; 2013).

[5] http://www.buddeblog.com.au/frompaulsdesk/some-fundamentals-of-dutch-fibre-success/

Institutional[6] and data collection[7] differences make direct comparisons of uptake rates difficult. However, in both cases, uptake rates are lower than expected. At the end of 2013, 27% of the planned New Zealand rollout had been completed[8] but only 5.5% of premises passed had connected to the network. In Australia, uptake rates of between 30% and 40% of premises passed are claimed[9], but the rollout targets have been revised downward several times due to failure to meet initial targets. The Australian budget has expanded substantially from its initial $A43 billion (Howell, 2013).

On first examination, the large difference in uptake rates between Australia and New Zealand appear to contradict the proposition that separation impedes uptake rates. However, it is most likely an institutional difference in the terms of the government subsidy programme that accounts for the difference. In Australia the owners of the incumbent copper and cable networks – Telstra and Optus – are compensated for each customer who transitions from the legacy networks to FTTH. The compensation payments account for around $10 billion of the original $43 billion project budget, but are paid only when each customer transition has been completed. This payment has the same effect as allowing retailers a margin premium for migrating consumers from copper to fibre to speed up the acquisition of scale economies by the network operator. As retailers, both Telstra and Optus face strong incentives to promote rapid substitution to the new network via both direct and indirect marketing efforts to bring forward the payment of the 'substitution bounty'. As the incumbent access-regulated copper operator, Telstra also faces strong incentives to make it desirable for its resale and unbundling retailers to transfer their consumers to the net network. It would be unsurprising if Telstra was not sharing some of the 'substitution bounty' with its wholesale customers to speed up the transition (in a similar manner as it was observed that interconnection revenues were used strategically by network operators to increase dial-up internet connection rates in the late 1990s – Karel, 2003).

Hence the rapid uptake rate in Australia occurs because a further contractual arrangement overrides the negative incentives that would normally be associated with a separated network. However, these incentives come at a very significant additional cost to the NBN rollout, and would unlikely be necessary to induce an unregulated operator to invest.

[6] In Australia, NBN is intended to preplace the copper network, whereas in New Zealand, the copper network remains as a competitor to the UFB.
[7] There is confusion in Australia about whether cited uptake rates represent operational connections or simply approvals for future deployment.
[8] http://www.amyadams.co.nz/index.php?/archives/1128-More-than-a-quarter-of-UFB-project-complete.html
[9] http://www.zdnet.com/rollout-not-slowing-down-as-nbn-co-quietly-smashes-targets-7000028007/

However, no such incentives apply in New Zealand. The four UFB network operators are exposed to the full ramifications of separated retailers with diminished incentives to market fibre connections. The two main ISPs Spark[10] (formerly Telecom) and Vodafone[11], who together have a broadband market share of around 80%, were very slow to develop fibre plans. Initial plans from these firms were still not available nearly a year after the first fibres were laid. Even once plans were developed, marketing of them also appears to be minimal. It is also nationally-focused rather than targeted at the areas where fibre networks are being deployed. Neither gives fibre priority over other broadband offerings in their nationally-focused websites. However, the third-largest ISP Orcon[12] (15% market share) has been more active in marketing fibre and to date has more customers connected to the UFB than any other ISP. This is most likely because it has historically been the innovation leader in New Zealand, and as a consequence has a much larger proportion of early adopters in its customer base than the larger two. It thus has a biased selection of customers and likely faces lower marketing costs as early adopters are likely to choose to substitute to fibre without having to be persuaded by marketing efforts.

On first examination, the very much lower uptake rates in New Zealand pose significant financial risks to the UFB network operators, as the scale economies are not being rapidly realised. However, the terms of the public-private partnerships shield the three non-incumbent network operators from financial risks of slow uptake, as the government has funded the network rollout and the partners buy shares in it only when customers connect and start buying services (Sadowski, Howell & Nucciarelli, 2013). The same is not true for Chorus, the structurally separate copper incumbent and contactor for 70% of the FTTH project. Chorus underwrites the deployment of fibre it deploys (albeit part-funded by interest-free government loans) and financial penalties if it fails to meet specific uptake targets. Whilst Chorus is aggressively marketing the concept of fibre connections both as it deploys in a given locality and nationally (e.g. with its' Gigatown competition[13]), it cannot market connections directly to consumers. It is ultimately the responsibility of the end consumer to contact a retailer to instigate the installation process.

Indeed Chorus appears to be doubly disadvantaged as a separated copper legacy and frontier fibre network operator. The firm faces regulatory 'double jeopardy' as ongoing regulation of the copper network threatens to undermine deployment of the fibre network (Howell, 2013). Arguably, a variation of the hold-up problem that occurs when separated downstream

[10] http://www.spark.co.nz/shop/internet/
[11] http://www.vodafone.co.nz/broadband/
[12] http://www.orcon.net.nz/
[13] http://gigatown.co.nz/

retail firms endeavour to earn quasi-rents by playing strategic games after the upstream firm has made relationship-specific investments (Cadman, 2010; Ergas, 2007) is playing out in addition to the diminished incentives. Legislation passed after the fibre prices were agreed requires the copper regulator[14] to set copper prices in a manner that means they will fall substantially in December 2014 from the levels prevailing when the PPP terms were agreed. The separated retailers can now potentially increase their margins on copper connections if they do not pass through the anticipated 25% copper price reductions fully to consumers. This even further reduces their incentives to market fibre connections in the present. Indeed, a number of ISPs were prominent supporters of a public relations campaign vilifying Chorus's endeavours to use a combination of legislative, regulatory and judicial means to get the proposed copper price reduction reversed[15].

Thus, the New Zealand evidence is consistent with structural separation being a major delaying factor in FTTH uptake. There are clear disconnections between the incentives facing retailers and the objectives of Chorus, at least, to capitalise upon scale economy benefits. Unlike Australia, other institutional arrangements appear to exacerbate the separation delays rather than ameliorating them. The cost to the government is lower, but the costs of foregone dynamic efficiency benefits from fewer connections than is optimal are likely very large.

3.2 The Netherlands

In sharp contrast with Australia and New Zealand, FTTH deployment in the Netherlands is bound by neither structural separation nor (in the large part) government funding. Private operator Reggefiber[16] has been deploying FTTH since 2005. In 2008, the incumbent copper operator KPN acquired a 41% share in the firm[17]. Reggefiber supplies over 90% of fibre connections in the Netherlands. At the end of 2013, nearly 10% of Dutch broadband connections were fibre-based, and the Netherlands had the second-highest broadband penetration in the OECD (after Switzerland)[18]. By Quarter 1, 2009, Reggefiber had laid fibre past 336,000 premises and sold 106,000 connections – an uptake rate of 31%[19]. This compares to New Zealand's uptake rate of 5.5% at the end of 2013 when a similar number of premises had been passed. By quarter 4 2011, 951,000 premises had been passed and 277,000 connections sold[20], confirming that the uptake

[14] Both regulation and network operation are separated in New Zealand - see Howell (2012).
[15] http://www.stuff.co.nz/technology/digital-living/9237280/Axe-the-Tax-group-hopeful-after-Key-comment
[16] http://www.eindelijkglasvezel.nl/
[17] http://ec.europa.eu/digital-agenda/sites/digital-agenda/files/Wouter.pdf
[18] http://www.oecd.org/sti/broadband/1d-OECD-WiredWirelessBB-2013-12.xls
[19] http://www.apritel.org/fotos/editor2/Jan_van_Rooijen.pdf
[20] http://www.slideshare.net/INCA_NextGen/reggefiber

rate of around 30% has been stable over time and across the localities where the network has been deployed.

Reggefiber's business model is to be a passive network operator, so it appears outwardly to operate in a similar manner to the structurally separate Australian and New Zealand networks. Other network operators (including KPN) supply the active network elements and then retail service providers (including KPN) bundle services sold to consumers. Reggefiber does not have an ongoing commercial relationship with end consumers. In this manner, it closely resembles local distributors in structurally-separate electricity networks (Howell, Meade & O'Connor, 2010). However, fundamental differences attend the marketing of the initial connections when the network is deployed. Reggefiber's rollout is not predicated upon the 'build it and users will come' model of the New Zealand UFB, but is much closer to the cable television model of working closely within a local community to ascertain economies of scale will be obtained immediately the network is deployed. When Reggefiber targets an area for potential deployment, it contacts all potential consumers seeking binding commitments to purchase a fibre connection when it becomes available. When at least 30% of householders commit, the network is deployed[21]. This minimises financial risk and ensures that the majority of economies of scale available from large numbers of consumers are obtained immediately. The local municipality is typically involved at this early stage, assisting with the co-ordination of marketing and facilitating community members to jointly consider the benefits of bringing fibre to their locality.

The Reggefiber business model is possible because there are no regulatory impediments preventing the network operator from working the manner of an integrated operator and marketing fibre connections directly to end consumers in the very earliest stage of network deployment. Reggefiber is directly involved in the initial marketing of connections, even though it does not have an ongoing retail relationship with end consumers. Although the municipality may assist with initial marketing, it is not a direct network investor, in the manner of the government in Australia and New Zealand. Reggifiber's success does not depend upon KPN being a part-owner, although that may lead to lower transaction costs from co-ordinating the interfaces between the passive and active layers relative to other providers. Whilst it cannot be discounted that there may be some potential opportunities subsequently for Reggefiber and KPN to exploit their relationship, at the early stages of deployment, it does not appear to have inhibited the ability for widespread deployment of FTTH that both captures scale economies and does not rely upon large government subsidies to either deploy the network or induce substitution from copper.

[21] http://www.eindelijkglasvezel.nl/corporate/?sc_lang=en&preflang=en

Whilst Reggefiber does not rely upon price discrimination to acquire scale economies, it has relied upon non-price discrimination, in that its direct approaches to consumers have allowed it to determine the localities in which the greatest numbers of individuals willing to pay for fibre connections are located. The 'discrimination' occurs because it is those communities that receive the option of fibre connections first. Arguably, this ensures that the scarce financial resources for building fibre networks are allocated most efficiently (to those communities whose residents on average value fibre connections most highly). Again, this contrasts to the New Zealand and Australian networks, where fibre is deployed according to political priorities.

The Netherlands case shows that, where no preconceived ideas of market structure o0r limitations on commercial relationships exist, it is possible for new institutional arrangements to emerge that differ from the arrangements in legacy markets. Reggefiber has voluntarily adopted a functionally-separate business model, but this works because it does not face contracting restrictions with end consumers at the time it is most important to co-ordinate direct marketing – when the connections are first laid. This suggests that contractual regulatory provisions may be more important than structures when seeking to maximise scale economy effects in the early stages of a network's life-cycle.

4. Conclusion

The case studies reveal that the rate at which FTTH networks are diffusing in New Zealand is considerably slower than in the Netherlands, Despite other regulatory institutions potentially also affecting the rate, structural separation is most likely contributing to the delay. Whilst the Australian diffusion rate is similar to that of the Netherlands, this is likely because a compensation clause in the Australian arrangements replicates the incentives for rapid diffusion to obtain scale economy effects enjoyed by firms not bound by vertical separation obligations. However, this is very costly and, as shown by the Netherlands case, is not necessary when the network operator is able to co-ordinate marketing of network connections in the earliest stages of network deployment.

The Netherlands case study shows that it may still be feasible for institutional arrangements resembling a separated market to evolve endogenously when there is no preconceived idea (beyond access regulation) or exogenous imposition of a 'correct' market structure. Importantly, the case shows that the limiting factors are not inherent in the ownership of the firms, but in the restrictions in the contractual activities that the different firms may engage in. In New Zealand, it is the rules preventing network operators directly engaging with individual end consumers that appear to be slowing diffusion. In the Netherlands, even though Reggefiber is not the firm that ultimately retails the connections, its end consumer engagement in the pre-rollout phase is crucial to its ability to achieve scale economies quickly.

In sum, therefore, the theory and case studies both appear to confirm that vertical separation – whether structural or contractual – delays the accrual of welfare benefits from new technologies in the early stages of their life cycle. Whilst in most cases the remedy is seen as a structural tool, the contracts associated with the regulation appear to be more important than the issue of ownership in this early stage. Nothing in this analysis is contrary to the position that regulatory instruments such as access regulation and vertical separation have a role to play later in the life-cycle of a technology – such as in the middle period when the early scale economies have been exhausted. Rather the learning is that regulation must evolve over the life of a technology, as the structures of the markets themselves evolve. For regulation, as with investment, timing matters.

Figure 1: Natural Monopoly Cost Structure

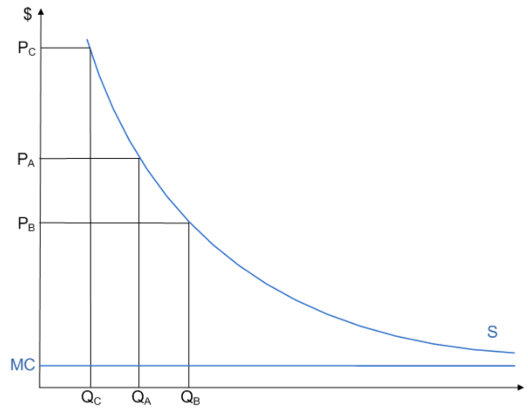


Figure 2: Price Discrimination

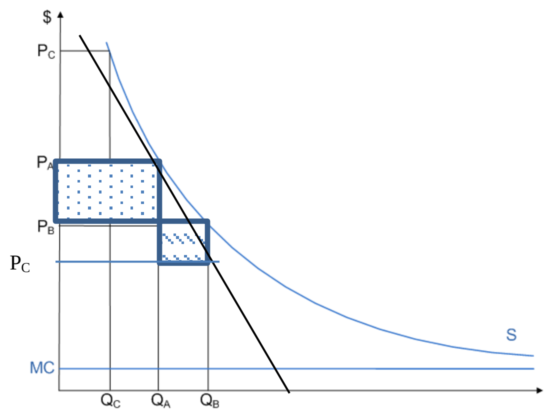
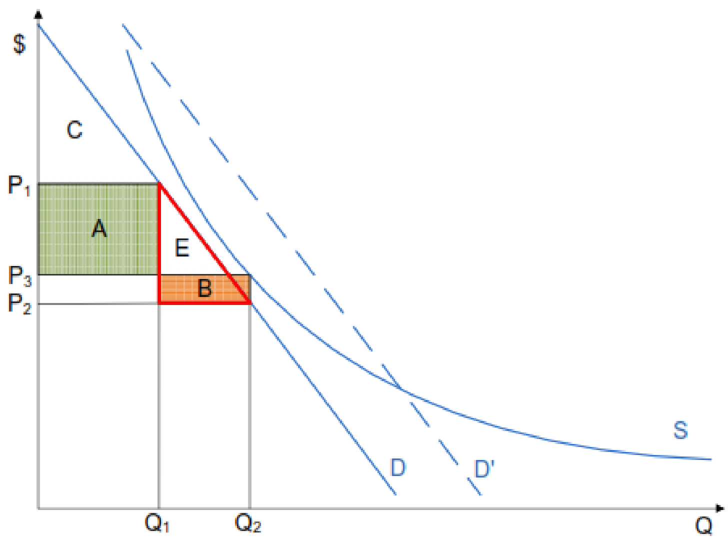


Figure 3: Price Discrimination Allows Earlier Introduction of a Technology



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