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Economies of Scale and Scope in Network Industries: Lessons for the UK water and sewerage sectors

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Michael G. Pollitt and Stephen J. Steer

Abstract

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Keywords Economies of scale and scope, vertical separation, water and sewerage

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Contact m.pollitt@jbs.cam.ac.uk
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EPRG WORKING PAPER

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Michael G. Pollitt

Steven J. Steer

ESRC Electricity Policy Research Group

University of Cambridge

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Many studies of the water and sewerage industries place significant importance on the benefits of economies of scale and scope and how these relate to vertically integrated firms. We have re-examined the early literature on scale and scope economies and find that these studies do not implicitly preclude non-integrated firms from fully utilising assets for multi-product activities; they can still reap scope economies through trading in the open market. Further, we demonstrate difficulties in separating these two types of economies when assessing firm performance. Trade-offs between governance and production costs are a key issue in determining the value of vertically integrated firms that may undergo divestiture. We discuss the present policy debate regarding the optimal structure of the water and sewerage markets in England and Wales in the light of this, and recommend avenues of research that will help determine the optimal policy.

1. Introduction

In the UK, among major network industries – which include gas, telecoms and electricity – the water and sewerage industry is the only one that has not undergone major divestiture, either during or since privatisation. The sector in engaged in the activity of water supply and sewerage removal and involves a number of potentially separable activities, as shown in Figure 1.1. The UK industry consists of both: water only companies that own water sources and engage in water transfer, treatment and delivery to customers; and water and sewerage companies that – in addition to the activities of water only companies - also collect, transfer, treat and manage waste water. Thus the

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companies which we observe in the UK industry exhibit different degrees of vertical integration. They also, in contrast to other network sectors – such electricity and gas – vertically integrate the operation of monopoly networks with potentially competitive retailing to final consumers.

The purpose of this paper is to investigate the scope for efficient unbundling or re-bundling of water industry assets in the UK in the light of economic theory and evidence, particularly relating to economies of scale and scope. To set this in context we begin with a brief history of the structure of these industries.

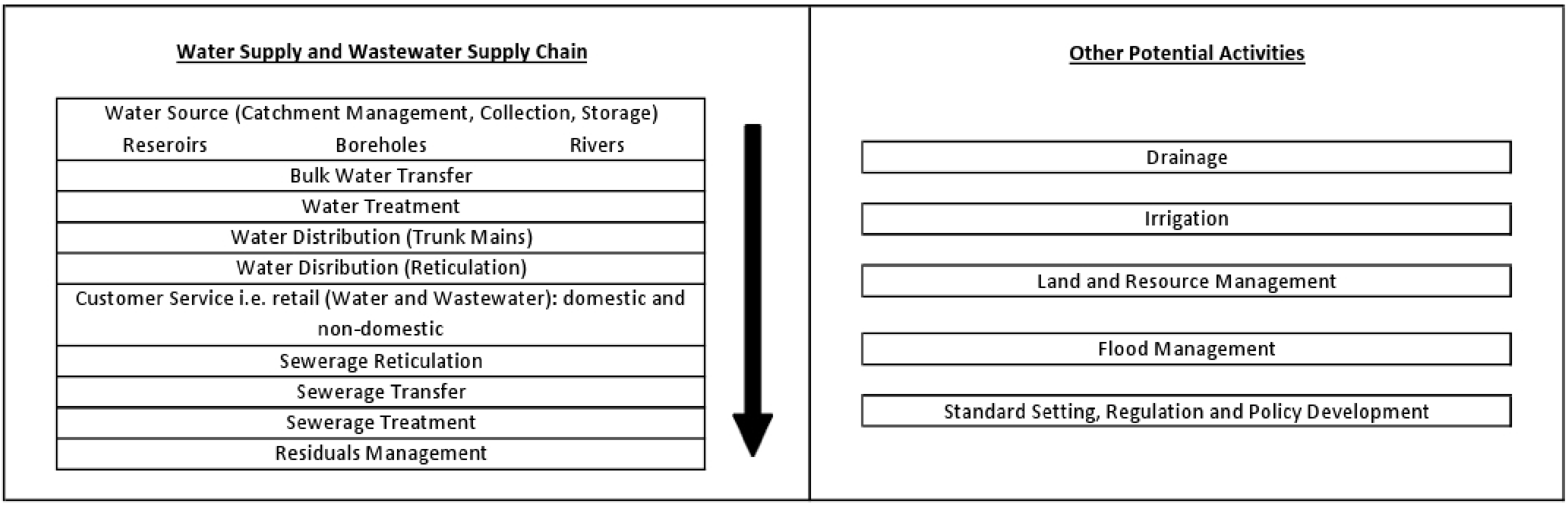

Figure 1.1: Key activities in the water and sewerage supply chain. Original source: Abbott and Cohen (2009, Figure 1, p.234); modifications informed by: Saal, et al. (2011a).

1.1. History of the UK Gas Industry Structure

The UK gas market originally developed in the form of large numbers of firms run either by local councils or privately firms. This was until 1948 when the government merged the then 1046 firms into twelve publically owned Area Gas Boards (UK Government, 1948). Further government intervention in 1972 enforced full centralisation of the industry into a single publicly owned vertically integrated utility, British Gas (UK Government, 1972). In 1986 it was then privatised (UK Government, 1986) and from 1996 to 2005 a series of divestitures resulted in the industry's vertical disintegration and the arrival of new entrants into the wholesale, transport and retail sectors. National Grid owns the high pressure gas transmission network and 4 out of 8 low pressure gas distribution businesses, the remaining 4 are owned by 3 newly created distribution companies. Finally, Centrica owns the former retail business of British Gas. The retail market has progressively opened up to competition and is substantially integrated with the retailing of electricity, with 6 major players active in both the electricity and gas retail markets. These major energy retailers also own electricity generation capacity.

1.2. History of the UK Telecoms Industry Structure

In telecoms, multiple UK firms first began business in the mid-19th century, however over the period 1896–1912 the vast majority of these were taken over by the General Post Office, which at the time was a government department (Baldwin, 1938). In 1969 the General Post Office was divested into a publically owned firm consisting of two internally unbundled divisions: post and telecommunications. This was under the name, the Post Office (UK Government, 1969). In 1980 the telecoms arm of this firm was rebranded British Telecom and in 1981 the postal and telecommunications firm was disintegrated, separating the activities. Simultaneously the same government legislation empowered both British Telecom and the Secretary of State for Trade and Industry to licence other telecoms operators, paving the way for a competitive industry (UK Government, 1981). The ownership of British Telecom changed from a public to private majority share in 1984 (UK Government, 1984) and in 1983 the industry had become a duopoly of vertically integrated firms with the entry of the privately owned company, Mercury Communications. In 1991 and 1993 the remaining publically owned shares were sold and 1991 saw the introduction of legislation allowing for the vertical disintegration of the industry, additional entrants and increased competition. Competition has been further encouraged through a Strategic Review of Telecoms in 2005 (Ofcom, 2005), this saw the enactment of local loop unbundling and the creation of BT Open-Reach, an internally unbundled arm of the BT group that ensures local service access for competing businesses, this is separate both from BT's wholesale and retail businesses. The increased competition has enabled further deregulation of the wholesale sector. By 2011 around 7.5m fixed lines[2] or around 22% of the total[3], had been subject to local loop unbundling and were operated by third parties.

1.3. History of the UK Electricity Industry Structure

The public supply of electricity began in the late 19th century, initially this was through independent local electricity networks; it was only in 1926 that the UK government paved the way for the construction of a national transmission system (UK Government, 1926). In 1947 the 505 firms that existed at that time in England and Wales were then all brought under state control and merged into 12 regional electricity boards (UK Government, 1947). In 1957 a further act of government restructured the industry such that the newly created Central Electricity Generating Board held responsibility for the majority of power sourcing and owned and operated the transmission grid; the 12 regional monopoly area boards served as retailers (UK Government, 1957). The government set the legal framework for the industry to be privatised (the government

[2] March 2011 figures, source: http://www.offta.org.uk/charts.htm. Accessed 28th March 2011.
[3] Quarter 4, 2010 figures for total lines, source: http://media.ofcom.org.uk/facts/. Accessed 28th March 2011.

held a minority share) and restructured in 1989; in 1990 this came into practice (UK Government, 1989a). The restructuring of electricity was different to gas and telecoms in that plans were already in place to restructure the industry as well as change its ownership. The power stations were divested between three different firms and the transmission system to a single independent transmission system operator. The distribution and retail sector was directly transferred to 12 private firms. The government sold its remaining share of the power generators in the year 2000.[4] The 2001 New Electricity Trading Arrangements (NETA) changed the mechanism for electricity trading and the latest major reform in 2005 has been to create one system operator for Great Britain (National Grid System Operation). This jointly operates the assets of the Scottish incumbent transmission owners and the transmission assets of National Grid in England and Wales as part of the British Electricity Trading and Transmission Arrangements (BETTA) (UK Government, 2004). As for gas, the retail market was progressively opened up to competition and there is substantial vertical integration of electricity production and retailing.

1.4. History of the UK Water and Sewerage Industry Structure

The present structure of the UK gas, telecoms and electricity sectors has followed a similar path. The industries begin with localised vertically integrated firms, these firms undergo government inspired mergers leading to monopolies featuring vertical integration. More recently they have been disintegrated, with the aim (among others) of improving the efficiency of the sectors through competition and regulation. The water and sewerage industry differs in some respects. Similar to the other industries, for England and Wales the industry was privatised in 1989 (UK Government, 1989b). However, it has never been owned by a single national firm. Immediately prior to privatisation, as now, there existed ten regional water authorities involved with water and sewerage combined. In addition to these companies, England and Wales has also featured water only companies since the 18th century. These are typically smaller than the water and sewerage companies. At the time of privatisation there were 33 such companies, following mergers and takeovers this number has now reduced to twelve licensed undertakings. Table 1.4 provides information relating to the scale of water only and water and sewerage firms in England and Wales in 2010. In Scotland and Northern Ireland the water and sewerage companies remain in public ownership. In Scotland in 2002 the regional water authorities were merged into a single company (UK Government, 2002). Competition has since been introduced in Scotland, for the non-household retail sector in 2008 (UK Government, 2008). There is limited direct competition in the England and Wales water markets, the industry performance relies strongly on rigorous comparative efficiency analysis (a form of yardstick competition, see Shleifer, 1985) provided by its regulator, Ofwat.

[4] The government did re-acquire some shares in the nuclear operator, British Energy, in 2004.

Table 1.4: Sizes of water only and water and sewerage firms in England and Wales (Ofwat, 2010).

Firm Structure	Number of Connections for households and non-household			Water Delivered (million US gallons / year)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Water Only	401,000	74,000	1,273,000	13,700	2,420	71,148
Water and Sewerage	2,024,000	577,000	3,601,000	93,700	27,522	200,755

1.5. Current Water and Sewerage Industry Structures Worldwide

While there is no global norm for the structure of water markets, there are certain industry structures that are not observed. Large countries, and even many small countries, do not have single monopoly providers. There is a mix of countries whose water and sewerage services are predominantly integrated (e.g. England and Wales, Canada, Greece) and those for which they are generally separate (e.g. Netherlands, Germany). Further examples of national water and sewerage structures are given in Saal et al. (2011a). Subject to the size and population of the nation, but sometime irrespective of these facts, countries can feature up to 1,000's of small firms, or just a handful of large ones, England and Wales have unusually large water and sewerage firms. Some countries are characterised by holding companies operating subsidiary firms (e.g. Spain, Egypt).

1.6. Topics of Discussion in this Paper

This paper discusses issues surrounding whether it makes economic sense for the water and sewerage industry of England and Wales to continue operating in a largely vertically integrated structure, at odds with other UK network industries. In Section 2 we discuss the nature of a generalised firm and how the water (and sewerage) industry might be expected to diverge from this general picture. In section 3 we examine past literature discussing the economic theory that describes the value of ownership economies, focusing on economies of scale and scope. In Section 4 recent econometric literature regarding the water and sewerage industries is discussed. Section 5 includes a discussion of ownership unbundling in similar network industries. Section 6 discusses case study evidence on alternative ownership structures in the water industry from Southeast Queensland, Melbourne and Munich. We summarise our overall findings in Section 7.

2. The Evolving Structure of Firms

The evolving structure of firms through the life cycle of a generalised industry is described in Stigler (1951). He elaborates on the theorem proposed by Smith (1776) in *The Wealth on Nations* that the division of labour is limited by the extent of the market. Stigler characterises young industries as having vertically integrated firms, because their product's inputs are unique and not available elsewhere, leading to the need for in-house production. In the growth period of an industry there is widespread vertical disintegration; this is because the demand for specialist tasks to be performed becomes large enough that it is most economical to have dedicated firms performing them. It is only when an industry is in decline that companies return to a vertically integrated structure; product demand eventually becomes so small that it is no longer economically efficient for firms to specialise in stages of the production process, requiring that the surviving firms reintegrate vertically.

Stigler's (1951) expansion of Smith's (1776) theorem of the division of labour and specifically the description of the evolving structure of an industry has been tested. A review of it and a number of related studies have been presented by Levy (1984). Levy shows that industry-specific effects can have a deterministically important impact on whether individual industries follow this structural lifecycle. Levy also makes reference to further studies, by Williamson (1975), referring to a small numbers bargaining problem, meaning that incentives for vertical integration are created due to their being low numbers of other market players. This behaviour is similarly described as taking advantage of market imperfections by Perry (1989), this is discussed in more detail in Section 3.2. The water and sewerage markets of England and Wales might be justifiably described as suffering from this small numbers bargaining problem, given that there are so few firms and their tendency to operate as regional monopolies at multiple stages of production.

With all other things being equal, the increasing world population certainly means that water markets globally (and specifically the demand for water and sewerage services) will continue to grow well into the twenty-first century. Since 1960 the world population has doubled to approximately 7 billion today, and is projected to grow to 9 billion by 2050 (Gilland, 2002; United Nations, 2008). In England and Wales the population was 54.5 million people in 2008 and is expected to be 64.0 million in 2033 (Office of National Statistics, 2009). This gives rise to several questions: are water markets of sufficient size that it is economically more efficient for vertically integrated firms to divest into specialist ones or internally unbundled subsidiaries of a larger umbrella group? Or instead, will water markets never be large enough for there to be economic benefit from the unbundling that characterises a generalised growing industry? Two prominent issues arise in determining the answer to this question. The first affects all industries and was raised in Lucas (1978) in his discussion of the size of monopoly firms. The issue is that, typically, firms are involved in selling multiple products in multiple markets, leading to a much more complex situation than is described by Smith and Stigler, which primarily relates to a single final product. The second issue is in the nature of water supply as a network industry, the transport costs of its products (via pipes) are considerably greater than a typical industry and the distribution options more restrictive (competing pipes into the home are not economic).

Both of these issues complicate the determination of the optimal size of water (and sewerage) companies and the extent of a company's market. Therefore, ascertaining whether or not it is economic to unbundle vertically integrated water (and sewerage) firms is complex. It raises a number of questions: Which markets do vertically integrated water (and sewerage) companies serve? How large are each of these markets? To what extent does the network-nature of the industry fragment the total market of each product into isolated subsidiary markets? And compared to the achievable efficiency of vertically integrated utilities, what market size would be required for it to become economically more efficient for firms to be non-integrated and instead specialise in individual stages (e.g. water sourcing, distribution or retail, see Figure 1.1 above) of the water and sewerage production process? To answer these questions, one can investigate a range of evidences. Some of the sources for this evidence are: revisiting the underlying economic theory of economies of scope and scale and understanding the extent of its application; investigating the robustness of frontier econometric studies in the water (and sewerage) industries; drawing comparison with evidence from similar network industries and; through examining any existing evidence directly in the water (and sewerage) industries via case studies.

3. Economies of Scale, Scope and Competition with Respect to Vertical Integration

3.1. The definition of Scale and Scope Economies

The degree of economies or diseconomies of scale in a firm have been defined as (Panzar and Willig, 1977);

$$Sca = \frac{C(q)}{\sum_{i=1}^{n} q_i C_i(q)} \ ,$$

where the scale of the economy (or diseconomy), *Sca*, is given by the production cost, *C*, for a single firm to produce, *q*, outputs; this is divided by the sum cost of producing each of the outputs separately over the full range of products, *n*; *q* is a vector of all of the products, i.e. $q = (q_{1,} q_{2,} q_3, \dots, q_n)$. Economies of scale are realised when $Sca > 1$ and diseconomies when $Sca < 1$. In most manufacturing industries it is accepted that there is a firm size beyond which economies of scale are exhausted (Scherer et al., 1975). For example, a firm may reach a size so large that if it's single largest asset were to be divided, that stage of production would still produce the same number of outputs for the same input cost, i.e. no value would be gained or lost.

Equivalently, for an example of two products (q_1 and q_2), the degree of economies of scope, *Sco*, are defined by Willig (1979) as;

$Sco = \frac{C(q_1,0)+C(0,q_2)-C(q_1,q_2)}{C(q_1,q_2)}$

That is, the degree of the scope economy is equal to the cost of producing each of the goods individually subtracted by the lowest possible cost of producing them jointly; this is all divided by the cost of producing them jointly. Therefore, if $Sco > 1$ there are economies of scope that can be gained and if $Sco < 1$ there are diseconomies of scope. Economies of scope can arise with different final products or with vertically related stages of production.

3.2. How Separable are Scale and Scope Economies?

It can be challenging to isolate economies of scope. By definition, when assessing the degree of the scope economy one compares a single integrated firm to two or more non-integrated firms of whose cumulative productive size is equal to that of the integrated firm. This means that the individual non-integrated firms are each smaller than the integrated one. If the integrated firm is maximising its economies of scale for the multiple products it is not necessarily the case that the non-integrated firms are also doing so. Equivalently, if the non-integrated firms are maximising their products' economies of scale, it may be that the implicitly larger scale of the integrated firm is such that it is subject to diseconomies of scale. This ambiguity lies in the rather vague definition of $C(q_1,q_2)$, which is simply defined as the firm's minimised cost of producing the goods. This minimisation can derive from common production processes in the goods (scope economies), but may also partially or even exclusively derive from gains through increased size (scale economies).

There is also an issue of definition and measurement of economies of scope. A vehicle factory might be operating at a size that returns the maximum economies of scale for vehicle manufacture; however, the plant could be redefined as a car and van manufacturing factory. Now it is a multi-product firm. The optimal economies of scale of vehicle manufacture are likely to include benefits derived from economies of scope. These would have previously been included in the measurement of scale economies. It may be that the plant is not configured to maximise scale economies for cars or for vans, but that it is maximising vehicle manufacturing scale economies. While this example is conceptually straight forward, the principle has far and wide reaching applications. The identification of vertical stages of production is at least to some extent arbitrary and relies on historically drawn accounting boundaries, the drawing of which will have been influenced by the context within which they emerged.

Situations such as these can make it challenging to separate the two forms of economy when assessing their contributions from high level data describing firm outputs. For a precise understanding an *ab initio* approach to modelling would be required, where by the origins of each microscopic production cost and its impacts on all other costs are explicitly defined in the model. Aside from the endemic complexity of such a method, data for this type of analysis is not available in practice. This makes challenging the purely theoretical assessment of determining the true combined economies of scale and scope realised by vertically integrated firms.

In addition to this other issues associated with the Willig (1979) definition of scope economies have been described by Teece (1980). Teece finds that Willig's definition is insufficient in describing the potential for non-integrated firms to benefit from economies of scope. It is possible for specialised single-product firms to capture the same economies of scope through their contracting in the market place. The explanatory example given by Teece (1980) is presently described in brief: an orchard owner, who must space out their fruit trees to give the tree roots space to grow can expand into grazing sheep in the open spaces between the trees. There appear to be economies of scope in doing this compared to having two separate firms, each specialising in one of the industries, this is because in the former case land is more efficiently utilised. However, in a competitive market the single-product orchardist can operate their orchard business, while leasing the space between the trees to a specialist sheep shepherd. In this case the asset (the land) remains fully utilised, and each company can focus their businesses on a single product. The economies of scope are therefore realised in this non-integrated structure. The only additional costs are transactional in arranging the contracts (so called external governance costs).

In a different example, consider a furnace as an indivisible asset. The furnace is in a factory and can be used to smelt both nuts and bolts from metal ore. This is a multi-product process. A bolt manufacturer can chose to either be a single-product firm, and lease the furnace when it is smelting nuts or it can chose to expand and become a multiproduct manufacturer of nuts and bolts. Because the knowledge required to manufacture nuts and bolts is very similar, one would not expect the cost of governing an integrated nut and bolt firm to be high. However, there would be considerable transactional complexity and therefore cost in arranging for the furnace to be leased to another company for smelting nuts and yet still ensure full utilisation. In this example one expects the integrated firm to incur the lower costs, whereas in the orchard and sheep example the non-integrated firms are likely to be the favourable option.

This relates vertical integration strongly to the specificity of the assets involved in both sides of the vertical transaction (as discussed in Williamson, 1985). Whatever the specificity of the assets involved, the associated governance costs in managing the vertical relationship are historically determined by the degree of integration. History shows that if firms at different vertical stages are kept separate they either develop better external transaction governance technology (e.g. Japanese car manufacturers' use of relational contracting) and / or they make use of less transaction specific assets (e.g. Japanese car manufacturers' use of standardised parts) – see Kreps (2004) for a discussion. Network industries generally exhibit different degrees of vertical integration in different countries showing that in some ways they are similar to observations from the manufacturing sector. In a long run context Hughes (1983) discusses the fact that electricity industries developed particular vertical structures because of path dependence not just because of underlying economies of scale and scope.

Drawing on Teece's (1980) findings for a third example, if a toll road were built leading up to a factory (and is the only road link to and from the factory) it would exhibit strong asset specificity. That is to say the road offers a highly specialised service for which there is a very limited market, the factory owners and employees need to use it and nobody else does. The toll road owner or the factory can 'hold up' one another when negotiating the leasing terms. Assets with high asset specificity tend to return greater efficiency when integrated, in this case that means by having the factory own the road. Extending this example, a second firm might also build a toll road leading to the factory; this creates competition and will serve to bring down the high transactional costs. Equally alternative ownership structures, such as the creation of a government owned road network which charges fair access rates may solve the hold-up problem and allow optimal provision of road access.

These insights lead to a deeper understanding of production and economies of scale and scope. Vertically integrated firms may very well benefit from both economies of scale and scope, but the value gains captured by these two economies may to some extent be overlapping. Non-integrated firms can benefit from economies of scope. The real issues when determining which firm structure is most efficient lies in a trade-off between the reduced governance costs of vertically integrated production vs any savings due to outsourcing from the wider market (Williamson, 1985). To keep external governance costs low the assets being used in the external market must not exhibit a high degree of asset specificity to the outsourcing firm, they must be capable of supplying a larger market.

Competition tends only to be economic in cases where scale economies are exhausted at only a fraction of the market size. While this is also the case for multi-product firms, they complicate matters through adding additional dimensions to the overall cost minimisation (economies of scope and multiple markets of varying sizes). The trade-off between favouring vertically integrated firms or non-integrated firms is therefore highly subject to industry-specific factors. These will include but are not necessarily limited to: transaction costs between non-integrated firms; the additional challenge and therefore cost of managing a vertically integrated multi-product firm relative to less complex single-product non-integrated firms, and; the ability of the market to act competitively either as a result of technical limitations (e.g. the cost of the distribution network) or legal and regulatory barriers.

3.2 Applying the theory of economies of scale and scope to the water industry

A paper by Garcia et al. (2007) presents an interesting study of the water industry within which some of these issues are observed. The article applies an approach to understanding economies of vertical integration that differs from considering only scope and scale. These have been previously described in a general context by Perry (1989), who identifies three key determinants for economies of vertical integration: (1) technological economies, (2) transactional economies and (3) market imperfections. Technological economies are focussed on reducing the number of inputs into a process but still returning the same number of outputs. The main aspects of transactional economies have already been discussed above, they involve a trade-off between the governance costs of vertically integrated firms against the transactional costs of non-integrated firms; asset specificity can have a strong impact on transaction costs. If an asset is highly specific in its functions there is a tendency for its market to be small, therefore leading to limited competition and allowing one firm to take advantage and exploit another. This serves to raise transaction cost, and economically can lead to favouring the integration of firms whose internal governance costs are lower. Finally market imperfections describe vertically integrated firms using their market power at differing stages of production up- and downstream, therefore keeping the firm's overall costs low relative to the costs of a production chain of non-integrated firms in the same market.

Garcia et al. (2007) analyse a balanced panel of 211 firms in the Wisconsin water industry for the period 1997–2000. It assesses the possibility that monopoly power and market imperfections in upstream water activities cause inefficient input allocation to downstream activities. Their cost function is individually specified for both types of industry structure (vertically integrated and non-integrated), therefore enabling the testing of global and technological economies of vertical integration separately. The water companies in Wisconsin are described as typical of the United States, in the US water firms tend to be small. The majority of firms are municipally owned (with 6 of 512 in 2003 being private firms). They are regulated by the Public Service Commission of Wisconsin through rate of return, hybrid rate of return and interim price cap regulation.

The Garcia et al. (2007) model vertically divides the industry into two production stages: Production and Treatment (P&T) and Transmission and Distribution (T&D) (which includes retail). They defined the firms in their data sample into three categories: vertically integrated utilities, P&T firms and D&T firms, with the definition derived from whether they bought/sold any wholesale water, or were a net seller or purchaser of wholesale water, respectively. Approximately 80% of their sample firms are vertically integrated, with P&T and D&T firms each making up about 10% of the sample. From simple examination of the data they find clear evidence that non-integrated firms suffer less network losses of water than integrated firms.

Garcia et al. (2007) compared global economies of scale (technological, transactional and market imperfections) and technological economies of scale only to water prices and delivered water volume. It is found that there are circumstances where both vertical integration and non-integration can be the favourable structure. They consider a range of firm sizes (100,000,000–200,000,000 gallons of water delivered per year) and retail water costs (US$0.5–1.67 per thousand of gallons of water). Vertical integration is observed to return global vertical integration economies as firm size reduces and water price rises. In addition to this they also find that only very small companies (<100,000,000 gallons of water) benefit from technological economies. They infer that these results show that economies of vertical integration for water firms derive from market imperfections and not technological economies. Providing adequate marginal pricing can be enforced in the upstream P&T of water, non-integration is the more efficient industry structure.

There are many studies that have assessed the potential for economies of vertical integration; their findings are diverse, with some in support of the argument and some against, see Section 4. Garcia et al. (2007) has been detailed presently because it attempts to separate the sources of these economies. Vertical integration economies in the water industry may derive from firms using their market power on up-and downstream activities. However, the introduction of competition (as in electricity generation markets around the world) or more effective yardstick regulation (as in gas distribution in the UK) may be economically more efficient. We discuss evidence for and against this in the context of other industry sectors in section 5.

3.3. Competition

A summary of key benefits derived from competition as identified by Hay and Liu (1997) are listed below:

- There are two behavioural benefits:
    - Discovery and selection: whereby a firm's market share is inversely related to its costs. The arrival of a low-cost entrant into such a market will shuffle the market and drive out the least efficient competitor.
    - A sharpening of managerial incentives: an increase in competition allows better comparison of managerial performance, it also more strongly links managerial performance to profit, therefore enabling managerial remuneration to reflect performance, thus better aligning incentive with efficiency.
- Increasing cooperation between firms (decreasing competition) non-linearly reduces the responsiveness of a firm's share of the market to its costs.
- A firm's long-term efficiency is linked to its research and development investments, however this hypothesis is not robustly tested in their analysis.
- Short-term efficiency is affected by two factors, one is comparison with rivals and the other is competition in the market place, a loss of market share stimulates firms to improve their efficiency.

In the study they examined 181 firms from 19 UK manufacturing sectors for the period 1970–1989. The sectors were selected based on a number of criteria: (a) narrowly defined products and markets, (b) a range of industries and technology types and (c) the selected sectors represented a range of industry structures. Frontier production function techniques were applied with consideration of each firms' performance relative to the industry frontier, and a firm's efficiency relative to its own 'best practice'.

Competition thus brings significant benefits in terms of reducing inefficiency. This suggests that rather than focussing on the theoretically optimal scale and scope of the firm, which may involve reducing competition and may not actually be observable, it is important to consider whether firms are under sufficient competitive pressure to lower costs and improve quality. The long run benefits of competition may more than outweigh the short run costs of deviation from optimal scale and scope, even if those were well defined concepts.

3.4. Conclusion

Economies of scale and scope have been discussed as have the difficulties in quantitatively separating the benefits they each offer; overlaps in the measurement of these two economies has the potential to lead to inaccurate economic assessment. Where competition is strong, a dispersed ownership structure does not always forbid the opportunity to realise economies of scale and scope.

Vertically integrated and non-integrated firms can both take advantage of them in the right circumstances. For vertically integrated firms this occurs when the firm optimally combines different stages of production with a sufficient degree of cost control over the integrated activities. For non-integrated firms this occurs when the vertically separate assets involved do not exhibit a high degree of specificity, and when competition is strong.

The particulars that dictate which of the two ownership structures can deliver the greatest efficiency are industry and history specific. One must be careful when performing econometric studies that compare the efficiencies of industry structures that the benefits observed by a specific structure are in the interests of the public, not corporate welfare – society is not interested in the shape of a cost function, but in the cost and quality of the products produced. In water and sewerage markets, if a competitive market can be realised there is potential for economies of scale and scope to be achievable for both vertically integrated and non-integrated industry structures.

4. Econometric Models of the Water and Sewerage Industry

4.1 Summaries of the literature on scale and scope

Numerous studies have been carried out with the aim of assessing the efficiency of the water industries and in particular the efficiency of individual market structures. Abbott and Cohen (2009) have recently published a review covering a wide selection of the econometric literature covering many different countries. The findings among the literature are diverse, but some trends were observed.

A brief numerical summary of the conclusions drawn by the literature included in Abbott and Cohen's review is given in Table 4.1, this table discusses water only and water and sewerage firms combined. 26 studies on this topic are discussed by Abbott and Cohen and they report diverse findings with regard to scale economies. Proper within country comparisons are complicated by the use of different samples. The US studies use a variety of different samples of data at both the state and national level. Of the UK studies, 2 pre-date the emergence of the current structure of the water industry in 1973, 4 use only water and sewerage companies and only one (Stone & Webster Consultants, 2004) uses both water only and water and sewerage company data. Interestingly, overall diseconomies of scale were only reported for firms in England and Wales. Some of the larger firms in other countries also reported diseconomies, however in these cases the smaller firms were found to be gaining economies of scale. There are three other cases, all in the USA, where individual stages of the supply chain reported diseconomies of scale (production and residential), which was offset by economies gained elsewhere (distribution and non-residential). The size at which economies of scale are reported to be exhausted is observed to vary considerably. The size at which this occurs is considered to be highly geographically and demographically dependent. The range of observations in the reviewed studies found exhausted scale economies for 100,000–1,000,000 connections. Considerably fewer studies have assessed the sewerage industry, but a greater degree of agreement was found between these studies; three identify economies of scale in the sewerage industry, however one reports diseconomies of scale in sewerage treatment (Knapp (1978) looking at England and Wales).

Table 4.1: Numerical summary of the review of econometric studies in the water and sewerage industries as reported by Abbott and Cohen (2009; page 237, Table 1) for water only and water and sewerage scale (dis)economies, findings for sewerage only (dis)economies are described in the text.

Country[a]	Number of Studies	(Dis)economies of Scale		Economies of scale followed by diseconomies beyond a certain firm size	Economies *and* diseconomies of scale in different parts of the supply chain	Inconclusive / no conclusion as per Abbott and Cohen (2009; page 237, Table 1)
		Economies	Diseconomies			
England and Wales	7	1	5			1
USA	7	3		1	3	
Italy	4	2		2		
Korea	1	1				
Canada	1	1				
Japan	1	1				
France	1			1		
Germany	1	1				
Portugal	1			1		
Brazil[b]	1					1
Colombia[b]	1	1				
Moldova[b]	1	1				
Vietnam[b]	1	1				

[a] One study examined 33 countries (Tynan and Kingdom, 2005), this has been excluded.
[b] These countries were all discussed in the same paper.

Abbott and Cohen examined ten studies regarding economies of scope, their findings are numerically summarised in Table 4.2. Abbott and Cohen used a broad definition of scope economies, encompassing wide-reaching activities, such as environmental planning, policy development and regulation (as noted in Figure 1.1 above). None suggest that there are economies of disintegration for small water firms, whereas two studies (including that of Garcia et al. (2007) discussed here in Section 3.3.) specifically found economies of scope for small firms, while 5 others did for firms in general. Two studies found economies of scope between water production and distribution, while the aforementioned Garcia et al. (2007) study found in contrast to this economies of disintegration between them. Abbott and Cohen stress the need for further studies on large firms.

Table 4.2. Numerical summary of the review of econometric studies in the water and sewerage industries as reported by Abbott and Cohen (2009; page 238, Table 2) for water only and water and sewerage scope(dis)economies.

Country	Number of Studies	(Dis)economies of Scope		Economies of scope followed by diseconomies beyond a certain firm size	Economies *and* diseconomies of scale in different parts of the supply chain	Inconclusive / no conclusion as per Abbott and Cohen (2009; page 237, Table 1)
		Economies	Diseconomies			
England and Wales	4	2	1			1
USA	3	1	1	1		
Italy	1	1				
France	1	1				
Portugal	1			1		

A few features do appear to be consistent across the literature examined in Abbott and Cohen (2009). For small companies vertical integration does appear to reap improved efficiencies, both in terms of scale and scope economies. Also, there is strong evidence that scale economies are becoming exhausted in large firms, with the specific size at which this occurs differing case-by-case.

Torres and Morrison Paul (2006) is included in Abbott and Cohen's review, this provides an interesting discussion that potentially explains how in practice these economies of scale become exhausted and also perhaps why some studies have observed diseconomies of scale. In their study of the US water industry. Torres and Morrison Paul (2006) highlight the importance of customer and spatial density. They generalise that vertically integrated water companies increase revenue through supplying increasing volumes of water. However, this additional revenue is offset against increasing costs of either (a) an increased network size or (b) an increased density of connections. Larger networks require additional pipes to meet the connections and an increasingly dense number of connections make the network complex and challenging to maintain, leading to water loss and increased maintenance costs. Economies of scale are therefore only realised if an increase in revenue from additional delivered water is greater than the increased costs from any associated connection density or network size increase and diseconomies of scale are found for the reverse case.

A more recent literature review has been performed by Saal et al. (2011a). Before reviewing literature the paper defines economies of scale and scope. There is an important shortcoming in the definition given. While they do point out that economies of scope require assets to be indivisible, they do not encompass the importance of asset specificity. This is important as their discussion is framed around the idea that only vertically integrated firms can take advantage of scope economies, which as was discussed in Section 3 is not necessarily the case. If water markets can be made to be competitive, transactional costs relating to assets will reduce and the cost of outsourced products will fall. In a world of competitive water markets the discussion of importance therefore, as noted above, is not with regard to whether or not vertically integrated firms can benefit from economies of scope, but whether any extra transactional costs associated with non-integrated firms relative to integrated firms are offset by the benefits of competition.

The literature review of Saal et al. (2011a) discusses economies of scope evidence from 21 papers. Eight of these papers are focussed on water and sewerage firms, ten on water only firms (one of which also discussed water and sewerage firms) and four on multi-utilities. All of the economies of scope papers discussed by Abbott and Cohen's (2009) literature review are discussed in this review; this review also discusses additional papers.

Five of the water and sewerage studies reviewed in Saal et al. (2011a) found economies of scope between the water and the sewerage activities, three identified diseconomies of scope. They conclude that there is mixed evidence for economies of scope between water and sewerage activities. Among the limited studies concerned with multi-utilities evidence is found for cost benefits from operating multi-utilities. A clear conclusion is drawn with respect to economies of scope through vertically integrating water activities. With that said, the earlier discussed paper by Garcia et al. (2007) – see Section 3.2. – is among the articles that are described as contributing to this evidence. The Garcia et al. (2007) paper by its own words finds that the disintegration of the production and treatment stages from transmission and distribution may lead to costs savings except only for the smallest utilities. Garcia et al. (2007) find that because scale economies were constant at the production stage that introducing competition might have welfare benefits. It is difficult to reconcile the Saal et al. (2011a, p.) discussion of the Garcia et al. (2007) paper with the findings as described in the paper itself. The Saal et al. (2011a) discussion limits itself to only the niche areas where vertical integration was found to be the more efficient structure. Similarly, Saal et al. (2011a) discusses Hayes (1987), and reports that there are economies of scope for small firms that fall off for large ones. However Hayes (1987) specifically concludes not just that the economies are less valuable, but that there are diseconomies of scale for large firms.

33 studies are discussed in the Saal et al. findings on economies of scale. Twelve of the 26 studies discussed by Abbott and Cohen's (2009) review are not discussed in this literature review. Therefore there is an overlap of fourteen studies. A similar conclusion is drawn by Saal et al. (2011a) as was in Abbott and Cohen (2009), small water firms benefit from economies of scale and the largest water and water and sewerage firms appear to suffer diseconomies of scale, the precise firm sizes at which these two turning

points in the realised scale economies occur is dependent on regional geography and demographics. It is suggested that water and sewerage firms in England and Wales are subject to diseconomies of scale.

In the conclusion of their study Saal et al. (2011a) make a number of key observations. They point out a need for understanding the impact of upstream abstraction technology on scope economies; of the impacts of geography and demographics on scale and scope economies; the need for quadratic cost function analysis to enable consideration of scope economies; a need to study sewerage in greater detail; a lack of understanding of the costs and benefits of unbundling retail activities, in light of the Scottish decision to do just this; the potential for strong correlations in scale and scope economies is highlighted, they recommend performing some data envelopment analysis to separate these correlated factors and; they recommend that frontier modelling of efficiency instead of average response might elicit systematic differences between vertically integrated and non-integrated firms.

Following examination of the literature reviews of Abbott and Cohen (2009) and Saal et al. (2011a) and also papers reviewed therein, a very important issue has come to light. The use of language with regard to the size of firms is loose and lacks precision. The size of firms across different countries varies by orders of magnitude. Authors have a tendency to use terms such as "small" and "large" etc. to define the firms in their data samples, without giving consideration to how the sizes of firms in their study marry with firms worldwide. For example, Figure 1.4. shows that the smallest firm in England and Wales delivers approximately 2,420 million gallons of water per year to consumers. In Garcia et al. (2007) they find diseconomies of vertical integration for "large" firms. In their study diseconomies are found for firms larger than 400 million gallons delivered per year (for water prices <$1.6/thousand gallons), this is a fifth of the size of the smallest UK firm. Similarly for Torres and Morrison Paul (2006) the "large" firm category in their study deliverers an average of 29.6 million gallons of water per year (1/80th the size of the smallest UK firm), and they conclude that medium-large firms do not return economies of scale. These firms are all dwarfed by the largest firm in England and Wales, which delivers approximately 200,755 million gallons of water per year (82 times larger than the smallest UK firm). There are significant issues in the literature regarding how the size of water and sewerage firms is described. This has the potential to cause confusion when discussing the presence of (dis)economies of scale and scope.

4.2. Recent Studies of England and Wales' Water and Sewerage Industry

Recently the UK Government's Department for Environment, Food and Rural Affairs (DEFRA) has received the final report from an independent review they commissioned on competition and innovation in England and Wales' water markets (Cave, 2009). The review finds that the value or rewards through firm performance are largely unrelated to the benefits delivered to customers (e.g. service innovation). The review also finds that the UK is less innovative than water industries in Australia, Germany, the Netherlands, Spain and the United States. The report finds that there are economies of scale and scope for small firms within both water and sewerage, but diseconomies of scale and scope between water and sewerage[5]. This observation derives from the study by Stone and Webster (2004). The Stone and Webster (2004) study uses annual returns data from firms in England and Wales for the period 1992-93 to 2002-03. Stone and Webster stress that their findings may provide guidance for identifying the most efficient structure of the water and sewerage industry in England and Wales, but nothing more than that. They do not find evidence for the overall economies of scope between water and sewerage activities, they find that the sample average water and sewerage firm returns diseconomies of scale and the sample average water only firm makes constant returns to scale. They point out that there will be considerable transactional costs in reorganising this industry and are not convinced that the efficiency gains following reorganisation will be worth that cost.

A number of recommendations are made by Cave (2009) focused on increasing competition and innovation. Prominent among these include: a reform of the abstraction licensing system (including unbundling the current supply licence enabling new firms to supply water into incumbent's networks), reforms to improve the regime for upstream entrants, and a framework for economic purchasing with a long-term option of introducing an independent entity to contract the delivery of water and wastewater services. Retail is also recommended for reform, whereby non-household customers will be able to choose their supplier and while household consumers will still not have this choice, the cost reductions for non-household consumers will spill over.

If these (or other) reforms are determined to be capable of encouraging a greater degree of competition in the industry then holdup problems associated with transactions between firms sharing assets (to gain scope economies) would be avoided. For assets that do not exhibit strong asset specificity, this would mean that both integrated and non-integrated firms would be expected to be able to benefit from economies of scope in the water and sewerage industry.

Some of the issues and recommendations on water industry structure from Abbott and Cohen (2009), Cave (2009) and Saal et al. (2011a) have been addressed in two econometric papers, both focussed on the England and Wales water industry and both derived from the same methodological approach (Saal et al., 2011b; Saal et al., 2011c). Each paper uses best practice econometric analysis of the water industry by using a quadratic cost function, which in these cases is informed by unbalanced panel data of either water only or water and sewerage companies for the years 1993–2009. They also attempt to compare the performance of vertically integrated firms with how non-integrated firms might perform, paying attention to the recent divestiture in the

[5] See Cave (2009, p.64).

Scottish retail sector. These papers represent the cutting edge in econometric modelling of the water industry and are based on the most recently available data for England and Wales.

Saal et al. (2011b) focuses on water only companies, using a panel data consisting of 243 observations of their activities. The impact of a range of portfolio choices for abstraction sources are tested in terms of their impact on economies of integration, both vertically and horizontally and differences are observed. However, it is concluded that for all of the abstraction sources firms will still achieve greater cost efficiency through vertical integration, rather than unbundling upstream water production. Regarding retail the study finds little difference between the costs of integrated and unbundled firms. They highlight the importance of consumer bills reflecting the cost of supplying the water and also that there may be efficiency gains through competition, not captured by their econometric analysis. The sample average firm is found to be subject to some diseconomies of scale. The clear conclusion is that integrated firms gain significant benefits from economies of scale and scope that will be lost if firms are unbundled.

Saal et al. (2011c) is primarily concerned with assessing economies of scope between the water and sewerage industries. In this study the data sample is taken from 170 observations of integrated water and sewerage firms and 243 of water only firms. The findings are that both the vertical integration of the water industry and the vertical integration of the sewerage industry reap significant scope economies, however diseconomies are found in the integration of water and sewerage. For a vertically integrated water and sewerage firm the economies of vertical integration are found to be greater than the diseconomies of horizontal integration. They therefore conclude that the two industries might benefit from separation horizontally, but should remain vertically integrated. However they suggest that combinations of water treatment and sewerage treatment and of water distribution and sewerage distribution might yield economies of scope.

The stated conclusions from these econometric studies are very clear: in England and Wales vertically integrated utilities can achieve lower costs than unbundled utilities, water and sewerage services should be separated and some firms are larger than the most efficient size. Providing the econometric assessments are robust, a clear policy route is available for the water and sewerage industries in England and Wales.

4.3 Shortcomings of cost function analysis of economies of scale and scope

Potentially important shortcomings can be identified in the models as applied. Some of these shortcomings are common to many econometric studies of economies of scale and scope.

1. Cost function analysis is fundamentally a best fit to the data of a particular (pretty flexible) functional form. The definition of particular stages of production and outputs to be analysed is arbitrary and limited by the available data. The choice of a single or multiple forms of the cost function is also arbitrary and may not reflect the nature of the production process. It is therefore unwise to put too much emphasis on any particular measured parameter and draw policy conclusions from it. Many of the variables are co-linear and hence the likelihood that individual parameters will incorrectly measure the underlying nature of the technology, while still collectively fitting well to the data, is high. Thus, as Saal et al. (2011a) point out, the modelling techniques that they and many others have used are unable to fully separate economies of scale and scope.

2. Data samples made up of data from England and Wales do not include companies which exhibit separation of water collection and water distribution or which exhibit separation of retail from water/sewerage distribution (e.g. Saal et al. (2011b and 2011c)). The impact on the cost function of these structures is only inferred from marginal differences in the degree of integration within individual firms. It is always unwise to project the impact of complete separation from data samples which only exhibit partial separation due to likely discontinuities in costs at the extremes. If two activities which were previously integrated are completed separated then it is likely that a fundamental change in the underlying technology is stimulated, rendering previous cost functions obsolete.

3. A positive impact of reorganisations of assets is that they may act to reduce input costs. This poses difficulties for cost function analysis which uses actual input prices or industry average prices[6]. In either case any purchasing savings are not correctly apportioned to the structure of the firm and the cost function is likely to be mis-specified.

4. Cost function analysis of capital costs in network industries is particularly unsatisfactory. Capital costs, based on historic asset values, are very difficult to measure and model effectively. They are often defined by arbitrary accounting rules, or initial regulatory asset values and reflect the sum total of past decisions. It is not clear that they give rise to reliable estimates of the efficiency of operation or of the shape of the cost function. One way around this is to fix the measured amount of capital and assume it is an environmental variable not under the control of management. This is not done in most studies, including Saal et al. (2011b and 2011c).[7]

[6] For example, average energy prices are used in Saal et al. (2011b and 2011c) and are assumed to vary in a particular way related to size. Thus these are neither an actual price nor an adequate modelling of efficient purchasing.

[7] Another approach is to use asset additions as a measure of capital input. See for instance Kwoka et al. (2010) who use this approach in electricity distribution.

5. In mixed samples of different ownership structures there is always the danger of selection bias. Thus in a sample of water only and water and sewerage companies in England and Wales, it seems likely that over time the less efficient water only companies have been taken over and only the most efficient remain. It would therefore be wrong to infer that water and sewerage companies should be vertically disintegrated based on the observation that the remaining water only companies are more efficient at water delivery than integrated water and sewerage companies. Indeed the opposite inference is more likely to be true: that the gradual takeover of water only companies indicates that integrated companies are generally more efficient. Similarly differences in the toughness of regulation may be an underlying reason for differential performance, rather than the nature of the cost function.

6. Most cost function analysis, including Saal et al. (2011b and 2011c), only looks at average not frontier cost functions. This is potentially a major shortcoming as other evidence suggests that the shape of frontier firms' cost functions (and hence the nature of measured economies of scale and scope) can vary substantially from average firms' costs[8]. This limits the role of efficient allocation of scarce managerial talent. Managers have optimal spans of control and some are exceptionally good at managing particular combinations of assets (Lucas, 1978). The quality of management varies substantially and may explain differences in the optimal sizes of firms (Rose and Shepard, 1997).

We have discussed two recent reviews of econometric studies of the water and sewerage industries (Abbott and Cohen, 2009; Saal et al., 2011a) and also two further econometric studies in the context of the England and Wales water and sewerage sectors (Saal et al., 2011b; Saal et al., 2011c). The encompassed literature represents a significant fraction of knowledge about econometric studies of the water and sewerage industries. Steps are clearly being taken to improve econometric modelling, however a number of important shortcomings are still present in the methodological approaches. It is therefore recommended that when addressing the on-going policy question faced by the England and Wales water and sewerage sectors, to better inform the real value gained or lost in increasing competition and unbundling industry activities, wider-reaching evidence ought to be considered too. We discuss some of this in what follows.

5. Experience in Other Network Industries

The efficiency of network industries as a whole continues to be an active field of research. Many studies have been undertaken with the broad goal of determining the efficiency of existing or historical world markets and testing the potential efficiency of alternative market structures. A brief examination of literature relevant to the telecoms,

[8] See Nillesen and Pollitt, 2010, for a discussion of this in the context of US electricity distribution utilities.

electricity and gas industries is now presented. The findings indicate that consumer welfare is benefitting in these industries as a result of divestiture and reorganisation.

5.1 Telecoms

Telecoms has undergone a dramatic transformation since the 1960s, as introduced in section 1.2. An example of a rather far-sighted study is that of Babe (1981) who makes suggestions for reform of the telecoms sector in line with subsequent successful evolution of the industry. Babe looked at telecommunications in Canada. He compares integrated and non-integrated firms across Canada. The full time range of his study covers the period 1950–1977, however, the years 1950–1967 are used only to test a baseline for the analysis. Babe introduces the study by pointing out the high degree of controversy between the vertical integration and non-integration of telecoms firms at that time. Following his analysis he concludes by highlighting that non-integrated telephone companies have been able to achieve considerable costs savings over vertically integrated firms and that the telephone companies' own research confirms this. The reason that Babe attributes to the success of non-integration is the growing importance of innovation at that time in the industry. The benefits of innovation in the competitive market outstripped those of scale economies associated with vertical integration. The Babe study is interesting because he makes use of a dataset including integrated and non-integrated firms to make predictions about optimal structure. This indicates importance of having sufficient variation in the sample of existing firms in order to be able to make valid policy predictions of performance under different industry structures.

5.2. Gas

In 2005 the European Commission expressed interest in pursuing the UK model for gas transport – i.e. an ownership unbundled gas transmission system- to optimise the use of networks (European Commission, 2005). In response to this Seris released a critical report of the unbundling of UK gas (Seris, 2006). Their opinion was that any transportation and distribution efficiency gains were purely coincidental during the divestiture. They pointed out that the 1996 unbundling of British Gas into Centrica and BG did not legally have to happen as it did as companies were entitled to be both distributors and shippers or suppliers. We might therefore interpret from this that British Gas made the decision to unbundle voluntarily because they needed to make efficiency improvements to keep competitive with new entrants whom were about to arrive in the market.[9]

The Seris report discusses five key points in its determination of whether UK gas optimised network usage. Of particular interest in this work is that the report finds that third party access to the network did not require ownership unbundling and that this

[9] British Gas unbundled under pressure from the competition authorities who had, unsuccessfully, attempted to force separation of the transportation from the rest of business (see Pollitt, 1999)

could equally have been applied through regulation. With regard to gas balancing and transport, they find that the internal unbundling of Transco within British Gas could achieve the same efficiency. In summary, this generally critical report of the unbundling of UK gas still finds that unbundling was advantageous to consumers; the key difference lay in the fact that Seris believe that the same ends could have been met through internal unbundling rather than legal separation.

In 2004 National Grid Transco agreed to the sale of four of its eight regional gas distribution networks in the UK. This led to the entry of three new firms (one bought two of the divested networks) into the market in 2005. The UK electricity and gas regulator, Ofgem, promoted this unbundling and were met with some criticism at the time. Oxera gave one such response and provided their prediction of the value of the sale (Oxera, 2003). They claimed that the Net Present Value (NPV) returned from the sale was overestimated by 33-50%. They were concerned about the possibility of economy of scale losses through the demerger. They anticipated that if scale economies were lost, that these could further reduce the expected NPV of the sale to as little as 0-20% of Ofgem's estimate.

Two key reasons were given for why they believed the value of the sale would be smaller than Ofgem's prediction. First, the expected rate of increase in efficiency gain was considered irreconcilable with other sectors, the assessment was deemed simplistic neglecting the underlying rate of technological change of an industry and the industry's level of quality investment. Oxera used cross-industry comparisons to suggest that higher efficiency gains are likely to be experienced in industries with a higher rate of technological change and that quality investment will increase an industry's current annual operating expenditure. Given rising concerns of water scarcity and therefore the need for technological innovation, this could be an important consideration. Second, Oxera identify that the Ofgem assessment assumes zero benefit from having separate price controls for the 8 regional distribution networks while under common ownership and that all of the benefit arises from realising individual price caps through separate ownership. This is at odds with previous statements by Ofgem. Regardless of which of Ofgem's statements is correct, benefits are observed through having more carefully controlled prices. Although it is not the only method available for achieving this, more unbundling of different vertical stages and use of yardstick or actual competition in the water sector would be one way in ensuring that prices are accurately determined (e.g. of the retail business segment).

These two critical studies of unbundling in the gas sector have identified within them the importance of some form of unbundling in gas. To the authors' knowledge, there has yet to be a rigorous econometric study of the performance of UK gas distributors since the 2005 ownership unbundling. Presently, we have performed a very simplistic assessment. Data published by Ofgem, the UK gas and electricity regulator, has been gathered regarding the total number of connections (domestic and non-domestic) each distributor served for the financial years 2003/04 and 2005/06 to 2007/08[10]. This has been compared to the firms' annual controllable operating expenditure for these years (Figure 5.1.1.) and the total costs (i.e. operating plus capital costs)[11] for each of these years (Figure 5.1.2.). The company names have been abbreviated as follows; NGG: National Grid Gas, NGN: Northern Gas Network, SGN: Scotia Gas Network, WWU: Wales and the West Utilities and National is the average for all connections. For 2003-04 and 2004-05 the regional gas networks have been grouped as per ownership after the network sales. This mean cost per connection analysis is simplistic and more detailed analysis is highly recommended. However, Figure 5.1.1 and Figure 5.1.2 show that since unbundling took place the mean cost per domestic and non-domestic customer has decreased year-on-year.[12] There has been an increase in capital expenditure during this time, off-setting the operational expenditure reductions. This can be taken as tentative evidence that the unbundling of the gas transport sector has met with success in terms of customer welfare.

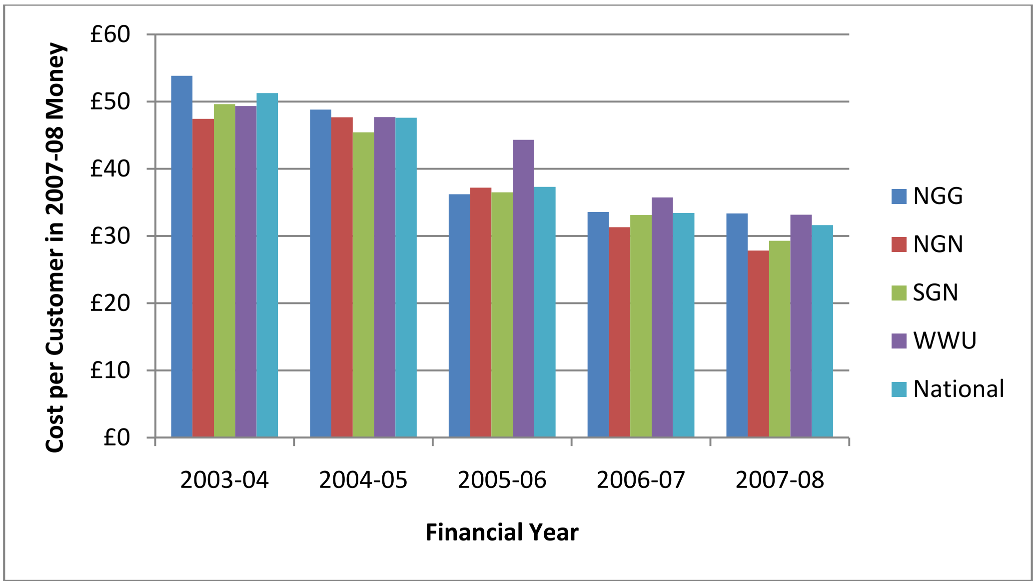

Figure 5.1.1: Mean controllable operational expenditure per connection for Gas Distribution Firms in Great Britain

[10] Sources: OFGEM, 2005; OFGEM, 2006a; OFGEM, 2006b; OFGEM, 2006c; OFGEM, 2007; OFGEM, 2008.
[11] Capital costs rise over the period due to sharply increasing investment, hence we report the operating cost separately as this reflects underlying efficiency improvements.
[12] Customer numbers data for 2004-05 is unavailable. We have taken the average of 2003-04 and 2005-06.

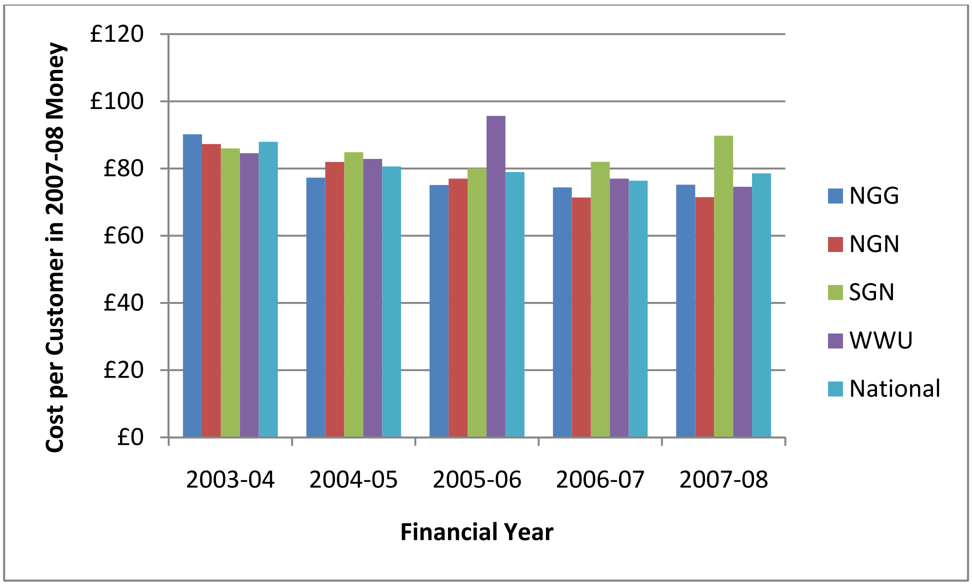

Figure 5.1.2: Mean total annual cost per connection for Gas Distribution Firms in Great Britain

5.3. Electricity

Newbery and Pollitt (1997) analysed the performance impact of unbundling the Central Electricity Generating Board (CEGB) in England and Wales. The CEGB was split into a separate transmission company and three successor generating companies. There was an initial rise in costs at the time of horizontal and vertical unbundling as new governance arrangements were put in place. However the unbundling significantly reduced both generation and transmission costs over time. The overall net benefit was estimated to be a permanent reduction in costs of the order of 5%, even after significant upfront costs. This was in spite of large amounts of evidence from before privatisation of the existence of economies of scope between electricity generation and transmission (see Pollitt, 2008 for a review). This example suggests that pre-existing evidence on economies of scale and scope can be fundamentally misleading as to the likely benefits of unbundling.

Pollitt (2008) has assessed the pros and cons of vertical unbundling in electricity networks in the context of recent EU debates about ownership unbundling of electricity and gas transmission assets from the rest of the industry. Five major structural models are given consideration, including the "classic" vertically integrated model and full unbundling, with an Independent Transmission System Operator (ITSO). A comparison is drawn between these two, and it is concluded that ownership unbundling improves competition and eases regulation. However, making the transition between vertically integrated networks to the ITSO model are characterised by upfront costs. These arise in the form of physically separating the unbundled firms and in transactional costs as there is the need to renegotiate contracts. The costs vary considerably between different countries and comparison with gas indicates that costs are industry dependent too. Transaction costs remain higher after the initial unbundling and in fact widespread evidence is found for economies of vertical integration over unbundled networks. Despite this, case study evidence demonstrates lower total costs in the long term from ITSO networks compared to vertically integrated firms. These efficiency improvements are considered to be attributable to the increased competition in wholesale and retail markets.

A recently study by Triebs et al. (2011) using unbalanced panel data of US electric utilities from 1994 to 2006 has carried out an efficiency assessment indirectly comparing the economies of vertical integration and benefits of competition through divestiture. The study finds that while divestiture decreases distribution efficiency (due to technological diseconomies of vertical separation), this loss is outweighed by increases in power sourcing efficiency through increased competition. The study concludes by pointing out that while many econometric studies might conclude that economies of scope are an important benefit of vertical integration, over time divestitures might still be more valuable due to the gains through competition.

Kwoka and Pollitt (2010) have used data envelopment analysis to assess the impact of mergers on efficiency in the US electric power sector. Contrary to conventional wisdom they determine that during 1994-2003 US electricity distribution firm mergers were actually instigated by underperforming firms and that after the merger the target firm's performance declines, while the acquiring firm shows little sign of improvement. While economies of scale were not strictly being questioned by this analysis, it is interesting to note that the merger – and therefore reduction in competition and increase in scale – is not seen to reap efficiency improvements, for electricity distribution on its own.

Pollitt (2008), Triebs et al. (2011) and Kwoka and Pollitt (2010) are consistent with a much earlier work of Pollitt (1999). While summarising the costs and benefits of widespread privatisation of publically owned industries throughout the 1980's and 1990's Pollitt (1999) finds that the increase in market competition in network industries that was simultaneously introduced into the industries has resulted in clear overall efficiency gains. The water industry was identified as differing from other industries because the majority of household consumers' charges are governed by the house's rateable value rather than on the basis of their demand for water. This made it difficult to enforce economically efficient pricing and efficient distribution (and to have retail competition).

6. Evidence from Existing Water Markets

Following an examination of water and sewerage industries in other countries we have not identified any water markets that have undergone divestiture such that they resemble the other network industries in the UK, i.e. disintegrated sourcing, transmission, distribution and retail. However, some water markets have been identified that are of interest for study and may help in determining whether the water industry of England and Wales, or any other water industry might benefit from unbundling. In addition to those presented below, more international examples of potential interest are highlighted in Saal et al. (2011a) such as: the Sydney Water Corporation which supplies water and wastewater services, but purchases its bulk water supply; the multi-utilities of Switzerland and Italy which offer water, gas and electricity; and the French local water concessions where assets are publically owned, but their use is contracted out to private firms. We, however, discuss three examples of recent water sector reorganisation.

6.1. South East Queensland

The region of South East Queensland underwent reforms that came into practice in 2008 and 2010 (Queensland Water Commission, 2008). Prior to these reforms its water and sewerage industry was run by local councils, multiple different practices were in place for operating the industry across the South East Queensland region. Its entire industry is publically owned. In 2008 bulk water sources were aggregated into a single supply firm, the Queensland Bulk Water Supply Authority. Desalination plants and recycled water are owned by another firm which was created at that time, the Queensland Manufactured Water Authority. Bulk water transport is owned by a firm created for purpose, the Queensland Bulk Water Transport Authority. All bulk water is sold to a grid manager, who manages the contracts between upstream and downstream firms. In 2010 local governments took ownership of distribution and reticulation for water and sewerage, sewerage treatment and retail concentrated in three separate distributor-retailers, with a total of 1.2m connections.[13] The reforms of South East Queensland are one of the most significant attempts that the authors' are aware of for any regional authority to unbundle the water and sewerage industries. This is a potentially important region of study with respect to any plans to unbundle water and sewerage activities in England and Wales or other countries.

6.2. Melbourne

In 1994 Melbourne Water had its responsibilities divested (Victorian Government, 1994). Its control over parks and gardens were removed, its remaining business interests were involved with water and sewerage. This aspect of the business was also unbundled into four different firms. Melbourne Water has retained its upstream activities (water supply and final wastewater disposal) and three other companies have been created, each is involved with reticulation, distribution and retail: Yarra Valley Water, City West Water and South East Water; they operate in different parts of the city to one another. This has enabled benchmarking between the firms (Abbott et al., 2010). This differs from the industry structure in England and Wales in that in England and Wales there are no distribution and retail only firms and benchmarking takes place

[13] In 2009-10, Queensland Urban Utilities had 510,000 connections; Allconnex had 400,000 connections; and Unitywater had 270,000 connections (sources: Annual Reports for 2009-10, for Queensland Urban Utilities and Allconnex; website for Unitywater, accessed 29th March 2011).

between fully vertically integrated firms, rather than by performances in individual stages of the water supply and disposal process.

When the possibility of reform was first being discussed in the 1990's the then leader of the opposition of the Victorian government, John Brumby, was noted as being the proposed reform's strongest opponent, citing diminishing economies of scale as reasons against it (Abbott et al., 2010). After more than ten years of this industry structure bring in place John Brumby, who had then become Premier of the Victorian government, ordered an independent study of its performance to be carried out. In 2008 this report was finalised (Victorian Competition and Efficiency Commission, 2008). The report has found that the Melbourne water and sewerage industry has been performing well since 1995, when the reforms came into practice. The report has presented price data (Victorian Competition and Efficiency Commission, 2008, p.22), which shows that water prices have come down slightly in real terms compared to prices prior to the reforms. It also suggests that the upfront cost of the reforms was reasonably large in comparison to the savings realised. The reasons given for the cost savings are outsourcing and competitive tendering for contracts and through having expanded the scope of the businesses.

The report considered potential benefits from a new wave of reforms in the industry. Reconsolidating the retail sector, but not reintegrating it with the wholesaler, was considered. This was predicted to return efficiency improvements, but these were expected to be very slight and in comparison to the cost of enacting them and downside risks led the report to recommend against this. Also considered was the further unbundling of the downstream firms, through separation of the distribution and retail services with either single or multiple distributors and multiple retailers. In view of the lack of precedent for such an industrial structure the report considered this to be a risky action to take, particularly in view of the more pressing water scarcity issues and therefore increases in wholesale water costs faced by Melbourne. They did however consider this kind of structural reform to be worthy of consideration once again in the future.

While further investigation into the Melbourne water and sewerage sector might return more precise findings, the present evidence strongly suggests that at the very least prices have not risen as a result of the restructuring of the distribution and retail sectors, costs appear to even have reduced as a result of the reforms, albeit the time scale for the return on investment is significant owing to the costs of the reform itself.

6.3. Munich

The utility infrastructure of Munich is interesting and may offer insights into the potential for water services to realise efficiency gains through forming a part of a multi-utility. Stadtwerke München (SWM) operates in the local Munich area, prior to 1996 it had dealings in water, electricity, gas and services including public transport and swimming pools. In 1996 the legal organisation SWM was changed from a publically owned company to a public limited company, shortly following and prompted by EU legislation for electricity liberalisation, SWM chose to form a daughter company, SWM-Versorgungs-GmbH (SWM Utilities Plc), which was and remains a publicily owned company; however, it has independent management responsible to SWM. Its public transport and swimming pool assets remain in the ownership of the SWM parent company. The daughter company therefore became an electricity, gas and water multi-utility (Lanz, 2005).

Further restructuring has taken place in 2004 (Lanz, 2005), SWM-Versorgungs-GmbH was unbundled into its current structure which consists of three legally independent bodies: a wholesale water-only company, a combined electricity, gas and water distribution company and a similarly integrated retail company. It is expected by the author of the WaterTime report (Lanz, 2005) that the combining of water alongside electricity and gas in the distribution and retail sectors will place pressure on the water divisions of the companies to improve their financial efficiency. We do not know of any formal analysis of the economics of Munich's water supply since this unbundling took place, however it is noted in Lanz (2005) that there has been an increase in cost cutting and commercialisation. This suggests that efficiency improvements may have been made. Lanz (2005) also reported that Munich is not the only German city to undergo unbundling, an investigation of Munich and other cities' efficiency performances before and after unbundling may prove enlightening in discussions of water structure reforms.

The potential for benefits owing to cross-industry performance comparisons is one gain that a multi-utility might provide, a second is that wide-scope projects may become more attractive as a result of horizontal integration. A case study example that may be of interest here has been identified. SWM and the car manufacturer, BMW AG, have developed an underground water cooling system for a major computer cluster, which demands multiple megawatts of power. There is potential for gains through scope economies here for a multi-utility (Arnold, 2006).

7. Discussion and Conclusions

This paper discusses the literature concerned with the water and sewerage sectors and similar industries, with a focus on efficiency differences between the structure of firms and the presence or not of competition. Other network industries have been found to return a net benefit from unbundling and the corresponding increases in competition. Arguments for why the water industry would not return the same benefits often focus on discussions about the existence of economies of scale and scope that could or could not be realised by divested firms. In this paper we have examined economies of scope, in particular, from several points of view.

We have returned to the original literature concerned with scale and scope economies and shown that these concepts are challenging to separate conceptually and to reconcile with the organisation of actual firms. Specifically, we find that the real difference in efficiency between integrated or non-integrated firms lies in the costs associated with realising the economies of scale and scope that the underlying assets have to offer rather than in the assets collected under the ownership of the firms. Changing the ownership structure of firms does not prevent underlying assets from being efficiently utilised, however, it does affect the governance costs associated with their utilisation. Therefore from the perspective of the economic theory the potential efficiency savings for unbundling (or re-bundling) within the water industry to return efficiency savings hinges on the extent to which competition or more effective regulation is facilitated by unbundling (or re-bundling), as well as the transaction costs imposed by the initial industry structure.

An ideal unbundling would therefore stimulate competition, improve the cost effectiveness of regulation, reduce the governance costs associated with optimal management of the existing assets and stimulate a development path (reflecting the ownership patterns) which was more dynamically efficient. Evaluating a proposed unbundling becomes difficult when it imposes potentially significant upfront reorganisation costs and is expected to improve some of the ideal elements but worsen others.

We have examined the findings of recent reviews of econometric literature on costs and have looked in detail at studies focussed on the England and Wales water and sewerage industry, which have been performed in light of the on-going policy debate. The econometric literature is characterised by the diversity of its findings on both scale and scope. This has provided evidence that industry costs are significantly influenced by regional geography and demographics and history. Such analysis can only really evaluate the relative performance of existing industry structures and is not particularly informative in judging hypothetical reorganisations of assets not reflected within the actual sample analysed. The data for England and Wales contains no actual examples of separated retail and network businesses or of separated bulk water collection and distribution and can therefore offer no conclusions on the likely impact of such separation.

A first step has been taken in identifying where other, more informative, sources of evidence might be found. We have looked at other sectors and at examples of water industry reform around the world. All of these suggest that claims of large increases in costs, based on cost function analysis of existing water industry data, due to reorganisations of water industry assets are not supported in analogous industries or in other jurisdictions. We emphasise that the structure of a water and sewerage industry should: be consistent with underlying economic theory; be informed by relevant econometric studies; and be consistent with the evidence available from actual reform in the water industry and other closely related sectors.

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