A preliminary analysis of water consumption in the Scottish water Market 2008-20
A working paper, 1st October 2020

1. Introduction

The water Market in Scotland opened on the 1st April 2008. For the first time anywhere in the world, Business customers in Scotland were able to choose their supplier for water and wastewater services. The Market is now more than ten years old and there are currently 29 suppliers (referred to as Licensed Providers) offering their services and competing for customers.

The impact of the Market on price and quality service has been formally assessed by the regulator and independent consultants (with evidence of a positive outcome on both measures), while there has also been considerable attention paid to switching numbers and the types of customer that have switched. This paper provides the first quantitative assessment of the environmental impact of the Market. The report is based on simple descriptive statistics, recognizing the limitations that attach to such an approach; our measure of environmental benefit is a reduction in consumption volumes, both in aggregate and for individual customers. While the analysis is simple, the preliminary results are nonetheless striking, with a 16.1% reduction in measured volumes over the lifetime of the Market. Such a reduction runs counter to general economic conditions in Scotland over the past decade and it is not explained by pricing policy in the water industry – we believe that there is a compelling case that the Market has fostered a significant water conservation effect.

In the light of this result, a more in-depth analysis, building on this preliminary assessment, is currently under way. That analysis will seek to apply more sophisticated statistical techniques to understand the reduced consumption volumes, picking up on the evidence in the preliminary results that geographical location and public versus private ownership might be predictors of the size of the conservation effect. It will also include an assessment of the reduction in CO^2 emissions associated with the volume reduction.

The current paper first provides some background on why the Market came about and the general economic conditions surrounding its first decade of operation. It then reviews the data on measured consumption volumes, considering various factors that might influence the scale of the conservation effect.

2. Background to the water Market in Scotland

In the early 2000s the Scottish water industry embarked on its second major structural transformation in under decade. This change was designed to address a legacy of under-investment in the industry and under-payment by customers for water and wastewater services. It was also a response to new European legislation, notably the Water Framework Directive (2000/60/EC), which entailed Scotland establishing higher national standards for drinking water quality and the treatment of wastewater. The poor state of existing assets, combined with introduction of new stricter health and environmental obligations, would necessitate an additional raft of investment with a substantial funding requirement attached to it.

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In 2001 the Scottish Government published the Water Industry (Scotland) Bill, which proposed the establishment of a single all-Scotland water authority. On 1st March 2002, the Water Industry (Scotland) Act 2002 received Royal Assent, and a month later Scottish Water was created from the three existing Regional Authorities. The new Scottish Water was set the objectives of improving customer service, realizing substantial efficiency savings and acting in a more commercial manner (within a framework of accountability to the Scottish Ministers and the Parliament). From its inception, Scottish Water was intended to be a vehicle for delivering environmental improvements for Scotland through a national investment strategy.

In parallel with these developments, considerable attention was given to understanding the implications of the Competition Act 1998, and the possible consequences for sustainability if third parties established the right to enter the industry and use Scottish Water's 'essential facilities'. The Scottish Government's concerns fell into two areas:

- That certain types of competition might benefit some customer groups, but disadvantage others (for example, by allowing cherry-picking of the most profitable customers under a 'common carriage' regime).
- That certain approaches to access pricing could allow entrants to use Scottish Water's infrastructure without paying the full economic cost of doing so (for example, pricing access at marginal cost).

These concerns fomented the view that some types of competition could threaten important policy objectives for the sector, for example, the policy of maintaining equivalent nation-wide tariffs for equivalent services, and, in the case of some systems of access pricing, the ability of Scottish Water to fund its investment programme.

To avoid these problems, the Water Services etc. (Scotland) Act 2005 facilitated the arrangements that make up the water Market in Scotland today. The implementation of this Act drew a line between the monopoly and the contestable parts of the value chain that left all the physical assets with the wholesaler. It then established a wholesale charge that included the full economic cost of investing in, operating and maintaining those assets, ensuring that Scottish Water would be funded to meet its obligations. Entry was to be managed by regulatory and technical gatekeepers (WICS and the CMA) and Market activities and operational processes were to be governed by a framework of rules that included a strong element of customer protection.

The Market went live on the 1st April 2008. Licensed Providers were licensed to provide services to businesses in Scotland in the customer-facing space of meter reading, billing and customer care. It was recognized that they may deliver innovation, which, along with novel approaches to pricing and billing, might include water saving initiatives and waste management services that could benefit the environment. However, this was not a primary objective of the Market, and the Licensed Providers were not viewed as the primary operational agents of environmental change – that role remained with Scottish Water and it emphasized the quality of treated wastewater discharged into the natural environment.

This paper considers evidence that the Market has in practice been more fundamental to environmental improvement than was either expected or hoped for at its inception.

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3. Economic context

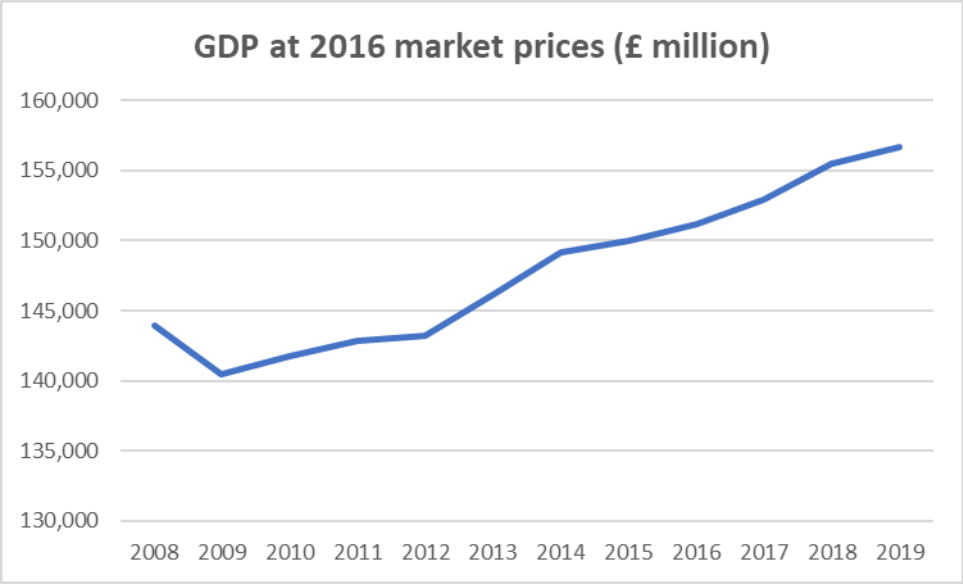
At the macroeconomic level, if aggregate demand in the economy is increasing, the demand for individual goods will also tend to increase, absent any changes in tastes and preferences for those goods. At the microeconomic level, changes in price affect the demand for a most goods, albeit that their responsiveness to price varies depending on their characteristics. To the extent that we identify a reduction in the volume of water consumed over the lifetime of the Market, we therefore need to rule out the possibility that this is fully explained either by general economic conditions or water-specific pricing decisions by asking:

- First, has the level of economic activity in Scotland changed in way that matches the pattern of change in water volumes consumed?
- Second, has the level of water charges changed in a way that could explain changes in the demand for water?

Macroeconomic activity

The water Market in Scotland went live on 1st April 2008 and has now been in operation for 12 years, during which time the wider economy has experienced one significant shock and a subsequent period of austerity in public sector expenditure. Figure 1 shows Scotland's real GDP for the onshore economy from 2008 to 2019. The fall in GDP from 2008 to 2009 reflects the international financial crisis and the subsequent global recession. However, from 2009 onwards GDP growth resumed, and over the whole period, including the 2008-09 reduction, Scotland's onshore economy grew by just under 9% in real terms.

Figure 1: Scotland's onshore economy real GDP



Another relevant measure of economic activity is the number of water connections in the Market. Figure 2 shows the number of measured and unmeasured water connections and their combined total over the lifetime of the Market.

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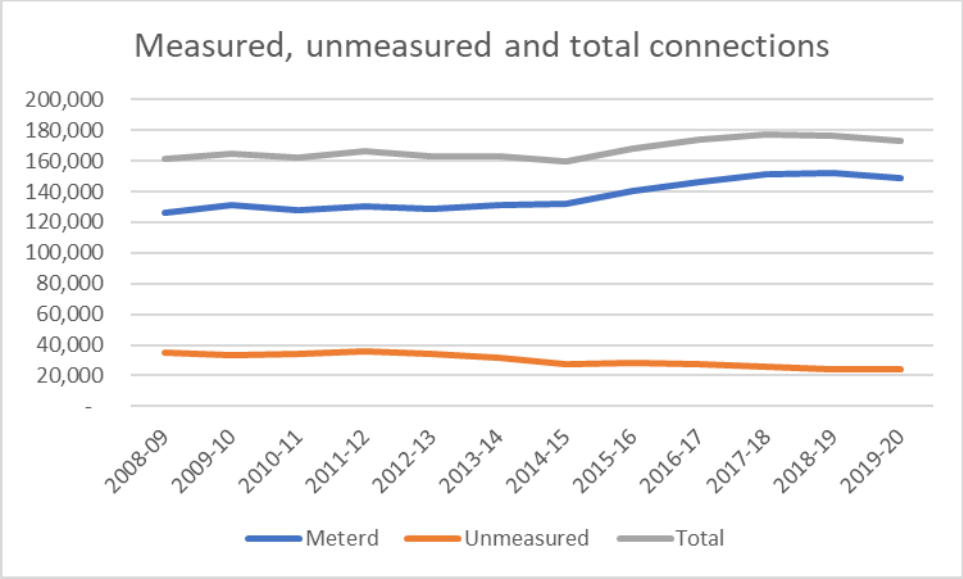
Figure 2: Non-domestic water connections



Over the period, the total number of connections has increased by 7.3% from 161,409 to 173,254, the net effect of a 10,770 decrease in unmeasured connections and a 22,615 increase in the number of measured connections.

The decrease in the number of unmeasured connections reflects not only disconnections but the installation of meters at some connections i.e. a change in status from unmeasured to measured. The increase in the number of measured connections reflects the combined effect of four factors: the installation of new connections at new premises; the installation of meters at previously unmeasured connections; the inclusion in the Market of connections that already existed but were not known about or in charge (referred to as 'gap sites'); and, netted off from these first three, the disconnection of some measured connections. The largest increases in connection numbers are for 15mm and 200mm connections (27k) in contrast there has been a reduction in the numbers of 80mm – 250mm connections (234).

On the assumption that water consumption tracks economic activity, we would not expect to see a significant reduction in the volume of water consumed by businesses over the lifetime of the Market.

Water charges

Water charges are capped by the Water Industry Commission for Scotland for 5- or 6-year regulatory control periods. Tariffs for 'service elements' (meter-based charges, volumetric charges, capacity charges etc.) set by Scottish Water on an annual basis must be consistent with the charge caps, recognizing that 'service elements' can be more granular than the charge categories used for regulatory purposes. Non-household charges have been subject to regulatory control through three separate determinations during the lifetime of the Market. The table below provides a high-level summary of the outcomes of each of the relevant price controls.

Table 1: Summary of price control for non-household water charges

Price control period	Price control outcome for non-household customers
The Strategic Review of Charges 2006-10	Charge caps for tariff baskets were set relative to RPI, with the difference expressed as a 'K' factor i.e. the real increase in bills for customer groups was capped. "Most non-household bills will increase by 1.5% less than the rate of inflation in each of the next four years – a total reduction of over 6% in real terms."
The Strategic Review of Charges 2010-15	Methodology the same as SRC 2006-10. "Over the five-year period 2010-15 charges will rise by 5% below the rate of inflation. – Households will enjoy a price freeze in the first year and, subject to inflation, the prospect of a further price freeze in 2011-12. Household charges will increase by less than inflation between 2012 and 2015. – Charges for businesses and public sector organisations (except for some users of trade effluent services) will also be frozen in 2010-11 and will thereafter follow the same profile as for households."
The Strategic Review of Charges 2015-21	Methodology the same as SRC 2006-10. "For non-household customers, Scottish Water will be permitted to increase its wholesale charges at no more than CPI minus 0.3% per year over the period 2015-21. We have also taken a related, although separate, decision about the default maximum retail tariffs which retailers can charge non-household customers. Our decision is to freeze default tariffs in nominal terms for the six years of the regulatory control period."

Over the lifetime of the Market, water charges have increased at a rate substantially below inflation. It follows that price is not a straightforward explanatory factor in any observed reduction in consumption volumes. However, there may be a price effect where previously unmeasured connections become measured; there is a substantial body of literature on the conservation effect of metering. This is particularly relevant given the Scottish government's 'full business metering programme', which ran during the lifetime of the Market. Any such impact is not separately identified in this paper but will be explored in the next stage of the research.

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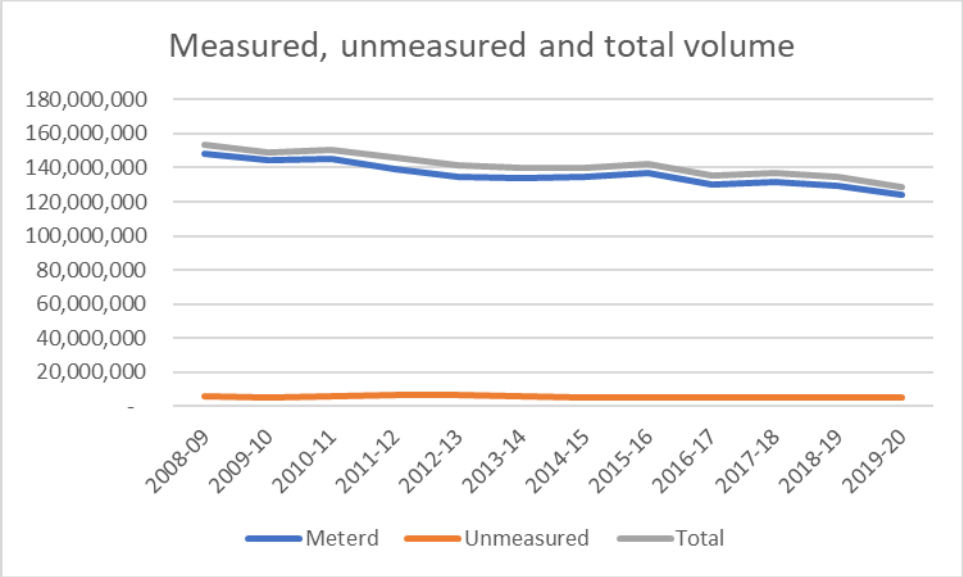
4. High-level volume analysis

In this section we review aggregate volume data from the non-domestic water market. Figure 3 shows the trends in measured, unmeasured and total volume over the lifetime of the Market. Figure 4 shows the same information scaled by connection numbers.

Figure 3: Non-domestic water consumption



From 2008-09 to 2019-20 the annual total volume consumed has fallen by 24.68 million m^3 or 16.1%.

For unmeasured connections, the annual reduction is 0.9 million m^3 or 15.5%. For the purposes of water charging, unmeasured volumes are attributed to connections based on the ratable value of the associated premises (with a threshold ratable value below which consumption is set to zero). Additionally, whether a property was vacant or occupied has also affected volume and charging over the lifetime of the Market. Consequently, unmeasured volumes broadly track unmeasured connection numbers and, whatever may be happening in practice, there can be no basis in the data for identifying any conservation effect at these connections.

For measured connections, the annual reduction in volume is 23.8 million m^3 or 16.1%. Despite the reduction in numbers of some larger connection sizes, this is sufficiently large to suggest a significant conservation effect. Another way of quantifying the reduction is to consider the trend in average volume per connection, which has fallen from 952m^3 to 744m^3 for measured connections.

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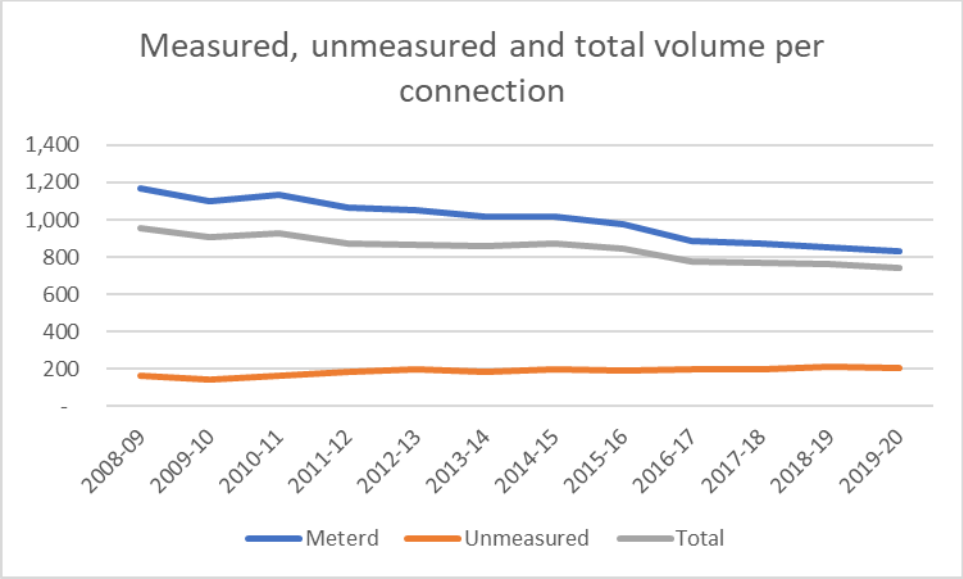
Figure 4: Average non-domestic water consumption per connection



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5. Sub-category volume analysis

In this section we examine the volume reduction for measured connections in more detail. We consider the impact of connection size, geographical location, public versus private ownership, and switching behaviour on volume reduction. While we recognize the potential for overlap between these explanatory factors, separating and quantifying the effects will be part of the next stage of research.

The impact of connection size

Table 2 shows the change in average non-domestic volume for each connection size over the life of the Market. For each connection size, it reports the average volume (the total volume divided by the total number of connections) in 2008-09 and 2019-20 and the difference between the two. The table shows that the average volume has fallen for 9 out of 13 connection sizes; two of the remaining four connection sizes show an increase of just 1%. The largest reductions in average volume occur at the largest connection sizes. In contrast, there is a less straightforward correlation between connection size and percentage volume reduction, albeit that some larger percentage reductions occur at large connection sizes.

Table 2: Change in average measured water consumption by connection size

Measured connection size	Average volume 2008-09	Average volume 2019-20	Change in average volume (m3)	Change in average volume (%)
15mm	355	244	-91	-26
20mm	338	332	-6	-2
25mm	1,050	1,152	102	10
40mm	4,141	4,193	51	1
50mm	9,103	8,342	-761	-8
80mm	12,046	9,666	-2,380	-20
100mm	60,901	61,807	906	1
150mm	189,368	203,643	14,275	8
200mm	772,809	343,692	-429,117	-56
250mm	242,419	NA[Note]	NA	NA
300mm	1,275,833	1,113,084	-162,748	-13
350mm	4,745,251	3,848,873	-896,378	-19
600mm	3,345,081	1,482,896	-1,862,185	-56

Note: 2015-16 was the last year there was volume associated with the 250mm connection size and in that year there was a single meter.

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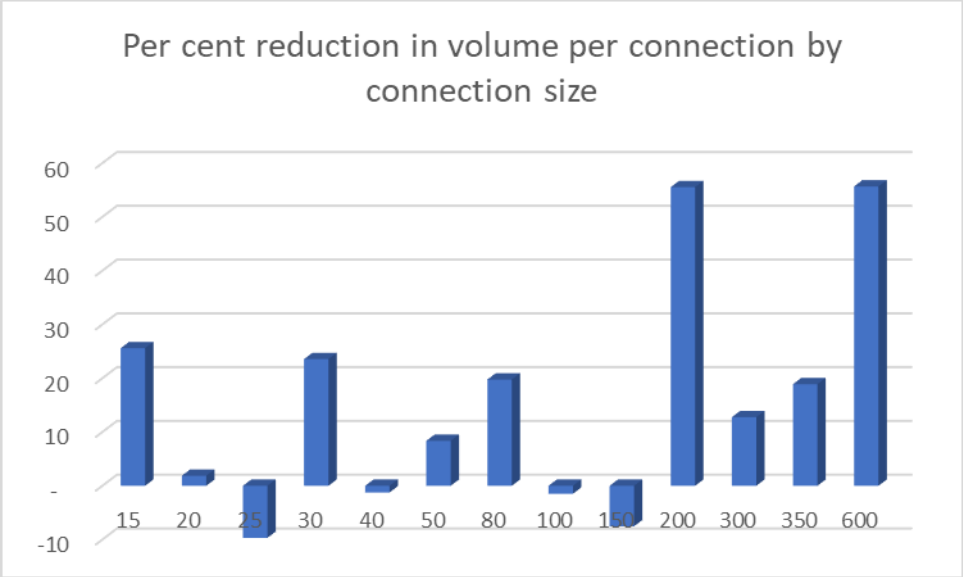
Figure 5: Reduction in average volume by connection size 2008-09 to 2019-20



The impact of location

Table 3 shows the change in total and per connection non-domestic volume by region over the life of the Market. Regions are defined according to Eurostat NUTS (Nomenclature of Territorial Units for Statistics) codes for the UK. Missing and incomplete postcodes on the Central Systems mean it is not at this stage possible to match all our connections to a NUTS region; unfortunately, the category of connections that are unmatched account for 37% of the reduction in volume over the life of the Market. Further work will be carried out to establish the location of these connections and the preliminary results should be treated with caution.

Table 3: Change in total and average volume by region

Region	Change in total volume (m^3)	Change in volume per connection (m^3)
North East Scotland	20,211	- 127 (-13.6%)
Highlands & Islands	944,064	- 100 (-15.6%)
Eastern Scotland	- 10,533,662	- 419 (-30.3%)
West Central Scotland	- 827,649	- 197 (-20.1%)
Southern Scotland	- 4,210,282	- 272 (-23.8%)
Not matched	- 9,171,217	- 2,777 (-72.4%)
All Scotland	- 23,778,536	- 337 (-28.8%)

To the extent that location can be identified, the largest absolute reductions in volume are observed in Eastern Scotland and Southern Scotland; in contrast, there have been increases in volume in North East Scotland and the Highlands & Islands, although these reflect increases in connection numbers. Scaling volumes by connection numbers shows that volume per connection has fallen in all regions (the reduction for connections not matched to a region highlights the importance of identifying location data for these). Figure 6 shows the percentage reductions in volume per connection by region – the largest

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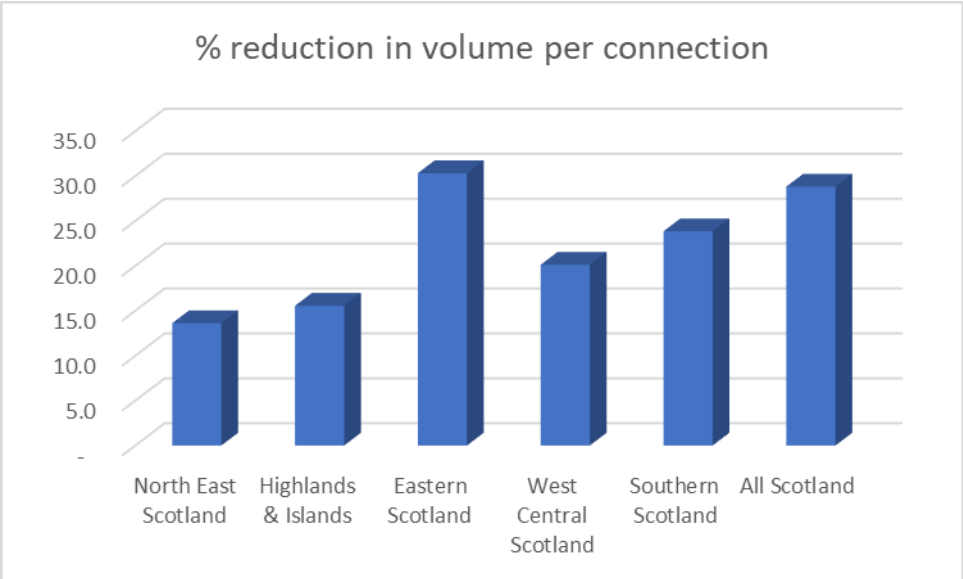
reductions are again in Eastern, Western and Southern Scotland, the smaller reductions are in North East Scotland and the Highlands & Islands.

Figure 6: Reduction in average volume by region 2008-09 to 2019-20



The impact of ownership

Central Systems data does not record whether a connection is associated with a public or private sector organization. However, we can observe the connections that switched from Business Stream to Anglian Water Business on 1st March 2016, and from Wave to Business Stream on 1st April 2020. As an approximation to ownership, we define any connection that appears on either list as 'public' and all other connections in the dataset as 'private'. On this basis, we test whether there is an association between ownership and volume reductions over the lifetime of the Market.

Figure 7 shows that the annual volume at private connections has fallen by 23.59 million m^3 since 2008-09, which represents nearly all the Market-wide volume reduction reported in section 3. In contrast, public connections annual volume has been quite stable at just over 20 million m3.

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Figure 7: Non-domestic volume by ownership

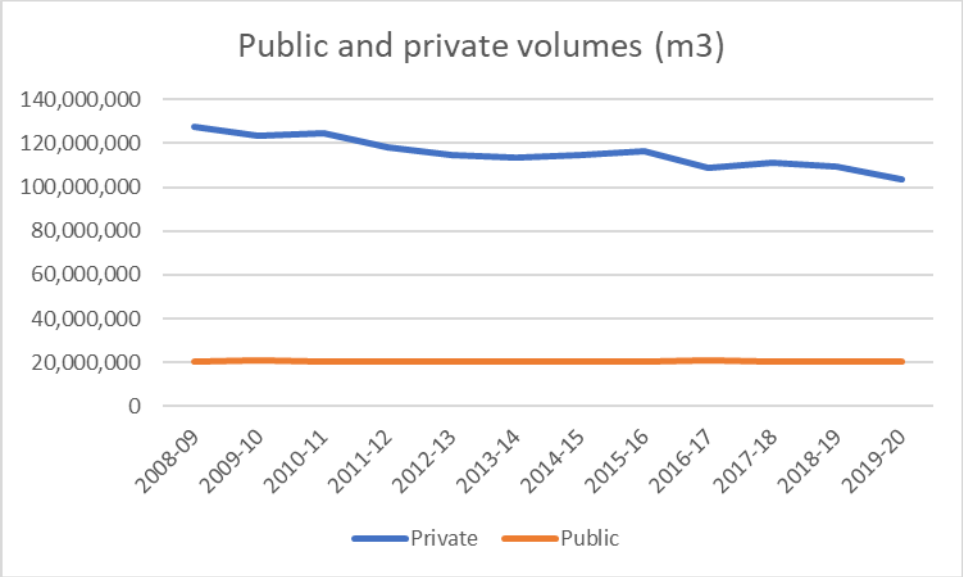
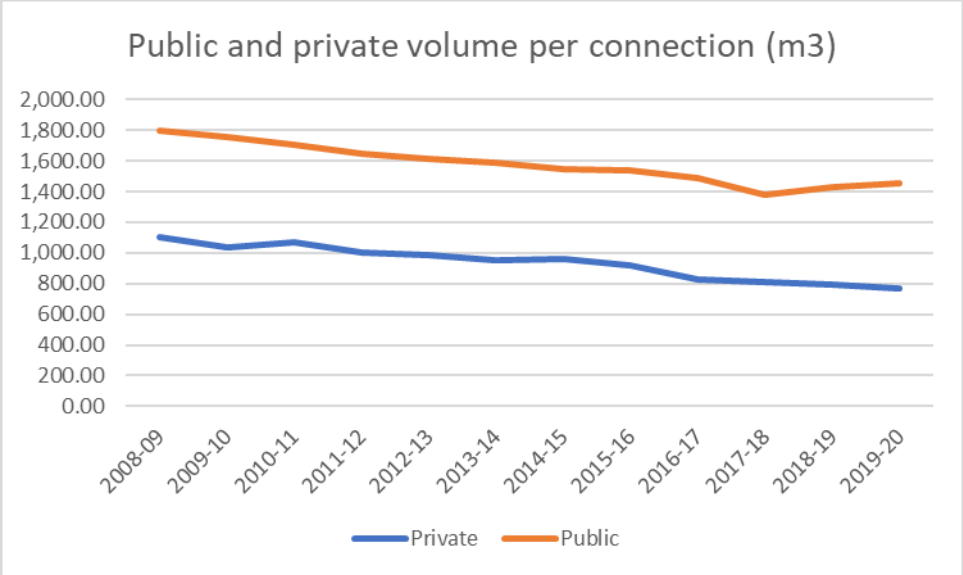


Figure 8 shows the volume per connection. Volume per connection for private connections has fallen by 30%, while the figure for public connections is 20%. For private connections the data is suggestive of a conservation effect. In the case of public connections, while the reduction is driven by an increase in the number of connections, there is also evidence of a data cleansing effect in the underlying data. The next phase of work will examine this more closely and attempt to establish the scale of the conservation element for the public sector.

Figure 8: Average non-domestic volume by ownership



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The impact of switching

In this section we consider the impact of switching on volumes. Figure 9 shows the cumulative total volume attributable to switchers and non-switchers. As time progresses and connections switch, so the volume associated with switchers increases and the volume associated with non-switchers decreases.

Figure 9: Switcher and non-switcher volumes

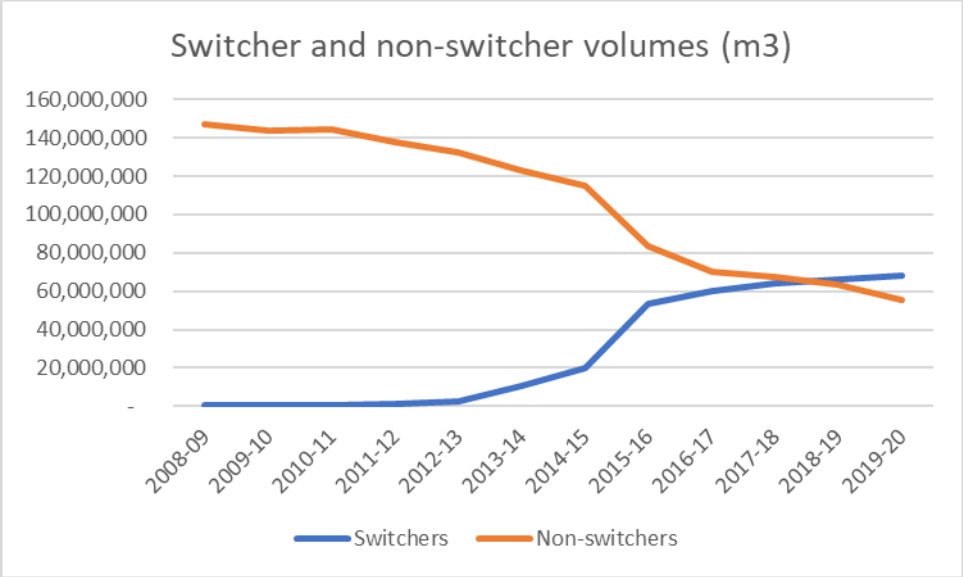
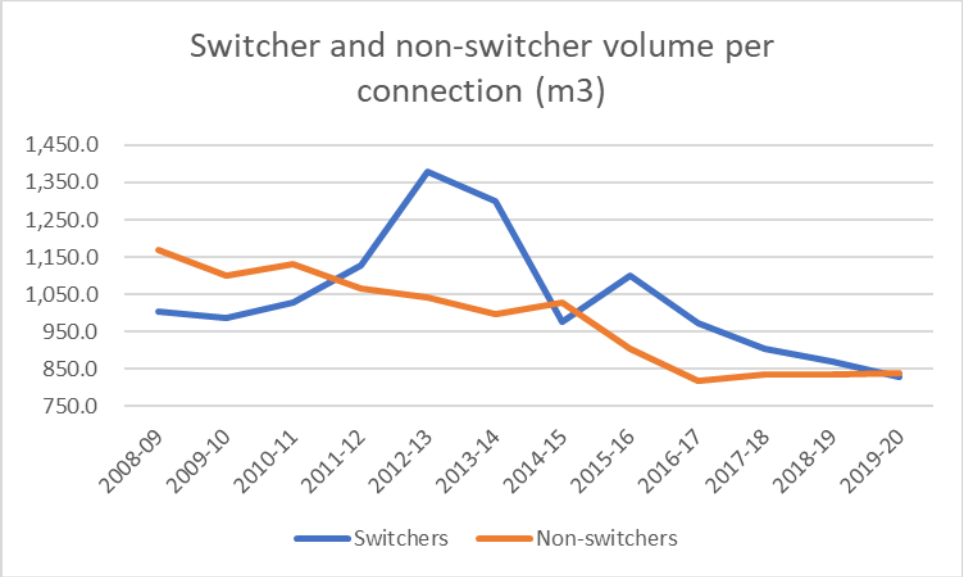


Figure 10 looks at the volume per connection for the two categories. Volume per connection decreases for both categories over the lifetime of the Market, but there is considerably more variability between years for the switcher category.

Figure 10: Average switcher and non-switcher volumes



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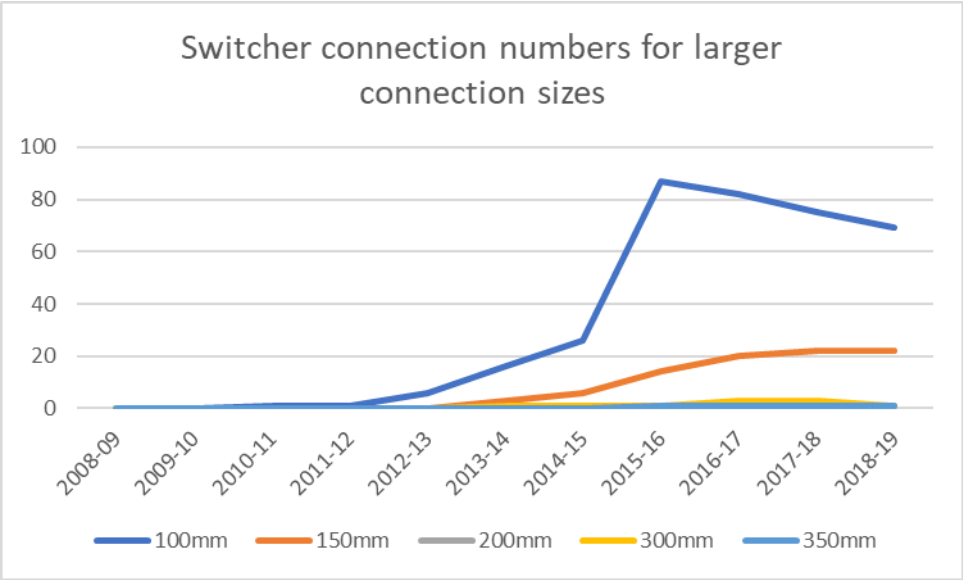
Average volumes for switchers incorporate two effects. Firstly, there is the conservation effect of reduced volumes at different connection sizes, as described in figure 4 and table 2. Secondly, in later years more large connections switch. As larger connections have much higher volumes than the small connection sizes, when these move into the switcher category they tend to increase the average volume per connection in that category. Figure 11 shows the numbers of 100mm and above connections that switch in each year of the Market; the increase in switching for these categories begins in 2011-12 and peaks in 2015-16. We take the fact that average volume per connection falls for switchers over the life of the Market despite this weighting in favour of larger connections as evidence of a Market effect on consumption volumes.

Figure 11: Switcher connection numbers for large connections



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6. Conclusions

The preliminary analysis in this paper suggests that there has been a significant conservation effect as a result of the operation of the water Market in Scotland. For measured connections, annual total volume has fallen by 16.1% between 2008-09 and 2019-20. This does not appear to be a consequence either of general economic conditions or regulatory policy with respect to the pricing of water. Instead, it seems to be a reaction to the new industry structure with its competing suppliers.

Although the reduction in consumption volumes is welcome, the data suggests that there is an opportunity to achive more, particularly on the part of the public sector. Whilst there is evidence of some conservation effect in the public sector, neither the total reduction nor the average reduction per connection matches that seen in the private sector. Further efforts in water conservation could be a useful target for all public sector organisations.

This preliminary analysis highlights that there is a significant amount of data acquisition and data cleansing required for the next stage of research. It would certainly be useful to have better data on the location of connections, as it would to have a more precise identifier for organisations in the public sector. Efforts in this area would not only support the research, but also have the benefit of improving the overall functioning of the Market itself.

Likewise, we recognise the limitations of simple observations of trends in the data, particularly where there are multiple factors that might predict the scale of the conservation effect. The next phase of work will consider the use of more sopisticated techniques to address this issue. It will also consider the definition of an environmental benefit, for example, by considering the quantification of the reduction in CO^2 emissions that should be associated with a reduction in consumption volumes.