CRITERIA TO SELECT PEERS FOR EFFICIENT BETA ESTIMATION

A report for ACM

08 January 2020

Mike Huggins

mike.huggins@frontier-economics.com

Matt Roberts

matthew.roberts@frontier-economics.com

CONTENTS

EXECUTIVE SUMMARY

When estimating the cost of equity for regulatory purposes, regulators typically base the allowances on the Capital Asset Pricing Model (CAPM). This requires, as an input parameter, an estimate of the beta for the regulated firm. To estimate beta, regulators and practitioners typically select a peer group of comparable firms whose stock is traded on financial markets. Identifying an appropriate comparator peer group is central to achieving robust beta estimates, and hence for a reliable cost of equity estimation.

This report evaluates a long list of criteria which might be used to test if the stock price of a candidate peer is sufficiently efficient (i.e. incorporates information in a timely manner), so as to produce a robust beta estimate. We note that regulators also use other criteria to select peer groups (i.e. criteria unrelated to informational efficiency, such as the comparability of business risk or geographical location). These other criteria are outside the scope of this report.

Long list of criteria considered

To estimate a robust beta there must be a sufficient amount of trade in a stock and low trading friction (e.g. low transaction costs). These conditions imply that when new information is revealed to traders which affects their valuation of a given stock, the information flows through quickly and easily to stock prices – so prices always reflect the latest available information. In the extreme scenario, if there is no trade on one day for a particular stock, there will be no change in the stock price during the day, and this will result in a downward-biased beta estimate.

The relevant metrics to use when selecting a peer group therefore seek to provide an indication of the extent of trade frequency or friction for a stock – i.e. the trading liquidity. The six metrics we have considered in this report for assessing liquidity are:

- **Bid-ask spread**: the difference between bid-price and ask-price quoted by market makers.
- **Price impact of trades** (also referred to as the Amihud metric): expresses how much prices change in response to trade (calculated as the ratio of the change in the stock price to the volume of trade).
- **Zero returns**: the number of trading days with zero returns relative to the total number of trading days. Zero returns are observed if the daily closing price of a security corresponds to the closing price of the previous day (which implies there has been no trade).
- **Variance ratio** (also referred to as the market efficiency ratio): tries to measure how much of the movement in prices is short-term vs. long-term (calculated as the ratio of the long-term variance of stock prices to the short-term variance).
- **Velocity**: defined as the volume of trade within a period divided by the volume of stock that is available to be traded on the market (i.e. the 'free floating' stock).

- **Number of trading days**: captures the number of days per year with positive trading volume. This is the one of the two criteria the ACM is currently using (threshold = 90%).

Further detail on why each of these metrics is relevant for assessing liquidity is provided in the report.

In addition, we evaluate some metrics which might indicate whether enough (high quality) information is likely to be available to traders in order to form accurate expectations about the value of a company. We describe these as "information availability criteria" - they are not direct measures of liquidity, but they may provide some use for regulators in identifying peers. These criteria are:

- **Annual revenue:** Gives an indication of the size of a firm – larger firms are more likely to have widely available, transparent, high quality information, and to be scrutinised more closely by market analysts. This is the second criterion currently used by ACM (threshold = €100m).
- **Market capitalisation** Market capitalisation (i.e. the number of company stocks times the stock price) is another potential indicator of a large firm and therefore relevant for the same reason as annual revenue, albeit this measure is likely to be more volatile (e.g. compared to annual revenue) due to its dependence on the market price, and therefore it may be less practical as a broad measure of information availability (e.g. if volatility means that firms fluctuate above/below any threshold over time).
- **Free float:** The free float describes the proportion of a firm's shares that are not held long-term by institutional investors, but are freely tradeable on market exchanges. A higher free float might mean there is greater incentive for traders to seek information on a stock. It is also possible to look at the "free float market cap" i.e. free float multiplied by stock price.
- **Coverage by analysts:** This measure simply considers how many analysts evaluate a company, and how frequently. A large number of analysts covering a company increases the probability that more accurate and more detailed information is available to market participants.

Summary of regulatory precedent

Several (but not all) regulators have specific criteria for liquidity in selecting comparator samples for beta estimation. The table below summarizes the liquidity criteria used by international regulators of which we are aware.

Table 1 Summary of liquidity criteria used by other regulators

Regulator	Country	Sector	Liquidity criteria
BNetzA	Germany	Energy	Bid-ask spread below 1% threshold
E-Control	Austria	Energy	Bid-ask spread below 1% threshold
Ofcom	United Kingdom	Telecoms	Bid-ask spread below 1% threshold
CNMC	Spain	Energy	Bid-ask spread below 1% threshold
IPART	Australia – New South Wales	Energy, Water, Transport	Amihud measure below threshold of 25
Ei	Sweden	Energy	Free float above 25% threshold

Source: Frontier Economics

The average bid-ask spread over a set period is the dominant measure used. Regulators in Germany, Austria, Spain and the UK all use the average bid-ask spread, with a threshold for exclusion from the beta sample at 1% being prevalent.

The New South Wales (Australia) regulator, IPART, uses the Amihud measure, with an indicative threshold of 25. The Swedish regulator Ei uses the free float measure with an apparent threshold of 25%.

Evaluation of criteria

We have evaluated each of the liquidity criteria to understand whether/how it meets ACM's objective of obtaining an efficient and robust beta for use in setting the regulated WACC. Our assessment considers:

- the support for each criterion in academic literature and regulatory precedent; and
- the practical computational challenge involved in calculating the metric.

Based on this assessment, we consider that the **variance ratio** is weaker than the others. From a practical point of view, the measure is challenging. It requires a determination (or assumption) of the horizon over which temporary price fluctuations fade out, while changes based on fundamental information persist. That determination is unlikely to be unambiguous and could be subject to challenge. We therefore do not regard this as practically useful for ACM's purposes, and it is less objective than other metrics.

The remaining liquidity criteria are all conceptually valid ways of evaluating liquidity and hold support in academic literature. However, we note that the **bid-ask spread** has a number of potential advantages.

- It has a clear conceptual underpinning as being relevant for beta estimation.
- It is the most prevalent tool used by other regulators – which supports its acceptability for the purpose of regulated beta estimation, and is particularly helpful for providing a threshold level. In contrast measures such as the

Amihud metric or velocity appear to have little regulatory precedent (at least in Europe).

- It is computationally straightforward with widely available data from public sources.
- More generally the bid-ask spread is a good and commonly referenced all-round measure of liquidity, which can be used not only for stocks but on most asset classes.

We note that some of the other liquidity metrics may be suitable for use alongside the bid-ask spread as a cross-check or supplementary criteria.

- **Number of trading days and zero returns**: Both of these are potentially relevant measures of liquidity and trading activity – it is clear that, for beta estimation, a stock with particularly low trading days or a high proportion of zero returns days should be treated with caution. However, these are only rough measures for the actual trading activity in a stock. One transaction per day would suffice to meet the number of trading days criterion and, assuming the price changed, the zero returns criterion too – yet one trade per day would not normally be described as a liquid market. In contrast, the bid-ask spread gives a richer understanding of the liquidity of a stock.
- Other metrics based on trading volume (e.g. **velocity**) may also be a useful supplementary measure to use alongside bid-ask spread, and would represent a more sophisticated way of cross-checking the volume of trading activity (e.g. compared to number of trading days).

We consider that the **Amihud metric** is also a good measure of liquidity. It is particularly relevant for equities, and is used by traders operating in the market, who are likely to be particularly interested in the impact of large orders. However, given that ACM's objective is to identify peers to estimate a beta in the regulated setting, we consider that the advantages of bid-ask spread identified above are particularly important. In particular, there is limited regulatory precedent for use of the Amihud metric, and at present there is no well-established threshold. It is possible that these issues will be evaluated more thoroughly through regulatory processes in Australia.

Finally, the criteria which assess information availability may be a useful supplement to the liquidity criteria, but they are not a substitute. As such, these measures should only be used in addition to the bid-ask spread (if at all). Of the measures we have considered, it is likely that the free float or the annual revenue would be the most appropriate for use in the regulatory context.

Recommendations and possible next steps

The implication of our review is that the two existing criteria adopted by ACM should be modified. For the reasons outlined above **we would recommend that ACM uses the bid-ask spread as the primary liquidity criterion**.

ACM has also asked us to comment on how the threshold would be set for our recommended criteria. However, it is challenging in principle to conclude what the right threshold should be on a continuous scale metric such as bid-ask spread.

Given this, it is worth noting that a bid-ask spread threshold of 1% seems to have support in terms of regulatory precedent. Should the ACM wish to set a single,

deterministic threshold, we recommend that 1% would be a reasonable threshold, in line with the approach taken by other regulators in Europe.

However, ACM may also wish to exercise some discretion around the application of this specific threshold, and potentially consider other metrics in addition to bid-ask spread. This is ultimately a choice for the regulator and may depend on wider factors. For example the regulator may wish to undertake some further analysis if:

- a minimum number of comparators in the beta sample is required, but this target is not met due to excluding companies very slightly above the bid-ask spread threshold; or
- other selection criteria - such as the degree of comparability with the regulated companies - are strongly (or weakly) met for a peer but it is slightly above (or below) the bid-ask spread threshold.

Therefore, should ACM wish to build additional discretion into its approach, we would recommend the following process.

- First, define a relatively narrow "grey area" above and/or below the 1% bid-ask spread threshold. Within this grey area the firm is probably liquid enough, but further checks are likely to be valuable.
- Second, consider the other liquidity metrics suggested in this report. If the peer is a clear outlier across these metrics, then there is good reason to exclude the peer.
- Third, if the previous step is not determinative, consider whether the additional information criteria provide a reason to exclude (e.g. annual revenue <£100m).

If these additional tests remain inconclusive, then the regulator should exercise its discretion. At this point the regulator will have taken all steps possible to evaluate the liquidity of the peer. Therefore, the regulator will need to balance the risk of including an illiquid peer in the sample vs. the benefits of including the peer (e.g. because it is a clearly relevant comparator, or increasing the sample size is considered particularly valuable).

We note that the optional process described above will clearly be more resource intensive than applying a simple 1% bid-ask spread threshold. It is for the regulator to decide whether the additional process cost is necessary or sufficiently valuable.

1 INTRODUCTION

The Authority for Competition and Markets (ACM) has commissioned Frontier Economics to provide a report evaluating the various criteria that could be used to select comparator firms when estimating beta. Specifically, ACM has asked us to focus on criteria which evaluate the stock price of a candidate peer is sufficiently efficient (i.e. incorporates information in a timely manner) to produce a reliable beta estimate. This report sets out Frontier's findings and conclusions on the topic.

1.1 Terms of Reference

ACM requires[1] a report that:

- identifies a set of **candidate criteria** which allow for an assessment of whether stock prices are sufficiently efficient and will therefore produce reliable beta estimates;
- explains, for each candidate criterion, why it is relevant (i.e. why it will identify stocks which can be used to give a reliable beta estimate);
- includes, as a minimum:
  - a discussion of the two criteria ACM is currently using (i.e. number of trading days and annual revenue);
  - a thorough explanation of the bid-ask spread as an indicator (i.e. explaining what it is, how it is calculated, how it is averaged over a certain time period (day, week, month, year), and why it is related to the aim to get a reliable beta estimate); and
  - a similar explanation for the candidate criteria of "free float" and "traded volume / free float / year (velocity)".
- provides (and explains) a recommendation on which criteria the ACM should use to test whether stock pricing is sufficiently efficient to produce reliable beta estimates; and
- provides (and explains) a recommendation for the norm or 'threshold' that the ACM should use for the recommended criteria (for example, if a criterion is the percentage of trading days the stock is traded, the threshold would be: "stocks should be traded on x% of all trading days").

ACM notes that there may be other criteria which can also be used to select a comparable peer group for use in beta estimation, but these other criteria sit outside the scope of this study, which focusses solely on informational efficiency.

1.2 Structure of this report

This report is structured as follows:

[1] See ACM's RFQ ref no. reference IUC201906123

- In Section 2 we set out more detail on the background and context for this report;
- In Section 3 we set out the long list of potential candidate criteria, and explain why each criterion is relevant (as well as potential weaknesses);
- In Section 4 we provide a summary of precedent on the criteria used by other regulators; and
- In Section 5 we set out some issues/questions which may arise in the course of ACM's empirical analysis of the various candidate criteria.

2 BACKGROUND AND CONTEXT

This section sets out the following:

- the objective for this report;
- a simplified description of how financial markets operate, explaining key terms/concepts that are used through this report;
- the criteria currently used by ACM to select peers for beta estimation; and
- the process we have followed to develop this report.

2.1 Objective for the report

When estimating the cost of equity for regulatory purposes, regulators typically base the allowances on the Capital Asset Pricing Model (CAPM). This requires, as an input parameter, an estimate of the beta for the regulated firm. To estimate beta, regulators and practitioners typically select a peer group of comparable firms whose stock is traded on financial markets. Identifying an appropriate comparator peer group is central to achieving robust beta estimates, and hence for a reliable cost of equity estimation. ACM is therefore seeking advice on appropriate selection criteria to determine the peer companies.

There may be many dimensions across which the appropriateness of a peer might be assessed. For example, ACM (and its advisors) have in the past:

- considered the location of possible comparators (e.g. inside or outside the EU); and
- sought to identify companies who operate predominantly regulated utility networks.

However, this report focuses only on the **informational efficiency** of the stock price of a potential peer company. We do not comment on any other selection criteria which may be used by ACM.

Informational efficiency is important because, if the stock price does not reflect the latest information (e.g. due to a lack of trading) the return measured on this stock will be inaccurate. This would in turn lead to an inaccurate measurement of the beta (which reflects the correlation between the stock return and the market return).

The standard way to evaluate the informational efficiency of a stock price is to consider measures of liquidity. As we explain further in this report, if a security is very liquid, traders who receive new market information face low costs to initiate new trades based on this information. These new trades are therefore likely to happen, and will change the market prices such that they reflect the new information. Therefore, the assumption underlying the use of liquidity is that the more frictionless trade is of a given stock, the more likely it is that the price of that stock reflects all available information to market participants.

In this paper we therefore focus first on measures of liquidity. However, we recognise that there are also other supplementary criteria which can provide a good indication of whether enough information is available to the market

participants, and therefore we also consider these "information availability criteria" in our review.

Finally, a key objective for this report is to identify an approach which is practically applicable in the context of fulfilling ACM's regulatory functions. We note that a large academic literature exists around different ways to quantify trading liquidity. Clearly a significant body of expertise and practice for evaluating stock prices will also be employed by market participants, who are seeking to extract maximum value from trading.

However, in the context of setting a regulated cost of equity, what is needed is appropriate high-level criteria which ACM is practically able to employ for future WACC determinations. While more sophisticated and complex methods could be identified in academic literature or may be used by market participants, such methods would not be appropriate or necessary for use in the regulatory setting. Therefore the scope of our report has focussed on identifying candidate criteria which are commonly used, and we provide an assessment of the degree to which candidate criteria are pragmatic for use in the regulated context.

2.2 How do stock markets operate?

In the rest of this report we refer to a number of concepts and terms which rely on an understanding of how financial markets operate. Financial markets encompass a variety of different asset classes, e.g. equity (stocks), fixed income (bonds and loans), money markets, derivatives, foreign exchange and commodities. In order to understand the relevant context, this section sets out a high level introduction to the typical functions of stock markets. While the exact detail of these mechanisms might vary between different markets, the basic structure can be described as follows.[2] We also provide a glossary of terms as an annex.

Types of agents in stock markets

We can distinguish between two different types of actors in stock markets – market makers and traders.

Market makers – The market makers' role is to provide trading opportunities in stocks – i.e. they facilitate trade by acting, in effect, as a 'go-between' for traders who are buying and selling stocks (see below).[3] Market makers will quote "ask prices" for a stock, which is the price at which they offer to sell the stock, and "bid prices", which are the prices at which they offer to buy the stock. The ask price is above the bid price and the difference is called bid-ask spread.

[2] More details are given, for instance, in Chapter 3 of "Market Liquidity" (2013) by Foucault, Pagano, and Roell, Oxford University Press

[3] Different markets function differently in regard to how liquidity is provided and maintained. Most stock exchanges function with an auction style market model where market makers within the stock exchange provide liquidity to all shares listed on that exchange by continuously providing buy and sell prices (quotes) while the market is open. There are also stock markets where the liquidity is provided by dealers who buy and sell stock at their own risk. They also provide buy and sell prices. The only difference between a dealer market and an auction market is that trades happen between buyers and sellers simultaneously in an auction market, while trades happen only with dealers in a dealer market. For the purpose of this study, we do not distinguish between auction market and dealer market, and we refer to both types of liquidity providers as the market maker.

Traders – These are market participants who buy or sell stocks.[4] Traders have reasons to trade if they have information about a stock that renders it either under- or over-valued by the market at the existing price.[5]

- Undervaluation means that the lowest ask price P_A quoted by a market maker is smaller than the value P_T that the trader assigns to the stock, based on its information. In this case, the trader has an incentive to buy the stock at the price P_A from the market maker in order to obtain the relative gain $P_T - P_A$.
- Overvaluation means that P_T is smaller than the bid price P_B offered by the market maker. In this case, the trader wants to sell the stock to the market maker in order to obtain the relative gain $P_B - P_T$.

How are trades executed?

Traders initiate a potential trade by placing an order into the market. Different types of buy-order and sell-order exist, e.g.

- A **market order** is an instruction to buy/sell a given quantity of the stock at the most desirable price available, and as quickly as possible. These orders can only be placed during trading hours (i.e. when the exchange is open). The fact that market makers continuously provide bid and ask quotes for the listed stocks ensures that any market orders can be executed. However, the trader has no guarantee of the price at which the trade will happen.
- A **limit order** specifies the maximum (minimum) price at which a trader will buy (sell) the stock. This is normally not yet available in the market and therefore a trade typically is not executed straight away. A limit order guarantees the price for the trader, but does not guarantee that the trade will happen (i.e. if the bid/ask price does not reach the specified limit price, the trade will not happen).
- A **stop loss order** specifies the price – typically below the current price - at which a trader will automatically sell its stock. The purpose is to protect the trader from price decreases (hence it is called "stop loss"). It is sometimes combined with a buy order.[6]

Many trades between traders and market makers will occur over the course of any given trading day. The price of the last executed trade is known as the "last price" for a stock. It is this "last price" which the exchange reports publicly and which is normally reported on data portals such as Bloomberg.[7]

For any given stock, a market maker will monitor the so-called "order book". The order book records information on buy and sell orders – e.g. the order originator, order prices and order quantities. The order book therefore provides information

[4] Typically, the person or company interested in trading will hire a 'broker' that executes the trade on behalf of the client. Since the brokers do not hold any position themselves, but simply serve the traders who are the ultimate buyers and sellers of the stocks, we ignore the role of brokers in this report.

[5] Traders may also need to move funds into or out of a particular asset class e.g. investments of excess cash or withdrawals to acquire cash, but such trades will still be based on investors' valuation of a particular stock.

[6] For example, if a stock price is currently 100, a trader can put in a market buy order at 100 with a stop loss of 80. This would mean the trader buys the stock at 100, and nothing else happens unless the price drops to 80, at which point the stock is automatically sold. An alternative trading structure might be to combine a limit order (e.g. "buy at 90") with a stop loss ("sell if price falls to 80"). This would mean the trader buys only when the price drops to 90, but if the price then drops further to 80 the stock is automatically sold again.

[7] Securities prices reported in the media are usually the current "last prices" of the securities.

on unmatched orders (either to buy or sell), and crucially, how liquid the market would be if a large trade were to be initiated.

The market makers will therefore take into account the order book when setting the bid and ask prices of the stocks. The bid-ask spread is essentially the expected margin earned by market maker after it buys and sells a stock as per the bid and ask quotes.

Clearly, market makers therefore have the incentive to achieve a larger bid-ask spread. However, competition between market makers will constrain the bid-ask spread – traders looking to execute buy orders will generally seek the market maker quoting the lowest ask price; and vice versa traders with sell orders will seek the market maker quoting the highest bid price. Therefore competition for trade will drive down the bid-ask spread (but even with a very narrow spread, market makers can still earn good returns given a high volume of trades).

At the same time, market makers need to quote a sufficiently large bid-ask spread to compensate them for the risk of entering into trades and their costs of operation. This risk is larger if

- the market is more volatile (i.e. the price changes drastically with trades); and/or
- the order book is thin, which makes it more difficult for the market maker to unwind its positions whenever it enters a trade (i.e. to resell bought stocks or to refill the inventory of stocks).[8]

As a result, market makers will quote a larger bid-ask spread for more illiquid stocks, in order to compensate them for this risk.[9] This is the dynamic through which the bid-ask spread reveals how liquid a given stock is.

How does information affect prices?

By buying or selling stocks, the traders reveal their information to the market. Suppose, for example, new information enters the market such that most traders' valuation of the stock P_T is now larger than P_A. One trader buys the stock at the price P_A from the market maker. The following will happen.

- First, the market makers executes the trade at P_A.
- Second, the market marker will update the bid and ask quotes around the new underlying value of the stock the price P_A. This means a new ask price to $P_A' > P_A$, and a new bid price $P_B' > P_B$.

[8] Generally market makers will seek to unwind all positions, as holding large uncovered positions are considered to be proprietary trading which market makers are generally not specialised in doing. However, in a dealer market (such as corporate bonds and derivatives), positions can be held by the dealer for a period of time.

[9] For illustrative purposes a broad analogy could be drawn between the market maker and a second hand car dealer. The difference between the part exchange price of a car that the dealer quotes and the forecourt selling price is the equivalent of the bid-ask spread. The car dealer will look to buy cars at a low (bid) price and sell them on at a high (ask) price – earning the bid-ask spread as profit. Car dealers will generally achieve a narrow bid-ask spread on high volume traded cars (e.g. on a VW Golf – a popular car with lots of potential buyers and information on its value). Conversely the spread is likely to be high on a low volume collector's car (e.g. an Aston Martin DB5 – a more niche/expensive car with a more limited market, whereby the dealer may have to hold the car for some time before finding a buyer). This dynamic drives the bid-ask spread the car dealer is willing to trade at, and demonstrates why this is a good indication of liquidity of an asset.

- Third, since the increase of the prices is public to all market makers who are in competition for trades, they also increase their bid and ask quotes (albeit not necessarily all by the same amount).
- Finally, with a lag of usually 15 minutes, the publicly reported "last price" moves to $P_{A,}$ so that all market participants see that there are traders who assign at least the value P_A to the stock.
- Any further buy orders on this stock will be executed at P_A', and the process repeats itself, until the ask price reaches $P_{T.}$ At that point the last trade will happen - P_T will become the last price, and a new ask and bid price will be set around P_T. No more trade attributable to the new information will take place.

This example describes an increase of market prices, when traders receive information that a stock is undervalued. The same mechanism leads to a decrease of prices if traders receive information that a security has been overvalued.

In summary, if the mechanism described above functions well, one can assume that all information available to market participants is quickly and accurately incorporated into the prices. The key condition for this is that traders with new information face no obstacles or costs when they want to trade based on this information. Put differently, the key condition is that trade in the stock is sufficiently liquid.

Relevance for beta estimation

It is clear that low liquidity for a stock will bias a beta estimate downwards. To take an extreme case, consider a firm which has a 'true' beta somewhere close to 1. However, if there were extremely low liquidity (e.g. no trade) in this stock, the last price will stay constant over time. Clearly the daily return (at least, price return excluding dividend) of this stock price will not exhibit any correlation with market returns, and therefore the beta estimated from the market data would be zero. While this is a purely hypothetical example, it illustrates the relationship between liquidity and beta – there needs to be sufficiently frequent trading activity in order for the beta estimate to be robust.

2.3 ACM's current approach

The ACM currently uses two conditions to measure the informational efficiency of the peers' stock price developments:

- **Number of trading days**: The stocks of the firm are traded on at least 90% of all trading days;
- **Annual revenue**: The firm has an annual revenue of at least € 100 million.

At the last energy network review, the peer group that was eventually used for beta estimation was criticised by regulated firms and challenged in court (in particular due to the inclusion of Fluxys in the sample). One of the criticisms was that even though Fluxys did meet ACM's two liquidity criteria, it was in fact not liquidly traded (e.g. based on looking at bid-ask spread as a measure of liquidity). The Court ruled that Fluxys should be excluded from the peer group and also noted that the liquidity criteria that ACM used where not strict enough.

2.4 Our process

To identify and evaluate the criteria for measuring informational efficiency, we have undertaken the following.

- **Literature review**: We have identified a small number of academic papers and reviewed relevant finance text books, with a focus on identifying key liquidity measures. This should not be considered a comprehensive review of all academic literature on the subject of liquidity, which is beyond the scope of this report.
- **Regulatory precedent**: To identify relevant regulatory precedent, we have drawn on the expertise of Frontier staff located across Europe, who work in a wide range of regulated infrastructure sectors. Frontier's experts work in many regulatory jurisdictions across Europe, and we are therefore familiar with the practice adopted by many regulatory offices. We have also drawn on the expertise available in our sister company in Australia, whose experts advise on cost of capital issues across Australia and south east Asia.
- **Peer review**: Frontier's finance experts have contributed to the Quality Assurance process in developing this report.

Through this we have developed and evaluated a long list of candidate criteria, as set out in Section 3.

3 REVIEW OF CANDIDATE CRITERIA

In this section, we review the long list of candidate criteria for informational efficiency. For each candidate, we:

- establish what each measure is, how it is calculated, and why it is relevant for assessing informational efficiency; and
- provide some initial evaluation of the strengths and weaknesses of each candidate, drawing on academic literature and our own understanding.

Potential criteria for informational efficiency can be split in two groups.

- **Liquidity measures** indicate whether available information is quickly and accurately incorporated into prices. We focus on liquidity measures as these are the primary metrics for evaluating if beta is efficient. We distinguish between[10]:
  - Price-based liquidity measures (section 3.1) which try to infer the degree of liquidity from observed market price information; and
  - Trade-based liquidity measures (Section 3.2) which seek to capture the extent to which a given stock is traded (and therefore could be considered liquid).
- **Information availability measures** indicate whether enough (high quality) information is likely to be available to traders in order to form accurate expectations about the value of a company and its securities. We discuss these in Section 3.3.

3.1 Price-based liquidity measures

This section discusses:

- the bid-ask spread;
- price impact of trades (AKA Amihud metric);
- zero returns; and
- variance ratio.

3.1.1 Bid-ask spread

This measure directly refers to the bid and ask prices quoted by the market makers. As described in Section 2.2, the bid price is the price at which a market maker is willing to buy a stock and the ask price is the price at which a market maker is willing to sell a stock. The relative bid-ask spread is calculated as the quotient of:

- the difference between the bid and ask prices (i.e. the absolute spread); and
- the mean of the two prices.

The first discussion of bid-ask spread as a measure of transaction costs (i.e. liquidity) dates back to Demsetz (1968).[11]

[10] Cf. Chapter 2 of "Market Liquidity" (2013) by Foucault, Pagano, and Roell, Oxford University Press

[11] Demsetz, H. (1968), "The costs of transacting", Quarterly Journal of Economics, 82(1)

As mentioned in Section 2.2., the size of the bid-ask spread depends on two opposed factors. On the one hand, the bid-ask spread will be higher the more risk market makers face by holding large positions on stocks that they may not be able to unwind at reasonable prices. On the other hand, the spread is constrained by competition between the marker makers.

In the case of a stock that has a particular lack of interest from traders, these two factors will both work towards a higher bid-ask spread. First, the lack of orders in the order book of each market maker will encourage the market maker to quote a large bid-ask spread to cover the risk of trading. Second, the lack of interest from traders may result in a lack of willingness for market makers to quote a competitive bid-ask spread for this particular stock, making the competition less fierce, hence reinforcing the wide bid-ask spread in the market.

This in turn has the effect of discouraging trades. It is fairly standard to interpret the bid-ask spread as a transaction cost, which introduces a degree of trading friction into financial markets. The wider the bid-ask spread, the greater this transaction cost. As such, it is possible that traders will obtain new information which might have resulted in a trade, but trade is prevented because the new information did not push the traders' valuations sufficiently far (i.e. outside the bid-ask spread).

Consequently, a larger bid-ask spread makes it less likely that new information is incorporated into prices:

- First, "small pieces" of information that only leads to small adjustments of the traders' valuations will not trigger trading.
- Second, the trading costs reduce the potential gains that might be associated with obtaining new information, reducing the incentive to seek new information and consequently to trade. If other transaction costs (such as broker fees, currency exchange fees and taxes) are also taken into account, the incentive to trade will be further dampened.

The illiquidity therefore is likely to persist unless there is material change to the underlying interest to trade the stock. Therefore this is a further reason (in addition to the pricing incentive of market makers) that the bid-ask spread can be considered as a good measurement for liquidity of a stock and informational efficiency of the stock price.

It is worth noting that even though we characterise the bid-ask spread as the cost of trading above, it is unlikely to be the root cause of the lack of illiquidity.[12] In other words, it is the lack of interest that causes the lack of orders, which causes the wide bid-ask spread, resulting in a lack of trading. With large interest in the underlying stock, the bid-ask spread would be low. The bid-ask spread is a way through which the exchange can ensure that any market orders can be executed by a market maker, while allowing the market makers to be financially viable. Without the market makers, there would be even less liquidity.

The bid-ask spread is one of the most established liquidity criterion, as it directly refers to the pricing mechanisms of the markets. It is the standard measure of

[12] We do not seek to identify the underlying cause of the lack of liquidity in this paper.

liquidity in academic research,[13] and it is a good proxy for the implicit costs that traders face when they want to trade based on new information. This implies that a low bid-ask spread is a good criterion for informational efficiency of the trade in a security.

Furthermore, bid-ask spread is usually also available on assets that are traded over-the-counter (OTC), where trades are not as transparently reported as stocks. Using the bid-ask spread as a generic all-round liquidity measurement can be practical for regulators should the need arise to assess the liquidity on corporate bonds for example.

3.1.2 Price impact of trades (AKA Amihud metric)

This measure expresses how much security prices change in response to trade in this security. It is defined as the average ratio of daily changes in security prices over the daily volume of trades, i.e.

- Numerator = $Price_t – Price_{t-1}$
- Denominator = $No.\ trades_t * Price_t$

It thus represents the average price impact per volume of trade. This liquidity measure was first suggested by Kyle (1985),[14] and the standard way to implement it has been suggested by Amihud (2002).[15]

Using the Amihud metric, a lower value implies a more liquid market. If a small number of trades creates large changes in the stock price, this would imply a higher Amihud metric. And vice versa, if the stock price did not change materially, even with a large volume of trade, the Amihud metric would be low.

The Amihud metric is potentially a helpful complement to the bid-ask spread, because it provides an indication of the depth of a market. A market has depth if there is a continuous flow of buy and sell orders at prices above/below the current price – i.e. the demand and supply curve for trades is continuous. A deep market also implies that demand and supply curves are highly elastic (quite flat) at prices around the current price. In other words, in a market with sufficient depth, the order book for market makers is ‘full’ – with lots of order placed at prices around the current price.

This means that larger trades can happen with only relatively small effects on prices, and without causing unexpected volatility or jumps in the price. In contrast, in a shallow market, small trades can have larger impacts on prices. The Amihud metric is therefore effectively a proxy for the depth of a market – and hence it reveals something about the liquidity of a stock.

The Amihud measure might be interpreted as another way for a trader to evaluate the implicit costs of trading. Small trades can typically be executed at the current bid and ask prices, and (in a liquid market) without causing a significant movement in those prices. However, if traders want to buy/sell large amounts of a security, they often cannot execute the large trade in a single order, because the market

[13] Cf. Chapter 2 of “Market Liquidity” (2013) by Foucault, Pagano, and Roell in Oxford University Press

[14] Kyle, A. (1985), “Continuous auctions and insider trading”, Econometrica, 53(6)

[15] Amihud (2002), “Illiquidity and Stock Returns: Cross-section and Time-series effects”, Journal of Financial Markets 5

makers only offer/buy smaller amounts. A large order then has to be split into a sequence of smaller ones. It is possible that the initial order can be executed at the current ask/bid quotes, but the later orders in the sequence will only be executed at higher asks/lower bids, because the market makers adjust the prices in response to the incoming orders. For traders, the execution of a larger order is therefore potentially more costly than the execution of smaller ones. The Amihud metric therefore provides another way to interpret or understand the extent of trade friction for a stock.

The Amihud metric is a well-established measure that is often used by market traders and analysts in their evaluation of the liquidity of a stock – in particular traders who might be considering if their own actions might cause price movements. It may therefore be a useful supplementary criterion in addition to the bid-ask spread for estimating potential frictions to trading.

However, we note that the Amihud metric has only very limited regulatory precedent (see Section 4) and requires a degree of extra computational effort by the regulator, relative to the bid-ask spread.

We also note that theoretically, the Amihud metric might be driven by other effects unrelated to liquidity. For example, if significant new information suddenly becomes available, it may be the case that a low volume of trade produces high change in the price, and hence a higher Amihud value would be derived. Such a situation is, however, unlikely to be repeated frequently over the course of a year, and therefore the average Amihud metric over longer timeframes should be considered to be a reflection of liquidity.

3.1.3 Zero returns

"Zero returns" is a liquidity measure that reports the number of trading days with zero returns relative to the total number of trading days. Zero returns are observed if the daily closing price of a security corresponds to the closing price of the previous day. This liquidity measure has been suggested by Lesmond, Ogden, and Trzcinka (1999).[16]

If prices do not change over time, this might have two reasons, either:

- the price happens to be exactly the same as the previous day (e.g. because no new information/valuation arises), or
- traders have not traded (e.g. because of trading friction/ illiquidity).

If there are a high proportion of zero returns days over the course of a year or longer, it is very unlikely that these are all due to the former reason – new information arises frequently and stock price valuations by traders are normally frequently re-visited. Therefore, if there is high proportion of zero returns days over a year, it is more likely that this indicates a lack of trading (i.e. poor liquidity). This could be due to a lack of interest in the asset or the high trading costs associated with it (e.g. high bid-ask spread), or a combination of both. Either way, this would impair the accurate incorporation of new information into prices.

[16] Lesmond et al. (1999), "A New Estimate of Transaction Costs", Review of Financial Studies 12(5)

If a stock has a high percentage of trading days with zero returns, it will therefore not be suitable to be used in beta estimations. However, the converse is not necessarily true, i.e. a stock that has a low proportion of zero return days is not necessarily sufficiently liquid to include in the beta estimation. This is because even a single trade during a day would be enough to modify the price – so a stock with a very low volume of trading may still have low zero returns days (e.g. a stock which was traded once every day for a year would have 0% zero returns days, but would probably not be considered liquid).

This is why we would generally recommend looking at the bid-ask spread as a better measure for liquidity – since bid-ask spread provides a more direct measure of liquidity, whereas zero returns requires some additional interpretation/inference. However, this does not mean the measure of zero returns has no practical use – it could be used, for example, to help identify outliers or refine the liquidity assessment.

3.1.4 Variance ratio (AKA "market efficiency ratio")

The variance ratio is another common measure for the efficiency of financial markets. It is the ratio of the long-term variance of stock prices over the short-term variance of these prices. It was first introduced by Hasbrouck & Schwartz (1988).[17]

The variance ratio tries to measure how much of the movement in prices is driven by temporarily diverging valuations of the stocks by the traders versus how much is driven by robust new information about the development of the company. The underlying hypothesis is that price changes in the first case do not last long, while price changes in the second case should have a longer impact.

This implies that if the long-term variance of the stock price is small relative to the short-term variance of the price (i.e. if the variance ratio is low), then most of the price changes in the short-term are probably only driven by temporarily diverging views of some traders instead of robust information about the company.

From a practical point of view, however, the measure is challenging. It requires a determination (or assumption) of the horizon over which price fluctuations due to temporary disagreements between traders fade out, while changes due to robust new information about the development of the company persist. That determination is unlikely to be unambiguous and could be subject to challenge. We therefore do not regard this as practically useful for the regulator's purposes.

3.2 Trade-based liquidity measures

This section discusses:

- velocity (i.e. traded volume per year / free float); and
- number of trading days.

[17] Hasbrouck & Schwartz (1988), "Liquidity and Execution Costs in Equity Markets", Journal of Portfolio Management 14(3)

In general, if there is a lack of trading volume (i.e. an illiquid market), price discovery can be slow or incomplete, so that new information might not always be incorporated into the price.

3.2.1 "Velocity" (traded volume per year / free float)

The velocity of a security is defined as the volume of trade within a year divided by the volume of securities that are available in the market. This measure is sometimes also called "turnover" in the academic literature. The volume of securities that are available in the market is equal to the 'free floating' securities. The free float describes the proportion of a firm's shares that are not held long-term by institutional investors, but are freely tradeable on exchanges.[18]

Bloomberg records the percentage of shares that are held long-term by large institutions and provides this data via its terminal. The remaining percentage of shares of the firm are the 'free floating' shares.

If securities are traded with a high velocity, one can expect that new information is frequently incorporated into the prices.

There are two ways to measure the trading volume and the volume of tradeable shares (i.e. the "free float"):

- In terms of **number of shares**:
  - the trading volume is derived as number of annual traded shares; and
  - the volume of tradeable shares is given as the annual average of the number of outstanding shares net of long-term holdings of large institutions (according to annual averages reported by Bloomberg).
- In terms of **prices**:
  - the trading volume is derived by multiplying the average price of a share with the number of shares traded on a trading day; and
  - the volume of tradeable shares is given by the average market capitalisation of the firm net of long-term holdings of large institutions (according to annual averages reported by Bloomberg).

These two measures can differ from each other due to the interaction of varying prices and varying trading volumes. Given the data available on Bloomberg we have used the measure based on number of shares in this report. We discuss some practical difficulties with the data on free float in Section 5.[19]

One issue with these measures is their focus on annual aggregated values. Due to using annual aggregated values, the indicator provides the same value regardless of whether 1% of the shares were traded on 50 days or 50% on one day. A concentration as described in the latter case would however be a stronger indicator for illiquidity in the market.

[18] "Institutional investors" are long-term investors like pension funds, insurance companies and large banks that hold large amounts of securities for long-term purposes and that do not regularly trade with these securities.

[19] To build the Velocity measure for each firm, we have used our constructed measure of a company's free floating shares to create the volume of tradeable shares needed as the denominator in the velocity measure calculations.

While this measure has been popular for some time, recent discussion of liquidity in the literature no longer appear to focus on it.[20] This tendency is supported by empirical evidence: Aitken & Comerton-Forde (2003)[21], for instance, showed that the bid-ask spread was a much better measure of the liquidity crisis in Asia in 1997-1998 than volume-based measure.

3.2.2 Number of trading days

A simpler trade-based measure is the number of days per year with positive trading volume. This is the first of the two criteria the ACM is currently using. The norm applied by ACM is that stocks are traded on at least 90% of all trading days.

Clearly there is a logic to using this criterion - the regular trade of stocks is an important precondition for the incorporation of new information into prices. Therefore it could be relevant to look at the number of trading days.

However, there are also two clear weaknesses relative to the bid-ask spread:

- First, it is only a rough measure for the actual trading activity in this stock, given that one transaction per day would suffice for the criterion to be met. However, one transaction per day would be very low activity, which would indicate that traders face obstacles to trade based on new information. In this sense the velocity criterion gives a richer understanding.
- Second, it is only an indirect measure of liquidity, and more direct measures (like the bid-ask spread) are therefore preferable if available. For example, it is possible that a company with trades on more than 90% of trading days still has a high bid-ask spread.

3.3 Information availability criteria

The measures described so far focus on the trading process that incorporates information held by traders into prices. However, informational efficiency requires not only that information is quickly reflected in stock prices, but also that the information available to traders to inform trading positions is complete and accurate.

It is plausible that some trades occur on the basis of incorrect or partial information. While this is unlikely to be persistent over time, it could imply that liquidity measures cannot, on their own, guarantee informational efficiency. Given this, the liquidity measures could be supplemented by criteria which try to ensure a sufficient amount of information about the respective firms is accessible to traders.

Since the availability of information cannot be measured directly, one has to resort to proxies. In the following, we discuss three examples of such criteria – annual revenue; coverage by analysts; and free float.

It should be emphasised that these criteria do not measure liquidity. Therefore it is clear that the criteria discussed in this section cannot be used on their own to

[20] see e.g. Goyenko et al. (2009), "Do Liquidity Measures Measure Liquidity?", Journal of Financial Economics 92 and Fong et al. (2017), "What Are the Best Liquidity Proxies for Global Research", Review of Finance 21

[21] Aitken & Comerton-Forde (2003), "How should liquidity be measured?", Pacific-Basin Finance Journal 11

determine informational efficiency, but rather they would be used in addition to one or more of the liquidity criteria discussed in the previous section.

Further, in practical terms, we expect that market trades generally are based on reasonably complete and accurate information – certainly traders have clear and significant incentives to obtain information about the stocks they are trading in. Therefore, we do not consider it is essential for regulators to take into account these criteria when selecting peers – rather they should be considered as potentially useful supplementary criteria.

3.3.1 Annual revenue

This criterion measures the size of a firm. One could expect that larger firms are more intensively analysed by traders or by the public, so that more detailed information about these companies is available, and therefore trades (and market prices) are likely to be based on more accurate information.

Annual revenues is the second criterion that the ACM currently uses to select peers. The norm used by ACM is that the selected firm must have an annual revenue of at least €100 million.

3.3.2 Market capitalisation

Market capitalisation is a potential alternative to annual revenue to measure whether a firm is large and therefore whether it is likely to be closely monitored and have good information available.[22]

We note, however, that market capitalisation could potentially be more volatile than annual revenue for regulated firms and this volatility might lead to inconsistency in the inclusion/exclusion of certain firms from the peer group over time. In contrast, revenue might be relatively more stable and therefore a preferable measure, since both metrics would be attempting to capture a sense of information availability to traders.

3.3.3 Free float

Traders might have a stronger incentive to seek and obtain new information about a company if there is greater possibility for trade in its stock. Therefore, the shareholder structure could also provide insight as a supplementary information availability criterion.

- If a large proportion of shares is held by a small number of long-term institutional investors, the incentive to search for and obtain new information is lower. This could be an additional indication that the price is not a reliable indicator and that information is not immediately reflected in the share price.
- In contrast, a large proportion of freely tradeable (i.e. “free floating”) securities is an indicator that there is likely to be keen interest from market participants in pursuing accurate and up-to-date information.

[22] We observe that market participants sometimes refer to stocks as “large cap”, “mid cap” and “small cap”. There is no single defined value for these terms, but as a rule of thumb, large cap might typically be greater than £10bn, mid-cap might be between £1bn – 10bn, and small cap £250m - £1bn.

The FTSE 100, which is the market index tracking the price changes of the 100 largest UK companies (measured in terms of market capitalisation), excludes companies with free float less than 25%.

A possible alternative would be to calculate the free-floating market capitalisation, i.e. the market capitalisation multiplied by the proportion of free-floating shares.

3.3.4 Coverage by analysts

This measure simply considers how many analysts evaluate a company, and how frequently. A large number of analysts covering a company increases the probability that more accurate and more detailed information is available to market participants.

It is clear that this measure is only a rough one, since the frequency and quality of information published by analysts can vary. Furthermore, while obtaining information on the coverage by analysts is possible, it is likely to be quite costly to obtain.[23]

[23] Information can be obtained via I/B/E/S, which is part of Refinitiv (previously Thomson Reuters), but we understand that obtaining a license for this service is likely to be significantly more costly and specialist than access to Bloomberg.

4 INTERNATIONAL EXPERIENCE

This section reviews international regulatory practice with regards to efficiency criteria for beta peer group selection. This review was carried out to inform the selection of relevant criteria and to ensure appropriate measures are considered.

We have identified six relevant regulators currently using liquidity criteria – these are BNetzA (Germany); E-Control (Austria); Ofcom (United Kingdom); CNMC (Spain); IPART (Australia); and Ei (Sweden). The policy and practice of these regulators in relation to liquidity criteria is presented in turn below. In addition, we provide some relevant information on other regulators who do not use specific liquidity criteria.

4.1 BNetzA – Germany

The BNetzA is the regulator for electricity, gas, telecoms, post and railway markets in Germany. When calculating the beta as part of its cost of equity analysis in the energy markets, BNetzA uses a liquidity criterion to help guide its selection of comparator firms.

The last assessment was done in 2016 before the start of the third regulatory period for gas and electricity network operators, starting in 2018 and 2019 respectively. During the 2016 assessment, BNetzA's liquidity criterion was the average bid-ask spread with a threshold of 1%.

The average was calculated three times: over the last year, over the last three years, and over the last five years. Comparators were only selected if all three averages were below 1%.

In the two previous assessments of equity returns in 2011 and 2008, the BNetzA used the same criterion for liquidity.[24]

In 2011, "zero returns" was also considered as an additional criterion for liquidity. However, the BNetzA eventually decided not to use zero returns, because it considered that the criterion was strongly correlated with the bid-ask spread and it would not have improved the selection of comparator companies.[25]

The bid-ask spread seems to have gained acceptance in Germany as the key criterion for liquidity. Companies have appealed the BNetzA 2016 WACC decision, but only in relation to the market risk premium, the liquidity criterion used has not been challenged.[26]

4.2 E-Control – Austria

E-Control regulates the electricity and gas market in Austria and it applies incentive based regulation to the electricity and gas distribution networks. The gas

[24] In 2011, the average bid-ask spread had to below 1% over the last 1,3, and 5 years. In 2008, the average bid-ask spread had to below 1% only over the last year.

[25] Frontier Economics, Wissenschaftliches Gutachten zur Ermittlung des Zuschlages zur Abdeckung netzbetriebsspezifischer unternehmerischer Wagnisse im Bereich Gas – Gutachten Im Auftrag Der Bundesnetzagentur, September 2011

[26] Cf. https://www.energate-messenger.de/news/180202/gutachter-eigenkapitalzinssatz-grenzwertig-niedrig-

distribution system operators entered the third regulation period in 2017, and electricity distribution system operators started the fourth regulation period in 2019.

When estimating the beta factor as part of the cost of equity calculations, E-Control uses a liquidity criterion to filter comparator companies. The liquidity criterion used in E-Control's 2012 Determination of Financing Costs for Gas Network Operators was that companies with an average bid-ask spread above 1% were considered insufficiently liquid.[27] In the 2012 calculations, E-Control excluded twenty-two companies from its comparator list based on the liquidity criterion and other additional criteria.

4.3 Ofcom - UK

In the UK, Ofcom regulates broadband and mobile telecoms, TV, radio, video-on-demand services, post, and the airwaves used by wireless devices. Ofcom uses a liquidity criterion when creating the comparator groups for its beta calculations across the areas it regulates.

Ofcom has recently undertaken two reviews relevant to its regulatory model:

- 2019 Business Connectivity Market Review[28], which reviewed competition in the markets for the provision of leased lines in the UK; and
- 2018 Wholesale Local Access Market Review.[29]

In both processes Ofcom states that the stocks of any comparator firms must be liquid. Ofcom uses the average bid-ask spread to define liquidity. Ofcom calculates the average daily bid-ask spread over a two year period. If the bid-ask spread exceeds the threshold of 1%, stocks are considered illiquid.

Prior to these, Ofcom had undertaken an earlier beta analysis. In the report published before the 2018 Wholesale Local Access Market Review, the bid-ask spreads were below 0.21% for Telecoms comparators and 0.08% for UK utilities firms, so no stocks were excluded.

4.4 CNMC – Spain

CNMC is the regulator of the energy, telecoms, post and transport sectors in Spain. Electricity and gas distribution and transmission network companies are about to enter into their second regulatory period, which will last from 2020 to 2025. In 2019, CNMC published its WACC methodology which it used for the second regulatory period for energy companies. CNMC excludes potential comparators using a liquidity criterion.

Specifically, CNMC excludes the beta coefficients of those comparators whose average bid-ask spread is greater than 1% over the last six years. The average is of the monthly bid-ask spreads over six years for each company. The monthly average is calculated as an average of the daily bid-ask spreads within each

[27] Frontier Economics, Determination of Financing Costs for Gas Network Operators – report for E-Control, June 2012 *(translated by Frontier Economics)*

[28] NERA, Cost of Capital: Beta and Gearing for the 2019 BCMR – prepared for Ofcom, October 2018

[29] NERA, Update of the Equity Beta and Asset Beta for BT Group and Comparators – for the Office of Communications (OFCOM), January 2018

month. CNMC evaluate the average over six years as that is the period used for its beta estimation.

CNMC excluded 5 of its 29 comparators for the second regulatory period WACC estimation due to the liquidity criterion.[30]

4.5 IPART - New South Wales, Australia

The Independent Pricing and Regulatory Tribunal (IPART) oversees regulation in water, gas, electricity and transport industries in the Australian state of New South Wales. In 2018, IPART reviewed its WACC methodology.

In response to stakeholder feedback about illiquid stocks, IPART decided in 2018 to use the Amihud measure as part of its liquidity filters when selecting comparator companies.[31]

To illustrate the new approach, IPART estimated a water industry beta for their regulated companies using the new liquidity criterion, as an example of the new method's results.[32] IPART removes a monthly observation for a given security if the calculated Amihud measure exceeds the threshold of 25. The Amihud measure is checked for each month within the four to five year time window for beta estimation. If the comparator has less than 36 months of available data in this period, it is excluded from the sample. On this basis, the Amihud threshold excluded 11 firms from IPART's sample.

The new methodology has only recently been adopted and will start being used for price reviews that begin after July 2019. However at the time of writing we are not aware that any specific price decision has been made using the Amihud measure.

4.6 Energy Market Inspectorate (Ei) – Sweden

In Sweden, the Energy Market Inspectorate (Ei) regulates energy markets. In its 2020-2023 cost of capital for electricity companies report a liquidity criterion was used to select comparators. Ei used the free float measure to see if companies were sufficiently liquid.

The report implies that any companies with a free float lower than 25% were excluded, although this is not entirely clear from published information.[33] However this threshold would be consistent with the figure used by the FTSE 100 (see Section 3.3.2).

[30] CNMC, Memoria Explicative De La Circular De La Comision Nacional De Los Mercados Y La Competencia, Por La Que Se Establece La Metodologia De Calculo De La Tasa De Retribucion Financiera De Las Actividades De Transporte Y Distribucion De Energia Electrica, Y Regasificacion, Transporte Y Distribucion De Gas Natural , November 2019 *(translated by Frontier Economics)*

[31] IPART, Review of our WACC method, February 2018

[32] IPART, Estimating Equity Beta, April 2019

[33] Energimarknadsinspektionen, Kalkylränta för elnätsföretag – För tillsynsperioden 2020–2023, October 2019

4.7 Other Considered Regulators

We note that while we have identified a few regulators which are explicitly using liquidity measures, there are a number of regulators who do not appear to use any liquidity criterion. We summarise some of these regulators here.

ARERA – Italy

ARERA (formerly AEEGSI), the regulator for energy, networks and environment in Italy, has no explicit liquidity criteria for selecting comparators but does use other criteria. In a 2015 review focusing on the rate of return on invested capital for infrastructure services in the electricity and gas sectors, ARERA had no explicit criteria for the liquidity of comparator companies. [34]

Ofgem – UK

In energy regulation in the United Kingdom the issue of efficiency has not arisen. This is because the number of available potential network company peers is already small and contains only large utility companies that are expected to be very liquidly traded. Ofgem has over time almost exclusively relied on the same five listed network operators in making beta estimations. These five companies are energy groups National Grid and SSE, and water companies Pennon, Severn Trent and United Utilities. The issue of informational efficiency has therefore not arisen in the GB energy regulation debate so far.

Finland

The Energy Authority regulates the electricity and gas markets in Finland. Before the start of the fourth regulatory period in 2016, the Energy Authority determined the reasonable rate of return for capital in both electricity and natural gas network activities. The results of the study were also intended to apply to the fifth regulatory period starting in 2020. The EA does mention that comparators need to be sufficiently liquid, but there are no details about the criterion used to measure sufficient liquidity.[35]

4.8 Summary

Several regulators have specific criteria for liquidity in selecting comparator samples for beta estimation. The average bid-ask spread over a set period is the dominant measure used. Regulators in Germany, Austria, Spain and the UK all use the average bid-ask spread, with a threshold of illiquidity at 1% being prevalent.

The New South Wales regulator, IPART, use the Amihud measure. In addition, the Swedish regulator Ei uses the free float measure with an apparent threshold of 25%.

---

[34] ARERA, Rate of return on Invested Capital for Infrastructure Services in the Electricity and Gas Sectors: Criteria for Determining and Updating, Resolution 02 December 2015 - 583/2015 / R / com *(translated by Frontier Economics)*

[35] EY, Energiavirasto - Kohtuullisen tuottoasteen määrittäminen sähkö- ja maakaasuverkkotoimintaan sitoutuneelle pääomalle – Loppuraportti, October 2014

The table below summarizes the liquidity criteria used by international regulators.

Table 2 Summary of liquidity criteria used by other regulators

Regulator	Country	Sector	Liquidity criteria
BNetzA	Germany	Energy	Bid-ask spread below 1% threshold
E-Control	Austria	Energy	Bid-ask spread below 1% threshold
Ofcom	United Kingdom	Telecoms	Bid-ask spread below 1% threshold
CNMC	Spain	Energy	Bid-ask spread below 1% threshold
IPART	Australia – New South Wales	Energy, Water, Transport	Amihud measure below threshold of 25
Ei	Sweden	Energy	Free float above 25% threshold

Source: Frontier Economics

5 QUANTITATIVE REVIEW OF CANDIDATE CRITERIA

We carried out quantitative analysis to test the practical implementation of the liquidity criteria. This section highlights points for ACM to consider when using the liquidity criteria at future price reviews.

This section will cover:

- Practical data issues that ACM should be aware of when constructing the criteria (Section 5.1);
- A description of the volatility of the liquidity criteria and a discussion of the time horizon over which to estimate the measures (Section 5.2); and
- Observations on setting thresholds (Section 5.3).

We downloaded data from Bloomberg for the 66 firms that were considered across ACM's most recent beta estimations in the energy, telecoms, drinking water and Caribbean Netherlands price controls[36] This section focuses on data from the energy price control, but we present the data for all comparators in Section 5.4.

5.1 Practical Issues

Constructing each of the measures requires financial data on the comparator firms. We used data from Bloomberg, but the potential issues to be aware of are likely to apply to any source of financial data.

Volume of daily trades

To calculate the number of trading days measure, the Amihud measure and the velocity measure of liquidity, data on the volume of trades per day is needed (i.e. how often a stock has been traded on a given day).

This data is available, but we have found some days with missing data. This is particularly an issue if missing data is on consecutive days, as this could lead to inaccurate calculation of the measures. If there is a large amount of missing data it could also suggest that there may be errors in the dataset. The data should be checked to make sure that there is data on the volume of trades for the whole time horizon in use, to avoid potential inaccurate calculation.

We also note that the data we have used from Bloomberg reports every comparator firm as trading on every day in 2018. Each firm therefore has 100% trading days in the data we have looked at. This contradicts the data found by ACM's previous advisors on cost of capital. Should ACM continue to employ the number of trading days we would advise closer scrutiny of the data (e.g. a discussion with Bloomberg or alternative data provider).

[36] A list of comparators was compiled from: Rebel, The WACC for the Dutch TSO's and DSO's, March 2016; NERA, Estimating the WACC for FTR-MTR – A Report for ACM, July 2016; Europe Economics, WACC calculation for the Caribbean Netherlands, June 2019; Brattle, The WACC for Drinking Water Companies in the Netherlands, July 2019.

The Free-float measure

There are two possible ways the free float measure might be obtained using Bloomberg.

- Bloomberg itself provides a free float measure that can be directly downloaded. This is calculated by Bloomberg as the number of floating shares divided by the total current outstanding shares, multiplied by 100.[37]
- Alternatively Bloomberg allows for the construction of a free float measure by providing a measure for the percentage of shares outstanding that are held by institutions.[38] In this case, the free floating shares would be the remaining shares not held by institutions.

The main difference between the two options is that they classify stagnant shareholders (i.e. those whose shares are not free floating) differently. In addition, the second method involves more computation as it needs to be constructed.

There can be practical issues with this constructed measure as one has to rely on data reported by Bloomberg (or similar data providers) that is built on regulatory reporting by the large institutional investors. This data is imprecise in two respects.

- First, Bloomberg's definition of "large institutional investors" appears to include both investors who hold stocks long term (like pension funds or insurance companies) but also some investors who are active in trading (like hedge funds). The latter traded shares should really be considered as part of the free-float, as they are traded and could contribute to price discovery.
- Second, the data can be subject to double-counting due to short sales.[39] In some instances this can lead to data showing that institutional investors hold more than 100% of a firm's stock (i.e. a negative free float value).[40]

We are aware that the constructed free float measure reports a free float for Fluxys of 98%, but in the GTS appeal of the recent WACC determination for energy, GTS stated that the Fluxys free float was 10%. The free float percentage measured directly from Bloomberg reports that Fluxys' free float is 10%. The difference between the constructed and downloaded free float measures would need to be

---

37 The measure for the number of floating shares on Bloomberg is the 'Equity Float'. This measure on Bloomberg describes the number of floating shares as the; "*Number of shares that are available to the public. This figure is calculated by subtracting the shares held by insiders and those deemed to be stagnant shareholders from the shares outstanding. Stagnant holders include ESOP's, ESOT's, QUEST's, employee benefit trusts, corporations not actively managing money, venture capital companies and shares held by governments. The number of shares is stated in millions.*"

38 Institutions are defined by Bloomberg in this case to include 13Fs, US and International Mutual Funds, Schedule Ds (US Insurance Companies) and Institutional stake holdings that appear on an aggregate level.

39 A paper by Asquith, P, Pathak, P, Ritter, J. (2005), "Short interest, institutional ownership and stock returns", Journal of Financial Economics, 78(2) states that: *"The institutional ownership of these stocks is also quite high for most of the sample and in some instances exceeds 100%. Because shares that are shorted are owned by more than one party (the original lender plus the purchaser on the other side of the short sale), institutional ownership can exceed 100%."* (p.251) An example of this issue would be when an institutional investor holds a stock long-term and thus reports this holding, but then it lends this stock to a second party who then sells this borrowed stock in a "short sale" to another institutional investor. If both institutional investors report this stock holding then this could cause the data problem.

40 For the purposes of our analysis of velocity we capped the free float percentage at 100% for the constructed free float measure rather than use a negative value. However, there may still be some doubts over the precision of the free float measure and the velocity measure which uses the free floating shares as part of its calculation. This is because short selling could affect the free floating value at any point on the scale, not just at the 100% limit. Therefore, these results should be treated with a degree of caution.

investigated further should measures relying on free float be used in future by ACM.

Zero returns measure

Zero returns days occur when the last price on one day is the same as the last price on the day before. In liquid markets we would expect the percentage of days with zero returns over the course of a year would be very low, as trades happen for most stocks on a daily basis.

However in the data we find that on average each firm has at least 4% of days as zero return days, with some firms having values close to 100%.

If the percentage of zero return days is very high, it could highlight that further investigation is needed – e.g. the firm may have been delisted or there could be something unusual happening with the stock.

Computational effort

As noted in Section 3 there is some variation in computational effort for each of the measures. A comparison of the methods to calculate the relative bid-ask spread and Amihud measures highlights this issue.

- The most common method for bid-ask spread calculation (as used by other regulators) is to calculate the daily difference between bid price and ask price at closing, divided by the mid–price. The simple average of this daily bid ask spread over the relevant period can then be calculated. This requires data for bid and ask prices, and we calculate the mid-price as the average of the bid and ask prices.[41]
- To calculate the Amihud measure, data on the volume of daily trades and daily prices are needed to calculate the daily stock return (numerator) and the monetary value of daily trades (denominator).
  - To find the stock return the absolute value of the difference in daily prices needs to be calculated.
  - The monetary value of daily trades can be calculated by multiplying the daily prices with the volume of daily trades.
  - The resulting ratio gives the daily Amihud measure which can be averaged over a given period.

The data for both criteria is accessible and the methods require no additional assumptions. However, the Amihud measure in our view requires some additional calculation steps as described above. While these are not particularly complicated, the additional steps do imply a slightly higher risk of computational error.

Our computations are based on daily data, because it is relatively easily accessible. As shown by empirical studies, computing the liquidity measures with

[41] We also note that as an alternative to direct calculation of the bid-ask spread, Bloomberg directly reports a value for the spread, should the regulator wish to simply extract a measure directly from an external source. However, we normally recommend that practitioners calculate the bid-ask spread directly as described here, to ensure there is clarity over the definition/calculation used.

data of higher frequency would not improve the results, but calculations based on daily data are a good proxy for the high-frequency calculations.[42]

Negative bid-ask spreads

We have observed that negative bid-ask spreads are also possible in the data, although this only affects a very small proportion of the observations. It would be important for regulators using this measure to check the number of instances of negative spreads. Large numbers of instances, especially if these occur consecutively, can highlight data errors and give reason to further investigate that comparator.

5.2 Volatility and Time Horizons

All measures of liquidity vary for each stock analysed depending on what time period is considered. It is important to consider the relevant time period to use, as many of the measures are calculated as averages over time. For example:

- regulators such as BNetzA and Ofcom report the relative bid-ask spread as an average over a certain number of years; and
- ACM reports the number of trading days as a percentage of a set time period.

Table 3 shows the average bid-ask spread for each of the eight energy firms considered, depending on whether a one, three or five year averaging period is used (these being the three time windows looked at by BNetzA). In this situation, there is not much variation across the three time horizons suggesting that the level of liquidity for these firms is fairly constant over the 5 year period. However, this may not be the case for all comparators used across ACM's regulated markets.

Table 3 Average Relative Bid-Ask Spread over Different Time Horizons

Firm	1 year daily average	3 year daily average	5 year daily average
Elia	0.21%	0.25%	0.23%
Enagas	0.08%	0.07%	0.06%
Fluxys	1.34%	1.20%	1.24%
Red Electrica	0.07%	0.06%	0.05%
Ren	0.18%	0.19%	0.22%
Snam Reta Gas	0.09%	0.10%	0.10%
TC Pipelines	0.08%	0.08%	0.10%
Terna	0.11%	0.10%	0.10%

Source: Bloomberg, Frontier Analysis

In practice, we would recommend that ACM uses the same time period for averaging as the window that is used for beta estimation, to ensure liquidity across the relevant period. For example, if a period of three years is used for beta

[42] Goyenko et al. (2009), "Do Liquidity Measures Measure Liquidity?", Journal of Financial Economics 92 and Fong et al. (2017), "What Are the Best Liquidity Proxies for Global Research", Review of Finance 21

estimation, then the liquidity measures could be checked over the same three year period.

In addition, it is clear that there is some volatility in these liquidity measures over the chosen time horizon. Plotting the time-series of the selected measure can highlight any periods of illiquidity and can be used as a sense check on whether taking an average is an appropriate method. ACM may therefore consider whether there is merit in removing specific periods of illiquidity from the beta estimation window. We note, for example, that IPART removes any specific months from its beta analysis in which the comparator goes above its threshold for the Amihud metric. Full consideration and evaluation of the pros and cons of this option is beyond the scope of this report.

5.3 Observations on setting the threshold

Although we recommend the bid-ask spread as the preferred measure of liquidity, there is no clear or specific rationale for the choice of any particular threshold. It is challenging in principle to conclude what the right threshold should be on a continuous scale metric such as bid-ask spread. In our view there is no single conceptually "right" answer to this question – there are likely to be firms located near any proposed threshold for which a degree of judgement may need to be exercised by the regulator.

Given this, it is worth noting that a bid-ask spread threshold of 1% seems to have support in terms of regulatory precedent. Implementing the thresholds used by other regulators can provide a good starting point for ACM - a bid-ask spread threshold of 1% is used by at least four regulators in Europe (BNetzA, E-Control, Ofcom, CNMC). Should the ACM wish to set a single, deterministic threshold, we recommend that 1% would be reasonable, in line with the approach taken by other regulators in Europe.

However, ACM may also wish to exercise some discretion around the application of this specific threshold, and potentially consider other metrics in addition to bid-ask spread. This is ultimately a choice for the regulator and depends, to an extent, on whether the liquidity test is considered sufficiently important to justify the additional time and resources that would be associated with a broader analysis. It may also depend on wider factors, for example the regulator may wish to undertake some further analysis if:

- a minimum number of comparators in the beta sample is required, but this target is not met due to excluding companies very slightly above the bid-ask spread threshold; or
- other selection criteria - such as the degree of comparability with the regulated companies - are strongly (or weakly) met for a peer but it is slightly above (or below) the bid-ask spread threshold.

Therefore, should ACM wish to build additional discretion into its approach, we would recommend the following process.

- First, define a relatively narrow "grey area" above/below the 1% bid-ask spread threshold. Within this grey area the firm is probably liquid enough, but further checks are likely to be valuable.

- Second, consider any or all of the other liquidity measures. If the peer is a clear outlier across these metrics, then there is good reason to exclude the peer.
- Third, if the previous step is not determinative, consider whether the "additional information criteria" provide a reason to exclude (e.g. annual revenue <£100m).

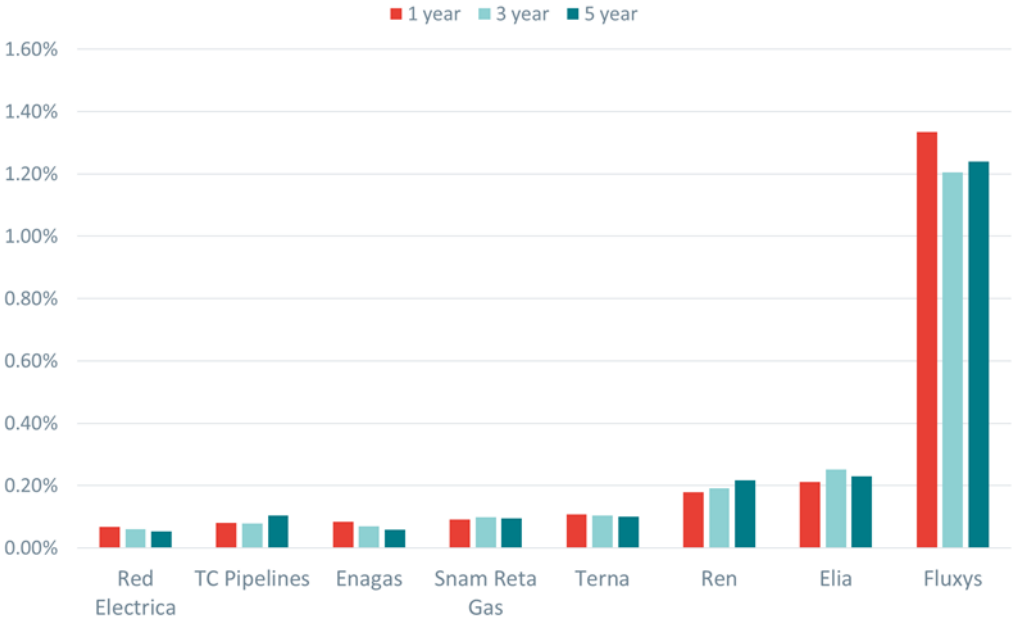
If these additional tests remain inconclusive, then the regulator should exercise its discretion. At this point the regulator will have taken all steps possible to evaluate the liquidity of the peer. Therefore, the regulator will need to balance the risk of including an illiquid peer in the sample vs. the benefits of including the peer (e.g. because it is a clearly relevant comparator, or increasing the sample size is considered particularly valuable).

We note that the optional process described above will clearly be more resource intensive than applying a simple 1% bid-ask spread threshold. It is for the regulator to decide whether the additional process cost is necessary or sufficiently valuable.

We note that plotting the data can be a useful tool to complement this process. This could allow ACM to evaluate what effect different thresholds will have and identify if there are outliers. While this is not a scientific approach, it may be a pragmatic way to inform the regulator's judgement – even if a specific threshold cannot be applied mechanistically, it is clear that metrics such as bid-ask spread allow for firm conclusions about *relative* liquidity between stocks. For example, a stock with a lower bid-ask spread is unambiguously more liquid than a comparator with a higher bid-ask spread. Since these variables are continuous, it may be helpful to take an approach which is based on identifying outliers in the data and investigating these more thoroughly.

So, for example, Figure 1 shows a plot of the one, three and five year daily average bid-ask spreads for the eight energy sector firms considered in this analysis. In this situation it is clear that Fluxys is an outlier compared to the other firms in the sample.

Figure 1 1, 3 and 5 Year Daily Average Bid-Ask Spreads



Source: Bloomberg, Frontier Analysis

5.4 Data Tables

The ACM asked Frontier to look at each of the measures suggested in Section 3 for each sector peer group, for the peers the ACM has used in the past for energy, telecoms, drinking water, and Carribbean Netherlands price controls. The tables below show the data.

Table 4 Energy Sector Comparators

	Annual Revenue (Million EUR - 2018)	Number of Trading days (2018)	Bid-Ask Spread (1 year daily average)	Bid-Ask Spread (3 year daily average)	Bid-Ask Spread (5 year daily average)	Amihud Measure (2 year average)	Market Cap (Million EUR-2018)	Average Free-Float (1 year) - Downloaded Measure	Average Free-Float (1 year) - Constructed Measure	Velocity	Zero returns (1 year)
Elia	1823	100%	0.21%	0.25%	0.23%	22	3557	42%	36%	0.50%	10.31%
Enagas	1342	100%	0.08%	0.07%	0.06%	4	5637	95%	46%	0.64%	3.82%
Fluxys	503	100%	1.34%	1.20%	1.24%	868	1721	10%	98%	0.03%	26.34%
Red Electrica	1961	100%	0.07%	0.06%	0.05%	3	10517	79%	31%	0.45%	4.20%
Ren	567	100%	0.18%	0.19%	0.22%	14	1624	51%	26%	0.05%	11.83%
Snam Reta Gas	2555	100%	0.09%	0.10%	0.10%	3	12606	59%	36%	0.08%	4.96%
TC Pipelines	465	100%	0.08%	0.08%	0.10%	18	2000	82%	24%	1.22%	3.82%
Terna	2273	100%	0.11%	0.10%	0.10%	3	9955	70%	45%	0.09%	5.73%

Source: *Bloomberg, Frontier Analysis*

Notes: *The list of energy sector comparators was taken from Rebel's, The WACC for the Dutch TSO's and DSO's, March 2016. The constructed free float measure has been used for all Velocity measure calculations.*

Table 5 Telecoms Sector Comparators

	Annual Revenue (Million EUR - 2018)	Number of Trading days (2018)	Bid-Ask Spread (1 year daily average)	Bid-Ask Spread (3 year daily average)	Bid-Ask Spread (5 year daily average)	Amihud Measure (2 year average)	Market Cap (Million EUR - 2018)	Average Free-Float (1 year) - Downloaded Measure	Average Free-Float (1 year) - Constructed Measure	Velocity	Zero returns (1 year)
BT	26899	100%	0.04%	0.04%	0.03%	1	25698	85%	45%	0.04%	3.05%
Freenet	2897	100%	0.56%	0.41%	0.41%	74	2170	100%	36%	0.88%	4.20%
Hellenic Telecom	3799	100%	0.25%	0.26%	0.28%	12	4569	49%	73%	0.09%	12.98%
Iliad	4891	100%	0.06%	0.11%	0.11%	5	7242	44%	78%	2.10%	2.29%
Kabel Deutschland	2475	100%	1.44%	1.15%	0.96%	2029	9649	25%	98%	0.00%	50.00%
Liberty Global	10134	100%	0.05%	0.04%	0.04%	4	13915	81%	0%	N/A	3.82%
Nos	1576	100%	0.16%	0.19%	0.21%	13	2717	45%	62%	0.05%	6.87%
Orange	41381	100%	0.04%	0.05%	0.05%	1	37551	76%	41%	0.18%	3.82%
Orange Belgium	1280	100%	0.20%	0.27%	0.25%	32	1035	47%	70%	0.23%	6.11%
Swisscom	10144	100%	0.10%	0.09%	0.08%	2	21618	49%	28%	7.87%	4.58%
TDC	2329	100%	0.28%	0.17%	0.14%	1	5455	-	86%	0.02%	100.00 %
Tele2	2311	100%	N/A	N/A	N/A	16	7631	68%	25%	0.82%	4.20%
Telefonica	48693	100%	0.03%	0.03%	0.03%	1	38105	94%	63%	0.06%	2.29%
Telefonica Deutschland	7320	100%	0.77%	0.60%	0.64%	11	10167	27%	83%	0.02%	3.82%
Telenet	2535	100%	0.09%	0.15%	0.16%	8	4779	39%	70%	0.54%	4.20%
Telenor	11490	100%	0.12%	0.11%	0.12%	2	24655	45%	19%	0.37%	4.58%
Vodaphone	46571	100%	0.03%	0.03%	0.03%	1	59085	100%	28%	0.05%	3.05%

Source: Bloomberg, Frontier Analysis

Notes: The list of telecoms sector comparators was taken from NERA's, Estimating the WACCs for FTR-MTR, July 2016. Comparator Tele2 was missing bid and ask price data. Velocity values of N/A indicate that the comparator had no free-floating shares. TDC had no information on Bloomberg for the downloadable measure of free floating shares.

Table 6 Drinking Water Sector Comparators

	Annual Revenue (Million EUR- 2018)	Number of Trading days (2018)	Bid-Ask Spread (1 year daily average)	Bid-Ask Spread (3 year daily average)	Bid-Ask Spread (5 year daily average)	Amihud Measure (2 year average)	Market Cap (Million EUR - 2018)	Average Free-Float (1 year) - Downloaded Measure	Average Free-Float (1 year) - Constructed Measure	Velocity	Zero returns (1 year)
American States Water	370	100%	0.03%	0.03%	0.04%	12	2152	99%	15%	4.13%	3.82%
American Water Works	2915	100%	0.02%	0.02%	0.02%	2	14321	100%	5%	12.55%	3.82%
Aqua America	710	100%	0.03%	0.03%	0.03%	3	5317	100%	34%	1.85%	3.82%
Athens Water Supply	322	100%	0.76%	0.69%	0.84%	77	533	29%	31%	0.15%	12.21%
California Water Service	592	100%	0.04%	0.10%	0.08%	11	2000	99%	12%	4.58%	3.82%
Connecticut Water	99	100%	0.14%	0.13%	0.16%	42	704	98%	42%	1.04%	11.07%
Eaux de Royan	N/A	100%	4.83%	4.60%	4.49%	3227	2291	100%	24%	2.08%	70.23%
Elia	1823	100%	0.21%	0.25%	0.23%	22	3557	42%	36%	0.50%	10.31%
Enagas	1342	100%	0.08%	0.07%	0.06%	4	5637	95%	46%	0.64%	3.82%
Fluxys	503	100%	1.34%	1.20%	1.24%	868	1721	10%	98%	0.03%	26.34%
Middlesex Water	117	100%	0.17%	0.14%	0.15%	68	764	96%	36%	1.10%	3.82%
Pennon	1583	100%	0.08%	0.08%	0.08%	5	3075	100%	0%	N/A	3.05%
Red Electrica	1961	100%	0.07%	0.06%	0.05%	3	10517	79%	31%	0.45%	4.20%
Ren	567	100%	0.18%	0.19%	0.22%	14	1624	51%	26%	0.05%	11.83%
Severn Trent	1924	100%	0.06%	0.06%	0.06%	4	5043	100%	0%	N/A	3.05%
SJW Group	337	100%	0.06%	0.05%	0.06%	24	1380	95%	33%	2.22%	3.82%
Snam Reta Gas	2555	100%	0.09%	0.10%	0.10%	3	12606	59%	36%	0.08%	4.96%
Societe de Eaux de Douia	N/A	100%	15.65%	23.02%	28.63%	4488	10517	100%	19%	20.48%	96.18%
Talinna Vesie	63	100%	0.64%	0.71%	0.73%	484	192	30%	64%	0.03%	36.64%
Terna	2273	100%	0.11%	0.10%	0.10%	3	9955	70%	45%	0.09%	5.73%
Thessaloniki W&S	73	100%	1.14%	1.11%	1.20%	923	161	21%	23%	0.07%	23.28%
United Utilities	1968	100%	0.06%	0.07%	0.07%	3	5554	100%	8%	1.60%	3.05%
York Water	41	100%	0.42%	0.31%	0.26%	154	362	99%	58%	0.33%	3.82%

Source: Bloomberg, Frontier Analysis

Notes: The list of drinking water sector comparators was taken from Brattle's, The WACC for Drinking Water Companies in the Netherlands, July 2019. Comparators Eaux de Royan and Societe de Eaux de Douia have missing data for annual revenue. Velocity values of N/A indicate that the comparator had no free-floating shares.

Table 7 Caribbean Netherlands Comparators

	Annual Revenue (Million EUR - 2018)	Number of Trading days (2018)	Bid-Ask Spread (1 year daily average)	Bid-Ask Spread (3 year daily average)	Bid-Ask Spread (5 year daily average)	Amihud Measure (2 year average)	Market Cap (Million EUR - 2018)	Average Free-Float (1 year) - Downloaded Measure	Average Free-Float (1 year) - Constructed Measure	Velocity	Zero returns (1 year)
Acea	2837	100%	0.23%	0.25%	0.32%	19	2553	21%	43%	0.19%	6.87%
AES	9098	100%	0.06%	0.08%	0.08%	1	8363	99%	0%	N/A	3.82%
Aguas Andinas	701	100%	0.85%	1.09%	1.01%	35	2939	45%	44%	0.00%	5.34%
Albioma	428	100%	0.28%	0.42%	0.52%	41	569	79%	45%	0.50%	11.07%
American Electric power	13725	100%	0.01%	0.02%	0.02%	1	32191	100%	16%	3.46%	3.82%
Aqua America	710	100%	0.03%	0.03%	0.03%	3	5317	100%	34%	1.85%	3.82%
Atlantic Power	239	100%	0.43%	1.51%	1.09%	17	569	95%	24%	1.21%	3.82%
California Water Service	592	100%	0.04%	0.10%	0.08%	11	2000	99%	12%	4.58%	3.82%
Clearway Energy	892	100%	0.07%	0.20%	0.16%	5	16401	99%	0%	N/A	3.82%
Compania de Saneamento de Minas Gerais Copasa	1103	100%	0.39%	0.35%	0.66%	6	1749	50%	11%	5.93%	4.96%
Compania de Saneamento do Porena Sanepar	969	100%	0.27%	N/A	N/A	7	533	100%	79%	1.10%	4.96%
CPFL Energias Renovaveis	451	100%	5.04%	3.03%	4.69%	2758	1830	3%	92%	0.00%	29.01%
Edison	10726	100%	0.03%	0.02%	0.02%	1	16151	100%	0%	N/A	3.82%
EDP Energias do Brasil	3222	100%	0.27%	0.34%	0.40%	2	2009	49%	22%	2.01%	4.96%
EDP Renovaveis	1697	100%	0.17%	0.22%	0.23%	24	6782	17%	88%	0.01%	11.45%
Enel Americas	11173	100%	0.58%	0.85%	0.92%	17	8722	48%	55%	0.00%	4.96%
Eneva	729	100%	0.36%	0.83%	2.26%	11	1140	62%	23%	1.50%	4.96%
Engie Brasil Energia	2048	100%	0.26%	0.55%	0.52%	3	6060	31%	11%	1.96%	4.96%
Eolus Vind	136	100%	N/A	N/A	N/A	1138	90	81%	86%	0.27%	4.20%
Falck Renewables	336	100%	0.31%	0.39%	0.52%	24	678	46%	35%	0.22%	5.34%
Middlesex Water	117	100%	0.17%	0.14%	0.15%	68	764	96%	36%	1.10%	3.82%
Pampa Energia	3519	100%	4.52%	6.36%	4.08%	39	2032	66%	61%	0.01%	6.87%
Pattern Energy Group	409	100%	0.05%	0.05%	0.05%	3	1594	98%	0%	N/A	3.82%
PNM Resources	1217	100%	0.03%	0.10%	0.07%	5	2858	99%	0%	N/A	3.82%
Public Power	4742	100%	0.31%	0.42%	0.42%	36	300	49%	28%	0.37%	8.02%
Renova Energia	165	100%	2.32%	2.01%	2.46%	696	68	63%	100%	0.11%	4.96%
Severn Trent	1924	100%	0.06%	0.06%	0.06%	4	5043	100%	0%	N/A	3.05%
United Utilities	1968	100%	0.06%	0.07%	0.07%	3	5554	100%	8%	1.60%	3.05%
Verbund	2848	100%	0.16%	0.19%	0.21%	26	12938	39%	91%	0.12%	4.96%
Zespol	541	100%	1.12%	0.96%	0.90%	531	89	48%	62%	0.04%	4.96%

Source: Bloomberg, Frontier Analysis

Notes: The list of drinking water sector comparators was taken from Europe Economics', WACC calculation for the Caribbean Netherlands, June 2019. Compania de Saneamento do Porena Sanepar only had data from 22nd Nov 2017. Eolus Vind had missing data for Bid and Ask prices before June 2019. Velocity values of N/A indicate that the comparator had no free-floating shares.

ANNEX A GLOSSARY

Table 8 Glossary of terms

Term	Definition
Bid Price	The price at which a market maker offers to buy a stock
Ask Price	The price at which a market maker offers to sell a stock
Price (or "Last Price")	The price at which the last executed trade was made on a trading day. It is this "last price" which the exchange reports publicly and which is normally reported on data portals.
Free Float	The proportion of shares that is traded freely instead of being held by large institutions that invest long-term
Market Makers	Financial firms that provide the possibility to trade by offering to buy stocks at a quoted price and to sell them at a another quoted price
Traders	Market participants who buy or sell stocks (often through a broker)

Source: Frontier Economics

frontier economics

www.frontier-economics.com