

Platforms, brokers, and connected devices: what are the implications of the use of consumer data?

An economic review prepared for Which?

March 2018



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Aims of this review

To provide a firm foundation for Which?'s future policy activities

- The use of consumer data can enable the provision of goods and services that benefit consumers, but it also has the potential to be detrimental – posing risks to consumer privacy, and to choice and competition.
- This review of economic literature on the issue aims to inform Which?'s activities – helping to understand the conditions under which data use may or may not benefit consumers, as well as signalling opportunities for future research.

We proposed a two-stage review:

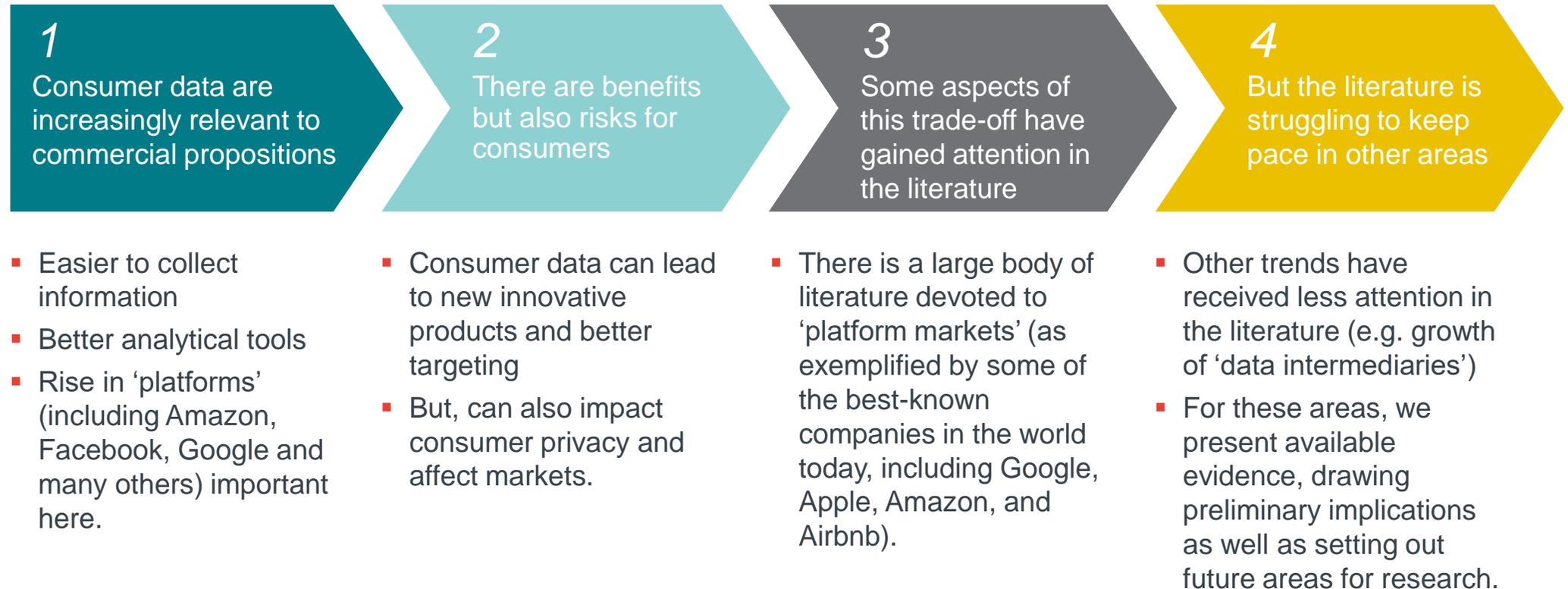
1
Wide review of evidence on markets, benefits and costs, barriers

- An initial scan of the literature identifying key themes – specifically:
 - What are the markets where the use of consumer data is a key feature?
 - What are the likely potential costs and benefits to consumers from this use?
 - What barriers may prevent realised benefits from outweighing the costs?

2
Focused review of specific areas

- An in-depth review of four topics that were considered of most direct interest and relevance to consumers, as well as providing sufficient material to conduct an in-depth review.
- The four topics are: the implications of data use for competition; the role of data brokers; the use of data from SMs and its implications for other CDs; the role of behavioural biases in shaping economic choices around privacy.

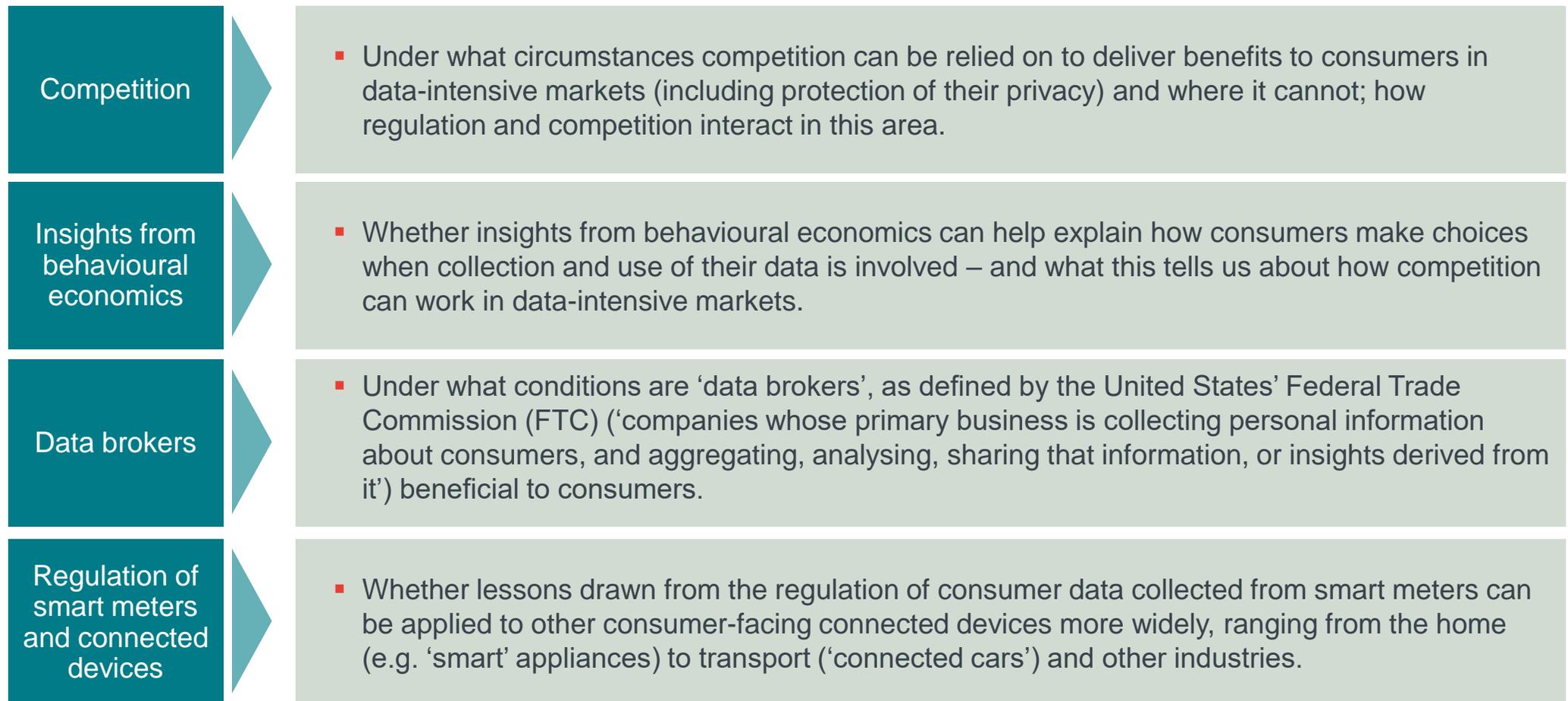
The uncertain balance for consumers of benefits and costs associated with the use of their data motivates this review of the economic literature



The review focused on four key areas, agreed with Which? on the basis of an initial scan of the economic literature

An initial literature scan identified over 80 relevant English language publications on the commercial use of consumer data, published in academic journals, commissioned or authored by regulators, or published by international organisations.

Having completed this initial scan, we agreed with Which? that the following four areas would be reviewed in depth:



There are potential reasons why competition may not work effectively for consumers in some data-intensive markets

Effective competition between providers in a market can benefit consumers by leading to improved quality, lower prices and, within certain parameters, greater innovation. However, effective competition is not always possible and regulation may be needed to protect consumers.

Specifically, competition may not work effectively for consumers in data-intensive markets due to the following issues:

Only a few providers can operate in some data-intensive markets

In several data-intensive markets, the value of the product to users increases with their number (there are 'network effects', as in the case of social media), making it harder for smaller or younger firms to compete with larger, established providers. However, network effects are not necessarily generated by data.

It may be difficult for new companies to enter an existing data-intensive market

Established companies may have access to extensive data on consumers in the market. If this provides them with a sustainable source of competitive advantage, that may deter other organisations from entering that market.

Consumers may not be able to effectively take into account privacy in their consumption choices

Choices that involve personal data are typically very complex. The relevant information may not be presented clearly and, even where it is, these choices typically involve balancing present costs against future, uncertain benefits (or vice versa).

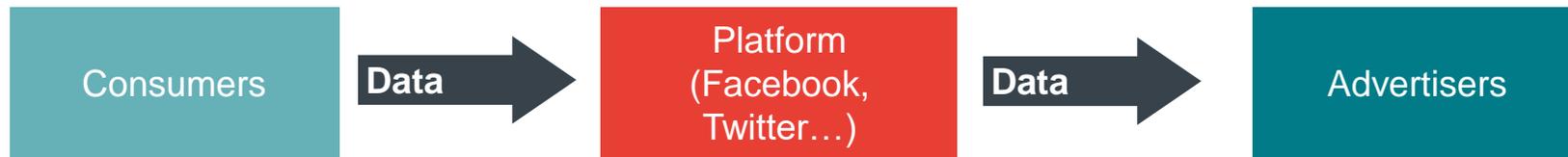
Actions taken by producers or consumers may also affect unrelated parties (there are 'externalities')

For example, when a consumer shares their data this may have effects on other consumers. These effects may be positive (more data can lead to better analysis, which in turn can lead to better products), but also negative in terms of privacy (when someone shares their interests, this makes it easier to infer the interests of people with similar characteristics).

The competition economics literature discusses at some length the first three issues. Externalities have been mentioned in the economic literature on consumer data, but their implications for the outcomes of competition have not been considered explicitly in the publications we reviewed.

Platform markets, which tend to use consumer data intensively, are often concentrated – but they can still be competitive

Increasing commercial use of consumer data is linked to the rise of on-line platforms. Platforms are intermediaries that enable buyers and sellers to interact. The diagram below provides a simple representation of the data flows involved in the case of social media.



Often only a few platforms compete with each other in a given market. This is explained by the network effects involved. In the case of social media, for example, the platform is more valuable to each user the more users are on board. Moreover, there are also 'indirect' network effects: when more users are involved, the platform becomes more valuable to the other side (in this simplified representation, advertisers – but this could also include developers, publishers and others).

However, the literature points to the following conditions that can enhance consumer choice:

Multi-homing	When consumers use more than one platform (they 'multi-home'), each firm has access to its competitors' customers, and can compete more effectively for these customers.
Asymmetric competition	Competition on one specific side of the platform (e.g. for advertising revenues) may lead to better outcomes on other sides as well.
Product differentiation	Multiple platforms can coexist when they provide differentiated services (for example, in the job-matching market, general platforms coexist with others that focus on specific occupations).

There is agreement in the literature that traditional competition analysis needs to be updated to be applied to platform markets, but theory and practice are still evolving and a new consensus has not yet emerged.

Entry may be less likely to form a competitive constraint in markets where data are critical, useful for prediction and unique

The possibility that new companies may start providing a product can be important in keeping markets competitive.

The literature agrees that collecting and analysing data can involve large fixed costs, and that large fixed costs can form barriers preventing entry by new competitors. However, there is disagreement on whether access to data involves costs large enough to form barriers:

- On the one hand, not only data collection and use involve fixed costs; network effects can also give an advantage to incumbents. Firms that gain more users early have access to larger datasets, which can lead to quality improvement, attracting even more users.
- However, there are countervailing arguments. For example, better analytical capabilities may trump larger datasets; moreover, similar data on consumers may be available from several different sources.

Based on our reading of the evidence, our hypothesis is that there may be reason for greater concern where a firm in a dominant position¹ has access to data that are:

Critical	Data that are critical to provide a product or a service
Useful for prediction	Data that enable firms to predict with reasonable accuracy consumer preferences or behaviour
Unique	Data that cannot be easily collected, purchased or inferred from other sources

This hypothesis could be tested and refined through engagement with experts and stakeholders in industry, academia and regulators.

1. The European Commission’s guidelines on abuse of dominance cases suggest that companies with higher market shares maintained for longer time periods are more likely to be dominant. Firms with market shares below 40% are considered unlikely to be dominant.

Regulation may be needed – but some forms of regulation could have a negative effect on competition

If competition may not always drive the market towards good outcomes for consumers, it may be necessary for governments to step in through public policy and regulation. Some of the behavioural issues in privacy decisions we discuss in a later section of this document also support the case for regulation.

Indeed, privacy regulations already exist, and new bodies of regulation are soon going to come into force (the Data Protection Bill, replacing the 1998 Data Protection Act, and the EU GDPR, effective in the EU from May 2018).

However, it is important to bear in mind feedback effects that regulation can have on competition. These will depend, among other factors, on whether regulation makes it easier for consumers to switch across providers, and whether it imposes costs that may disproportionately affect smaller and newer companies. The types of regulation discussed in the literature include:

Potential positive effect on competition	Neutral	Mixed
Standardising privacy agreements: making it easier to switch	Requiring consumers to consent to their data being shared with groups of organisations, rather than with specific firms	Data portability aims to make it easier for consumers to switch. However, the cost of developing processes to implement portability could be harder to bear for smaller and younger businesses.
Requiring privacy guarantees that obscure personal information: may reduce firms' incentives to merge		Limiting how long consumer data can be stored for – could reduce the competitive advantage of incumbents but has been shown to have little impact in the search engine market.

Consumer choices around privacy are complex, and further research on what influences them could inform public policy

Key findings

- There is a rich and growing literature describing how privacy decisions are made, and the implications of this for consumers' welfare.
- Making choices around privacy involves significant uncertainty over the consequences of data use, and often over one's own preferences.
- Privacy choices are influenced by context: choices others make, perception of the organisation the consumer is interacting with and framing (design choices, apparently irrelevant information).

Key implications for consumers

- Our reading of the literature suggests that:
 - Providing information that helps remove uncertainty (for example, making benefits and costs tangible) could help consumers make better decisions
 - Discussing norms and presenting consumers with alternative models of privacy behaviour could help them make reasoned choices
- Small details may have a large effect. This may apply to policy and regulation, and to the design choices made in products and services consumers engage with.

Gaps in the evidence base

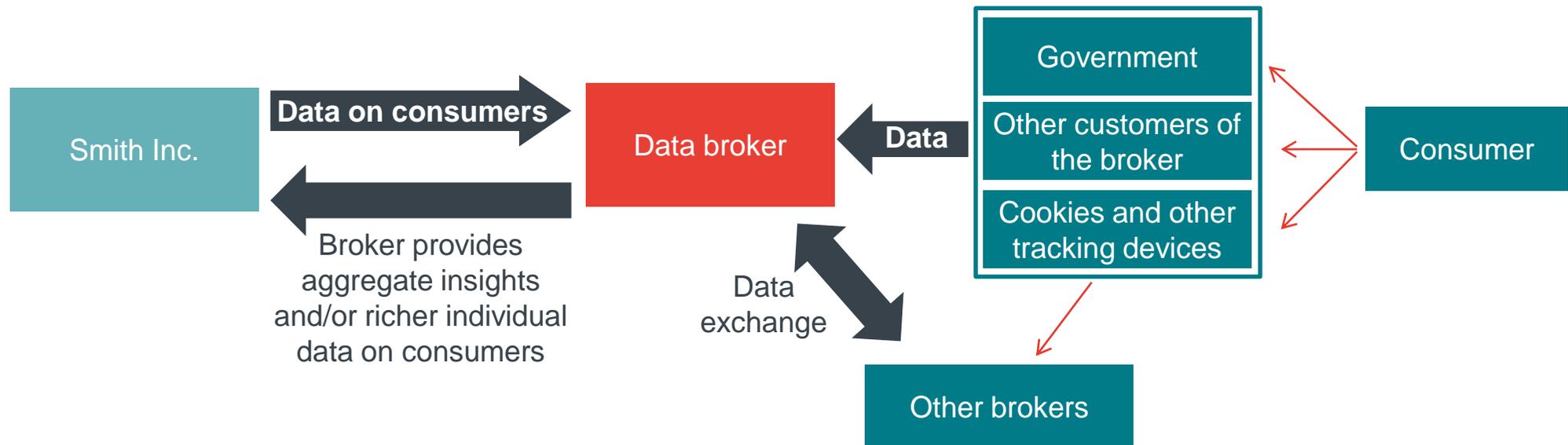
- It is not clear what type of information is most valued by consumers to support privacy decisions, and how it can be delivered most effectively
- Further research valuing costs and benefits of personal data use may support consumer decisions
- There is evidence that privacy choices are influenced by framing (including design of websites, apps and other services). Further research on what types of framing are most influential could be useful.

What is a 'data broker' and what services does it provide?

Data brokers have been defined as 'companies whose primary business is collecting personal information about consumers, and aggregating, analysing and sharing that information, or insights derived from it'.¹

Brokers use a combination of individual and aggregate data, from government and commercial sources, to provide marketing services, risk mitigation products and consumer services (e.g. identity theft protection). Data from commercial sources include what is gathered from (third-party) cookies placed on the websites of companies that use brokers.

The diagram below provides a simplified representation of data flows in the case of marketing or risk mitigation products.



The main source of information on data brokers is a report published by the United States' FTC. Anecdotal evidence suggests that the role of brokers is similar in the UK, but there is little UK-specific evidence.

1. FTC (2014)

Note: figure adapted from FTC (2014).

What is the impact of data brokers on consumers?

The FTC called for brokers in the United States to be increasingly transparent and accountable in the interest of consumers. However, understanding what their role implies for consumers would require a firmer grasp on how brokers compete with each other, and how they interact with their customers within the wider targeted marketing landscape. To date, this is a key gap in the literature.

However, economic theory, including recent work on data-intensive markets, can help us frame a discussion around what the role of brokers may imply for consumers.

What explains the role of data brokers?

Economies of scale and scope in the collection and analysis of data are likely to play a role. Individual firms may want additional information on consumers, but may not have sufficient incentive to invest in the collection and processing infrastructure needed.

What is the net impact of data brokers on consumers?

Brokers can enable more precise targeting of marketing efforts. In this sense, a debate on their role is really a broader discussion on the conditions under which targeting benefits consumers

Potential drivers of positive impact

- Brokers may provide a competitive constraint to other data intermediaries.
- Brokers may also limit the potential for data to be a barrier to entry, reducing the chances that data held by an incumbent will be unique.

Potential reasons for concern

- Brokers may make it harder for consumers to trace their data and to be aware of when and how they are being targeted.
- Brokers may face lower reputational risks compared to consumer-facing firms from intrusive behaviour or data breaches.

Evidence from Smart Meters and other areas of this review provide some insights into potential adoption of Connected Devices

Existing evidence on CDs suggests the following potential benefits and costs, along with key barriers/enablers of adoption by consumers:

Potential benefits

- **New products and tailored solutions:** CDs allow companies to offer products and services tailored to each user.
- **Efficiency:** allowing consumers to manage resources more efficiently (e.g. energy management with connected home solutions).

Barriers/enablers

- **Lack of interoperability:** a fragmented ecosystem could limit adoption, undermine potential efficiency benefits and/or lock in consumers with specific providers.
- **Trust:** adoption and realisation of the benefits will depend on the extent to which potential users trust the technology and related products.

Potential costs

- **Security:** digital security issues involving CDs may have physical consequences (for example in the case of connected vehicles).
- **Privacy risks:** CDs will increase the amount of data points that can be collected, aggregated and analysed by providers and potentially third parties.

- Potential benefits, costs and barriers reflect to an extent what we observe in the case of SMs – greater efficiency with potential privacy concerns.
- However, the choice of whether to adopt a CD (and therefore typically to share data through the device) may be more similar to a typical on-line privacy choice, entailing immediate benefits (a service or product) with potential future, uncertain costs (loss of privacy).
- Future research could elaborate further on this comparison drawing out analogies and differences – and implications for policy, regulation.

Key gaps and areas for further research

We have identified the following key gaps and opportunities in the literature:

- In general, the available economic literature is largely theoretical, as might be expected given the novelty of the issues we reviewed and the difficulties in testing empirically some of the key questions. However, we anticipate that the availability of empirical work on the commercial use of consumer data will increase substantially in the future. Specifically, analysis of the effects of the new Data Protection Bill and the EU GDPR will shed light on how regulation of consumer data can affect market outcomes.
- There are a number of opportunities to improve the knowledge base on data brokers. There is little UK-specific evidence on their role, and even beyond the UK limited consideration of how their role fits within the wider digital marketing landscape and of whether their services may foster competition by providing wider access to data on consumers.
- It may be useful to test what type of information is most valued by consumers to support privacy decisions, and to test what is the best way to deliver it, potentially using on-line experiments. While it seems clear that behavioural biases will always affect consumers' privacy choices, it is difficult to disentangle their role from the question of what information consumers have and how it is made available. The growth of CDs makes these questions increasingly relevant for the 'off-line world' (consumer behaviour that does not necessarily involve interaction with a smartphone, computer or tablet).
- There is limited empirical evidence on the prevalence, costs and benefits of consumer data use to target marketing efforts and in particular on-line advertising.
- A growing literature considers the economics of how firms compete for consumers' on-line attention, and the psychological and social implications for consumers. To the best of our knowledge, this literature does not yet provide robust information on the economic benefits and costs of consumer data use – the focus of this review. However, this line of research may provide interesting insights in the future, particularly when it comes to assessing the value of goods and services provided to consumers free of charge.

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Definition of 'consumer data'

Definition

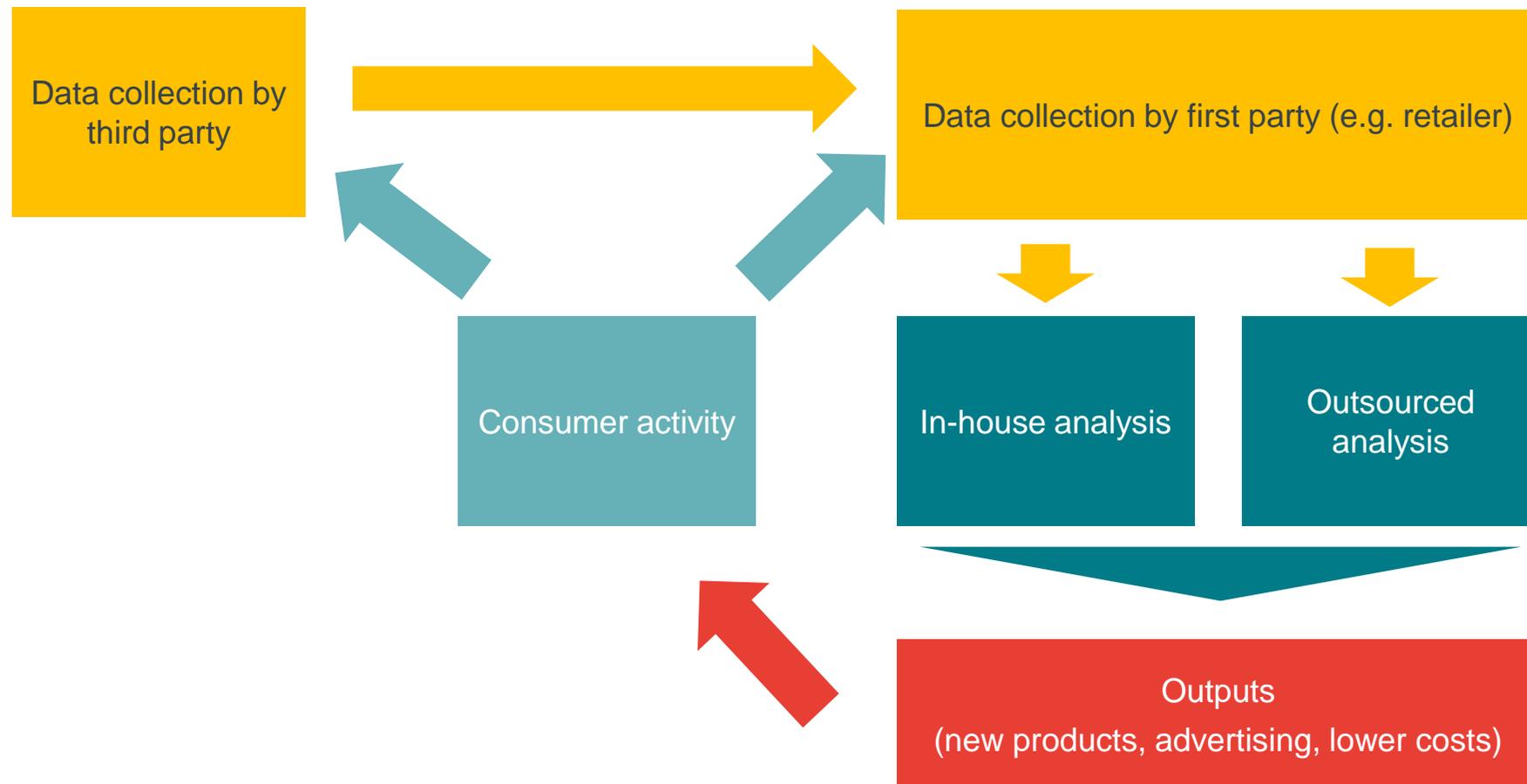
- 'Any information firms might collect from and about consumers that is used, or intended to be used, to support commercial activities'.
- This includes:
 - Data offered voluntarily (or 'actively') by consumers: when registering for a service, when building profiles on social media (e.g. age, gender on Facebook)
 - Observed data (supplied or generated 'passively'): activity on social media (e.g. 'likes'); browsing history collected through cookies or other tracking technology; data from sensors (e.g. Fitbit)
- Inferred data: generated by first or third parties as a result of analysis or in combination with other data.

Types of data (from the point of view of the consumer)

- Personal data or personally identifiable information: data that can be used to identify specific individuals, on its own or in combination with other data. For example, an individual can be identified:
 - From national insurance number alone
 - From gender, age, postcode, information on disabilities in combination.
- Non-personal data:
 - Anonymous or pseudonymous data: where personal data are not included and may have been replaced with artificial identifiers
 - Aggregate data: obtained combining personal, anonymous or pseudonymous data for a sufficient number of individuals in a group.

Source: Competition and Markets Authority (2015)

Consumer data can be gathered and processed in different ways to generate value for firms and consumers



Source: adapted from Competition and Markets Authority (2015)

A number of statistics can provide a partial picture of the scale of consumer data use

We have not identified comprehensive statistics on the scale of commercial use of consumer data.

However, there is information available on a number of trends that are closely linked to the increasing use of consumer data:

Connected devices (CDs)

- The use of CDs typically generates data on consumer behaviour.
- Adults in the UK have more than doubled the time they spend on-line on an average day since 2005.
- Not only the use of computers, smartphones, and tablets has increased – other devices are also connected to the internet and increasing in use: wearable technology, smart TVs and other appliances, and others.

Platforms

- Platforms are intermediaries that enable buyers and sellers to interact – e.g. users and advertisers on Google or Facebook and many others.
- Consumer data are often central to platforms' business models. They often need information as input (e.g. a search query on Google, a connection on Facebook). They also use information on consumers to improve their services and, often, to place targeted adverts that provide their main source of revenues.

Tracking technology

- Consumers' internet browsing behaviour can be tracked through a number of tools, including cookies,¹ pixels and beacons.
- These tools can be placed on a consumer's device by the business they are interacting with ('first party') or by a third party.

Average time spent on-line per day by adults in the UK



Market capitalisation of selected global companies



US\$ 182 bn US\$ 423 bn US\$ 579 bn

80%

Proportion of top-500 websites hosting third-party trackers according to Falahrastegar et al. (2014)

1. Note, however, that cookies can also be useful to support basic functionality on some services (e.g. remembering the content of a shopping basket on an on-line retailer's website).

Sources: Ofcom (2017), PWC (2017)

The commercial use of consumer data can lead to benefits and costs for consumers

Benefits

- Innovation: new products and services (incl. ad-funded free services)
- Better targeting: reduced search costs for consumers, better match with products/services
- Process innovation: benefits passed on to consumers in the form of lower prices and/or higher quality (including fraud prevention, better stratification of risk).



Costs

- Loss of privacy
- Fraud (financial costs)
- Higher prices/lower quality:
 - Driven by reduced competition
 - Driven by price discrimination
- Nuisance costs of advertising and on-line services (costs on attention).

- There have been some attempts to quantify benefits and costs, but this is difficult as it requires assessing the value of privacy and of a number of services that do not have an explicit price.
- As a result, the literature does not yet quantify costs and benefits in general, or for specific markets, to understand where benefits are likely to be particularly large relative to costs.
- However, it is possible to assess (qualitatively) how important the use of data is to delivering benefits, and which barriers apply in which markets.

A number of barriers may prevent competition from working effectively and delivering optimal outcomes for consumers

- The benefits of data use are likely to outweigh the costs if competition works effectively in the markets where data are used.
- However, there may be barriers to this happening: reasons why markets are not competitive, and other market failures that can lead markets to inefficient outcomes.

Benefits

- Innovation: new products and services (incl. ad-funded free services)
- Better targeting: reduced search costs for consumers, better match with products/services
- Process innovation: benefits passed on to consumers in the form of lower prices and/or higher quality (including fraud prevention, better stratification of risk).

Barriers

- Consumer awareness and engagement
- Indirect network effects (characteristic of 'platform' markets, tend to lead to concentration)
- Existing market power
- Asymmetric information
- Externalities: positive (providing access to my data may benefit others), negative (low investment in security can put others at risk).

Costs

- Loss of privacy
- Fraud (financial costs)
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Empirical evidence on benefits, costs, barriers

Benefits

- Innovation: new products and services (incl. ad-funded free services)
- Better targeting: reduced search costs for consumers, better match with products/services
- Process innovation: benefits passed on to consumers in the form of lower prices and/or higher quality (including fraud prevention, better stratification of risk).

- Limited empirical work showing impact of data use on firm performance
- Limited work evaluating benefits to consumers from targeted advertising.

Barriers

- Consumer awareness and engagement
- Indirect network effects (characteristic of 'platform' markets, tend to lead to concentration)
- Existing market power
- Asymmetric information
- Externalities: positive (providing access to my data may benefit others), negative (low investment in security can put others at risk).

- Good evidence on lack of consumer information/engagement
- It is generally accepted (including by competition authorities) that indirect network effects lead to concentration.

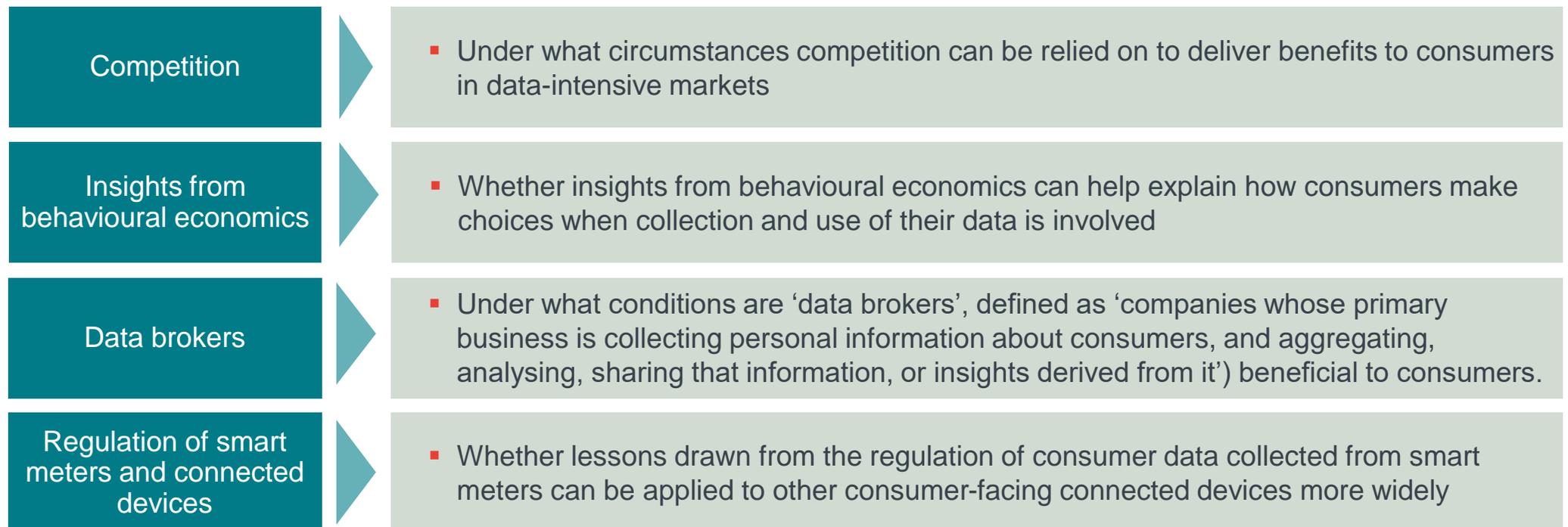
Costs

- Loss of privacy
- Fraud (financial costs)
- Higher prices/lower quality:
 - Driven by reduced competition
 - Driven by price discrimination
- Nuisance costs of advertising and on-line services (costs on attention).

- Few publications and no or limited evidence on higher prices/lower quality
- Anecdotal evidence of fraud/loss of privacy
- Limited or no evidence on 'attention costs'.

This review investigates under which conditions benefits and costs to consumers are likely to materialise

- Our initial scan of the literature found that the scale of benefits and costs of data use to consumers has not been quantified in a systematic way
- However, the literature offered insights on how businesses act in markets where data are important (specifically, how they compete – or may not compete – with each other), how consumers decide how to behave when their privacy is potentially at risk, and how Government has dealt with the collection and use of consumer data in regulated markets
- Therefore, we agreed with Which? that the review would investigate in detail three aspects of business and consumer behaviour in data-intensive markets, and provide a case study of a market where consumer data are collected outside of now ‘traditional’ connected devices (computers, smartphones, tablets). The four areas this review focusses on are:



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Focus on competition: key findings

- 1 Data-intensive markets are often 'platforms' (e.g. social media). Platform markets tend to be concentrated due to network effects. But concentration does not necessarily imply lack of competition – the literature points to cases where platform markets are more likely to be competitive.
- 2 It is not clear whether companies that have access to large amounts of consumer data can use them to prevent potential competitors from entering the market. We analysed the arguments made in the literature and suggest a list of conditions that may lead to greater concern for competition.
- 3 In general, the literature has started to identify the ways in which the use of data requires updating existing competition analysis. This includes recognising that integration can generate efficiency benefits where data are involved. However, a consensus on the new issues has not yet emerged.
- 4 The literature suggests that even in competitive markets, consumers may not have meaningful choices over privacy. Consumers often know little about what data companies hold and how they use them. Moreover, a number of behavioural biases may prevent them from exercising rational choice.
- 5 Introducing privacy regulation can also affect competition, but this will depend on the type of regulation, market conditions and the types of consumers. The literature identifies different ways in which privacy can be regulated, but there is no clear consensus on which is best.

Most of the competition literature is academic and theoretical with a large focus on ‘platform’ markets

We reviewed 15 publications focusing on competition issues around consumer data:

- Nearly half of the 15 focus on multi-sided ‘platform’ markets and their characteristics. Multi-sided platforms have been defined as businesses that ‘have (a) two or more groups of customers; (b) who need each other in some way; (c) but who cannot capture the value from their mutual attraction on their own; and (d) rely on the platform to facilitate value-creating interactions between them’.¹ Social media, videogame consoles, operating systems can all be considered platforms.
- Most are published in academic journals (13 of the total 15), while two are OECD publications.
- Only one of the publications included original empirical work.

	Theme		Number of publications
1	Characteristics of platform markets		7
2	Barriers to entry in data-intensive markets		6
3	Competition policy in data-intensive markets		5
4	Consumer choice over privacy		4
5	Privacy regulation and implications for competition		8

¹ Adapted from Evans and Schmalensee (2007)

Note: the number of publications in the table above does not add up to the 15 because several publications are relevant for more than one category.

This part of the review did not include literature on algorithmic pricing as this is a significant area that Which? will be exploring as a distinct piece of work.

What are platform markets and why are they increasingly relevant?

- Platforms are intermediaries that enable buyers and sellers to interact.
- Platform markets have existed for a long time (newspapers can be thought of as such a market), but digital technology has increased their relevance, first purely on-line (as in the case of social media), and then also in the 'off-line' world (as in the case of cab-hailing applications). This trend may continue into the future.
- Platforms are characterised by network effects:
 - Direct network effects: the value of the platform to users often increases with the number of users on the same side. Social media provides again a clear example
 - Indirect network effect: users on one side of the platform (e.g. advertisers) value increases in the number of users on the other side (e.g. users on social media, Google...)
- In an on-line environment, platforms can scale up quickly, as information can be distributed with near-zero cost, transmitted perfectly and instantly.¹
- The use of consumer data is often central to platforms' business models. First, they inherently need information as input (a search query on Google, a connection on Facebook...). They also use information on consumers to improve their services and, often, to place targeted adverts that provide their main source of revenues.

1. McAfee and Brynjolfsson (2017)

Even though platform markets are likely to be concentrated, consumers may still be able to choose...

Network effects drive concentration in platform markets...

- In platform markets, there are 'indirect' network effects: users on one side (e.g. advertisers) value a platform (e.g. social media) more when there are more users on the other side (people with active accounts on the platform).
- This typically makes platforms 'winner take all' markets: only a few platforms can attract a sufficient number of users to stay in the market.

...But the following factors, reviewed in Evans and Schmalensee (2015), can give consumers the ability to choose between different platforms:

	Findings	Examples
Multi-homing (consumers using more than one platform in a particular market)	<ul style="list-style-type: none">▪ When consumers multi-home, each firm has access to its competitors' customers and can compete more effectively for these customers compared to a single-homing situation.▪ Single-homing on one side can lead to market power on the other side. If only one platform has access to a group of users, it could be able to charge high prices to firms who want to advertise to those users.	Anecdotal, there is less multi-homing in transport (at least in the UK, Uber is much more popular than other platforms) and internet search, but more multi-homing in food delivery services and apps, card payment methods.
Product differentiation	<ul style="list-style-type: none">▪ It is possible for multiple providers to exist when they offer products that are at least somewhat differentiated.	Several job search platforms coexist: some are general (LinkedIn, Indeed) and some specialised (Econjobs, Mediabistro).

Note: we did not perform a comprehensive review of the literature on competition in platform markets as we were specifically interested on the implications of data use in these markets.

...And there can still be competition, at different stages of the evolution of the market

Competition to serve all or most consumers in a market

- Since platforms are often 'winner take all' markets, when a new platform market emerges firms have incentive to compete fiercely, as the 'winner' will end up serving all or a large share of the market.
- This is particularly strong where there is no multi-homing and limited or no differentiation. Multi-homing and differentiation make it more likely that the market will always be served by multiple providers, and therefore that the 'prize' for competing fiercely in the market may be smaller.

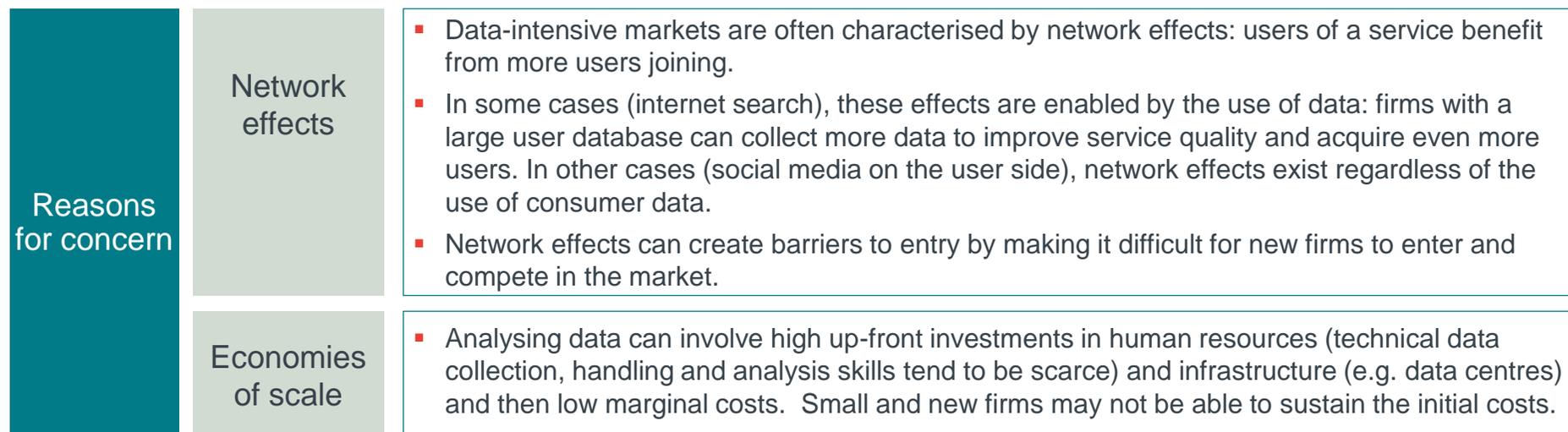
Competition on other sides of the market

- Since platform businesses have multiple sides, they can face competition on several different dimensions. Therefore, a platform company may not be constrained by competition on one side, but still face significant competition on other sides of the market – the market may be characterised by 'asymmetric competition'.
- For example, Facebook may face greater competition for application developers (who can develop games for Facebook, or as apps for Android/Apple iOS/other mobile systems) than for social media users.

Can having access to consumers' personal data form a barrier to entry?

There are reasons to be concerned...

- Existing companies with large market shares can have access to data on consumers that have used their services or purchased their products. As described in previous sections of this report, the analysis of large datasets has the potential to drive innovation and productivity, with possible benefits for consumers.
- However, there are also concerns that this can prevent potential competitors from entering into a market. In this scenario, existing firms ('incumbents') with large market shares will often have an advantage over new entrants, who could not rely on a similar amount of information on consumers.¹
- The economic literature recognises that there are reasons to be concerned that data could enable incumbents to establish and maintain market power. However, there are also countervailing reasons to think that access to large datasets, in itself, would not be sufficient to prevent new entrants from competing in the market.
- We present reasons for concern below, describing countervailing arguments on the following slide.



¹ See for example <https://hbr.org/2015/03/data-monopolists-like-google-are-threatening-the-economy>
Sources: OECD (2016a, 2016b), Stucke and Grunes (2016), Evans and Schmalensee (2015)

...And reasons to think concerns may over-estimate the value of large datasets

Offsetting arguments	Limits in network effects	<ul style="list-style-type: none">▪ Larger datasets may enable better analysis to take place – and may be indeed particularly valuable where they are used to train machine learning algorithms. However, it is not clear to what extent increases in the size of a dataset over a certain level can really improve the quality of the analysis generated using that dataset.▪ Network effects may be more important in the development phase of a new product (e.g. generating an effective search algorithm) than in following phases.
	Decreasing costs	<ul style="list-style-type: none">▪ Collecting, storing and analysing large amounts of data can require significant investment, but the cost of the required technology is falling quickly over time.
	Data availability	<ul style="list-style-type: none">▪ The same piece of information on a given consumer can be available to many different firms. For example, one's gender may be known to a large number of companies, from social media to any firm that requires registration to use a service.▪ Moreover, even where a piece of information is not known, it may be inferred from other data points. For example, one's interest in specific goods (e.g. ties or sports) may signal gender relatively precisely. Advances in machine learning and artificial intelligence may expand analysts' ability to infer information from data.¹▪ Data brokers may also help new entrants gain information on customers in a given market.
	Predictive power and analytics	<ul style="list-style-type: none">▪ Access to data will only be crucial where this enables a firm to understand consumers' preferences and predict their behaviour in ways that are not feasible otherwise. Not all pieces of information will have this predictive power.▪ Using large datasets can only confer an advantage where coupled with the necessary analytical capabilities.

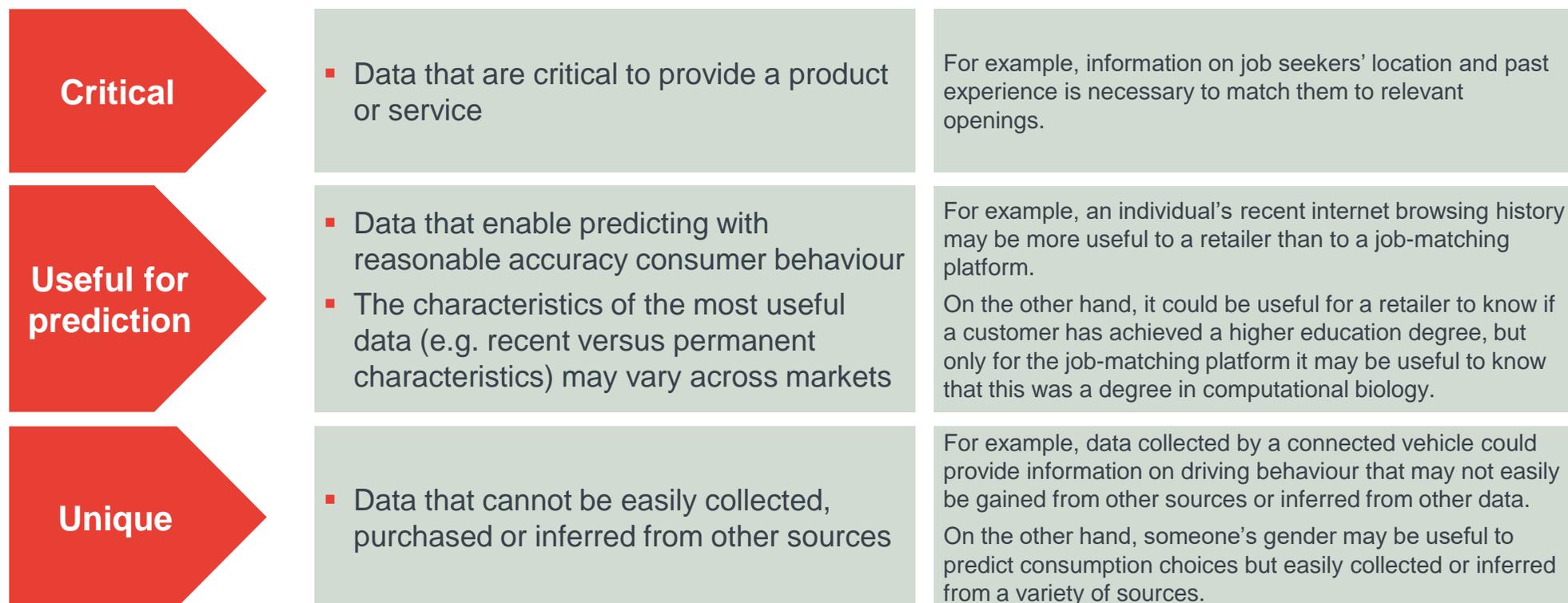
¹ See Tucker (2017) for a recent discussion. Clearly these advances present issues for privacy, which we do not discuss in this section of the report. For example, most recently, the claim of researchers at Stanford University to have trained an artificial intelligence neural network to recognise sexual orientation from photos has sparked considerable debate.

Sources: OECD (2016a, 2016b), Stucke and Grunes (2016), Lambrecht and Tucker (2017)

The following conditions may lead to greater concern about data being a barrier to entry

Based on our reading of the literature, we can formulate a hypothesis on the conditions where data may be more likely to form a barrier to entry.

Our hypothesis is that there may be basis for greater concern where a firm in a dominant position has access to data that are:



This hypothesis could be tested and refined through engagement with experts and stakeholders in industry, academia and regulators.

An emerging literature describes the areas in which competition policy should be updated to deal with platform markets and consumer data

Assessing market power

- Typically, a firm is considered to have market power if it can increase its prices by a small but significant amount and not lose many customers. In a platform market, a small price increase on one side may only turn away a few customers. However, feedback effects may make this increase unprofitable: the loss of customers makes the platform less attractive for the other side, which in turn makes the platform less attractive for the initial side.
- Typically, competition drives prices down to marginal cost (the price of producing an extra unit). Firms with market power can set prices above marginal costs. However, in digital markets fixed costs are high (e.g. designing a platform), while marginal costs are negligible and therefore not a good benchmark for prices.
- It is difficult to compute market shares (as there are many different user sides) or a value-based market share (since zero prices do not reflect the value received by the user).

Mergers

- Mergers in data-intensive markets can increase efficiency, due to economies of scale and scope in data analysis, and due to indirect network effects in multi-sided platforms.

Exclusionary conduct

- Exclusive dealing contracts could be used by incumbent companies to prevent a more efficient competitor from entering the market, by making it impossible for the competitor to reach enough customers on one side of the market.
- In some cases, exclusive dealing can facilitate entry by allowing entrants to offer differentiated and exclusive products that the incumbent cannot (for example, a video game designed exclusively for the entering platform).
- Low marginal costs also make it difficult to assess whether a platform is charging unprofitably low prices for the purpose of excluding competitors ('predatory pricing'). To test this, prices are typically compared to marginal costs, but as described above this is unlikely to be a meaningful comparison in many digital markets.

Coordinated behaviour

- The welfare effects of collusion are harder to assess given the number of parties involved in platform markets.
- Interlinked prices may make it more difficult for firms to collude: there are multiple prices to be agreed; indirect network effects increase the gains from price-cutting and make collusion harder to sustain.

...But a new consensus on what updated policy should look like has not yet emerged

Source: Evans and Schmalensee (2015), Stucke and Ezrachi (2015), Stucke and Grunes (2016) and OECD (2016a, 2016b)

Does competition allow consumers to exercise choice over the privacy and security of their data?

- So far, we have discussed whether markets that feature prominently the use of consumer data are less likely to be competitive than other markets. What we have gathered from the literature is that this is not necessarily the case. However, platform markets will tend to be concentrated, and there are conditions under which one might be more concerned that a dominant firm's use of data could form a barrier to entry.
- For privacy outcomes, then, the next question is: does competition allow consumers to exercise choice over their privacy?
- The available evidence so far suggests that this may not be the case. Consumers can choose to protect their privacy by not using particular services, or adopting privacy-enhancing technology (using advertisement blockers on-line, setting their internet browsers to send do-not-track requests). But we do not observe many cases of firms competing on the level of privacy they provide, or providing services differentiated in terms of their privacy content.
- Three factors may explain why this is the case:
 1. Consumers are not informed about the use of their data, and therefore about the privacy element inherent in many of their purchasing choices and on-line behaviour
 2. Even if consumers are informed, they typically do not weigh benefits and costs of their privacy choices rationally.
 3. Consumers do not want to protect their privacy, despite statements to the contrary in surveys and interviews
- If consumers do want to be protected, factors 1 and 2 (both of which find some support in the literature) suggest that regulation may be necessary – at least to provide a minimum level of protection to consumers. Acquisti et al. (2015), who reviewed the literature on privacy behaviour around personal data, argued that policy should provide a level of protection over and above transparency requirements and user control over what to share.
- The introduction of regulation, in turn, may have positive or negative consequences for the level of competitiveness in affected markets.
- The following slides list the types of regulation and their likely effects on competition considered in the theoretical literature.

If competition is not sufficient, what regulatory mechanisms are possible?

Customer consent requirements

- Broadly, customer consent can be required through:
 - Specific consent – requires customers to consent to their data being used for a particular website or service provider
 - Global consent – consumers provide a ‘blanket’ consent to share information with groups of companies.
- Consent can be required through opt-ins or opt-outs. To the best of our knowledge, the literature does not investigate how consequences for competition change between these two cases.

Privacy guarantees

- Privacy guarantees are tools that obscure personal information, such as aggregation, anonymisation, and pseudonymisation to protect the identity of individuals within datasets (Jentzsch 2016).
- Privacy guarantees can also be used as a commitment device to ensure that privacy levels are maintained after there is a merger (Jentzsch 2016).

Portability rights

- Portability rights ensure that customers are able to move their data across different services or platforms – for example, users being able to export their search results and other personal data from one search engine to another (OECD 2016a, 2016b).¹

Limitations on customer data storage

- The length of time for which a customer’s data can be stored after a person’s consent has been acquired is relevant because access to a history or time series of customer data (e.g. a time series of customer searches or web browsing behaviour) can be used to de-anonymise datasets (Chiou and Tucker 2017).
- Reducing the time for which firms can store and use customer data may help to alleviate privacy concerns (Chiou and Tucker 2017).

1. Note that implementing portability could be more complex in cases where data relate to more than one individual (e.g. information on connections in social media).

Privacy regulation may hinder or foster competition, depending on the specific mechanisms adopted

A general principle discussed in the theoretical literature is that rules which in principle apply equally to every firm may have a disproportionate effect on smaller and newer (or larger and more established) organisations.

The table below summarises the mechanisms discussed in the literature for a number of regulation options.

Type of regulation	Likely competition impact	Mechanism	Source
Specific consent (most common)	Unclear	<p>Driver of negative effect: the cost of obtaining consumers' consent adds to investment required to enter a market</p> <p>Driver of positive effect: Opt-in consents can incentivise firms to compete on privacy. Limiting detailed opt-in consent requirements to only dominant firms could prevent the opt-in from creating a barrier to entry for smaller firms.</p>	Campbell et al. (2015)
Global consent	Neutral	Less likely than specific consent to require investments from smaller firms or new entrants.	Cambell et al. (2015), Newman (2014)
Standardised privacy agreements	Positive	Standard easy-to-follow agreements may reduce the costs to consumers of consenting and so reduce the cost barriers to entry for new firms.	OECD (2016a, 2016b)
Privacy guarantees	Positive	Tools that obscure personal information create uncertainty about customer switching intentions and introduce competition.	Jentzsch (2016)
Portability rights	Negative	Data portability aims to enable consumers to easily switch between providers. But when portability rights apply to all companies in the same way, the cost of developing processes to implement portability could be harder to bear for smaller and younger businesses.	OECD (2016a, 2016b)
Limitations on customer data storage	Neutral	Reducing allowed storage time of search data has been shown to have little impact on the accuracy of search engine results. Therefore this does not appear to affect the competitive advantage of firms in the market. ¹	Chiou and Tucker (2017)

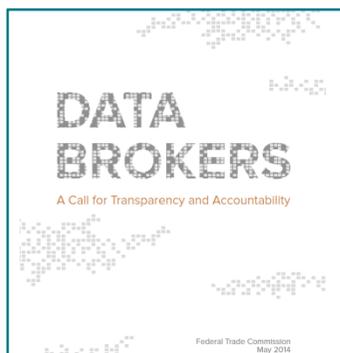
1. However, limitations on storage may affect performance in other contexts – for example, in the development phase of a service, where data are used to develop predictive tools.

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Focus on data brokers: key findings

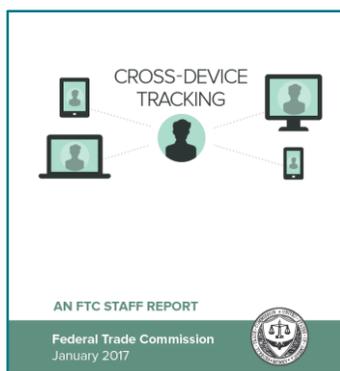
- 1 Data brokers have been defined as ‘companies whose primary business is collecting personal information about consumers, and aggregating, analysing, sharing that information, or insights derived from it’.
- 2 However, this definition could also apply to third-party advertising companies, analytics companies, and potentially to media platforms. The role of data brokers within the consumer data landscape has not been analysed yet.
- 3 Data brokers use a combination of individual and aggregate data, from government and commercial sources, to provide marketing services, risk mitigation products and consumer services (e.g. identity theft protection). Data from commercial sources include what is gathered from (third-party) cookies placed on the websites of companies that use brokers.
- 4 In the United States, data brokers are used by companies across a wide range of markets, including automotive, insurance, media, retail and other data brokers, among others.
- 5 Most available information on data brokers is included in a report published by the United States’ Federal Trade Commission (FTC). Anecdotal evidence suggests that the role of brokers is similar in the UK, but there is very little UK-specific evidence.

Our review in this area has relied on two FTC reports, and drawn on other areas of the literature



Report published by the FTC in May 2014, relying on information provided by nine data brokers¹ to the FTC and on publicly available information. The report describes:

- The sources of data used by data brokers
- The products and services offered by brokers
- Characteristics of the industry
- FTC recommendations for legislation and best practices.



Report published by the FTC in January 2017, based on an earlier workshop held by the FTC. This report describes technology employed to track users across different devices ('cross-device tracking'), its benefits and the challenges it poses, and provides recommendations for transparency, providing choice to consumers, use of sensitive data, data security.

This publication does not mention data brokers explicitly, but tracking consumers across devices is part of the offer of at least some data brokers.² This report was then useful to understand the wider context.



We also drew on insights from the wider economic literature, including the following areas:

- The impact of tracking (e.g. Johnson 2013)
- On-line advertising (e.g. Evans 2009)
- The economics of information security and on-line crime (e.g. Moore et al. 2009).

We have also reviewed the websites and annual reports of two of the largest data brokers: Acxiom and Experian.

1. Acxiom, Corelogic, Datalogix, eBureau, ID Analytics, Intelius, PeekYou, Rapleaf, Recorded Future.

2. See for example <https://www.acxiom.com/what-we-do/abillitec-people-based-marketing/>

Data brokers offer marketing products, risk mitigation products and consumer services

Marketing products

- Direct marketing: providing to a firm additional information on its customers, including 'onboarding' data (that is, linking data across sources, including from the 'off-line world')
- On-line marketing: using a combination of data held by the customer firm and data held by the broker to target people on-line
- Marketing analytics: providing insights on how to target consumers, and on marketing strategies.

Risk mitigation products

- Verifying customers' identities
- Detecting fraud
- Providing information for credit ratings.

Consumer services

- People search – to find old acquaintances, researching competitors...
- Identity theft protection services
- Credit matching – helping consumers find credit cards, loans and mortgages they are more likely to be accepted for.

Sources: FTC (2014), Acxiom and Experian's annual reports and websites

Data brokers gather individual and aggregated data from several sources

Government sources

- Aggregated: data on characteristics of local neighbourhood from census, survey or administrative data
- Individual: licence registrations, open electoral register.¹

Commercial sources

- Other data brokers
- Retailers (e.g. data collected by Datalogix – now part of Oracle Data Cloud – on off-line purchases)²
- Brokers' customer companies can provide information on the consumers they have interacted with
- Cookies or other tracking technology placed on websites of brokers' customer companies.

Other data available on-line

- Information provided by individuals on social media, blogs, other websites
- Information from other media (e.g. newspaper articles).

¹ In the UK, information included in the open register can be sold for commercial purposes. Registered voters can opt out from inclusion in the register. Source: <https://ico.org.uk/for-the-public/electoral-register/>

² <https://techcrunch.com/2013/04/25/datalogix-offline-purchase-data/>

Other sources: FTC (2014)

What makes data brokers unique, compared to other players in the digital marketing and advertising landscapes?

The FTC defines data brokers as ‘companies whose primary business is collecting personal information about consumers from a variety of sources and aggregating, analysing, and sharing that information, or information derived from it, for purposes such as marketing products, verifying an individual’s identity, or detecting fraud’, and adds ‘Significantly, data brokers typically collect, maintain, manipulate, and share a wide variety of information about consumers without interacting directly with them’.

But does this always allow us to distinguish clearly brokers from other types of companies?

Linking data across different sources?

- This is possibly a key feature of brokers – but it is also an inherent objective of firms that help companies track consumers across the different devices used (phone, computer, tablet...).¹ It is not clear whether all firms that offer cross-device tracking should be considered data brokers (e.g. this may include other firms in the digital marketing space).
- The linking of data on off-line behaviour, specifically, is more likely to be unique to brokers.

Not having a direct relationship to consumers?

- This is also true of many other business-to-business players in digital marketing, who use data on consumers but do not necessarily interact directly with them.
- Firms that have a direct relation to consumers (e.g. any company that provides a service on-line) may also collect data without consumers necessarily knowing, through cookies and other tracking technology.

Helping firms target consumers?

- This is clearly not specific to brokers, but rather a key objective of digital marketing and digital advertising in general.
- Some of the largest digital technology firms, including Facebook and Google, offer this to their business customers.

¹ Cross-device tracking can be achieved through several different strategies, including matching cookies related to different devices (‘cookie syncing’).

Data brokers enable more accurate targeting, and the impact of this on consumers is unclear

- Data brokers have gained attention because of the ways in which they collect and share consumer data. There has been less discussion of why firms use data brokers, and the impact of this on consumers.
- Given evidence on the services provided by brokers, it looks reasonable to conclude that brokers aim to let firms target consumers (current and potential customers) more effectively.
- A recent strand of economic literature models the impact of using data for targeted advertising and pricing.
- In general, this literature concludes that targeting can be beneficial for consumers, if consumers are aware that their data are being used, and that interacting with a firm (for example, making a purchase) implies revealing some information about them.
- Johnson (2013) provides interesting analysis including consumers choice of whether to block advertisement (through the use of browser add-ins, subscription to do-not-track programmes, or other means). In this model, improvements in targeting technology that make ads very precisely targeted lead to less blocking, and to higher consumer welfare. However, this depends crucially on the assumption that the nuisance cost of advertising to consumers does not increase with the precision of targeting (while one might imagine that consumers may be put off by targeting that is in some sense too precise).
- Without a deeper analysis of the theoretical frameworks provided by this literature, it is unclear whether it matters *how* firms are accessing the information that allows them to target advertising and/or personalise pricing.
- However, it is possible that, in the presence of brokers, it may be more difficult for consumers to anticipate the use of their data and the consequences of their actions. In other words, it may be harder for consumers to be sufficiently 'sophisticated' in the sense required by these models for targeting to benefit them.
- Again, this point is not necessarily specific to brokers only, but it may also apply to other cases of data collection and use which consumers are less likely to be aware of.

The economic literature has not explored the role of brokers explicitly, but there are studies focusing on ‘data intermediaries’

- The CMA defines intermediary [data] markets as those where ‘a variety of firms buy and sell consumer data and use other sources of data to gain insights about a range of different consumers’ whose activities include, for example, the supply of targeted advertising.¹
- According to an Analysis Mason report prepared for Ofcom, data intermediaries or ‘infomediaries’ ‘help other parties [...] collect, store, aggregate, combine and analyse customer data’, and ‘help manage customer data and make sense of it through analytical techniques’.²
- A theoretical literature analyses the incentives of data intermediaries. Two groups of findings can be gleaned from this literature without a specific focus on it:
 - De Corniere (2015) explains why many intermediaries engage directly in data collection (they are vertically integrated upstream) and why there is sharing of data among intermediaries:
 - Vertical integration helps solve a problem of coordination between collection and analytics (a ‘hold-up’ problem). If a firm invests in analytics, this makes data more valuable for it. Without integration, this means a data provider can charge more to sell data to the analytics firm. This discourages investment in analytics, in a vicious cycle.
 - When two intermediaries exchange data, this generates efficiency gains for both, as they can exploit economies of scale in the data.
 - Several papers (e.g. Bergemann and Bonatti 2015) discuss the pricing strategies of data intermediaries, and argue that it may be profitable for a monopolist intermediary to disclose less information than what they hold to their customers (other firms). However, the limited evidence available suggests that there are several data brokers competing in this market. This finding then may apply to other types of intermediaries (e.g. platforms that provide advertising on one side and services to consumer on the other) more than to data brokers.

1. CMA (2015)

2. Analysis Mason (2014)

An open question: how strong are brokers' incentives to invest in information security?

- According to the FTC, a number of brokers provide risk mitigation services, helping customers prevent fraud.
- Experian and possibly others also provide identity theft protection services to consumers.
- A question that – to the best of our knowledge – has not been explored is whether brokers and other intermediaries have similar, stronger or weaker incentives to invest in information security compared to consumer-facing companies.
- Moore et al. (2009) and Anderson and Moore (2006), among others, document that economic incentives are important in determining the prevalence of on-line crime, and the speed with which crime is tackled. For example, they summarise research reporting that phishing websites (which 'impersonate' legitimate websites to get users to enter their personal information) are removed within hours on average, while other types of illegal websites are on-line for much longer. This is linked to the fact that a phishing website typically impersonates a specific service or company, giving that company a strong incentive to find and remove the website as quickly as possible.
- Along similar lines, research on information security could analyse whether particular types of firms (in this case, brokers) have lower incentives to prevent personal data breaches.
- In Europe, the General Data Protection Regulation (GDPR) will introduce a requirement to report security breaches to relevant supervisory authorities – thus limiting the risk that breaches go under-reported. But the impact of a breach on a company's reputation, and ultimately on its profits, may vary.
- On the one hand, data brokers may be less exposed to reputation risk from personal data breaches because they do not interact with consumers directly. On the other, their entire business model is centred around the collection, aggregation and analysis of data – so their incentives to prevent breaches may be just as strong if not stronger than in other firms that hold consumers' personal data.

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Focus on smart meters (SMs) and connected devices (CDs): key findings

- 1 The literature on the use of consumer data from CDs is limited. There have been some reviews of likely benefits and costs. These reviews suggest that benefits are likely to stem from tailored solutions and efficiency gains. Costs could arise in the form of possible privacy and security losses.
- 2 The UK Government has estimated that SM data will deliver net benefits (£47 per household) to consumers. The SM roll-out is still in progress.
- 3 The benefits of SMs should mainly arise from reduced energy consumption, lower intraday prices and lower carbon emissions. Costs include the cost of installation (financial cost, passed on to consumers in their energy bills; time required for the installation process) and the potential loss of privacy.
- 4 Main reported barriers to SM adoption are the perceived inconvenience of the installation process, trust and privacy concerns and behavioural biases.
- 5 The government has established a Central Hub (the Data Communication Company) to route the data from SM to energy suppliers, network operators and third parties, and it has given consumers significant control over the level of data that companies can access.

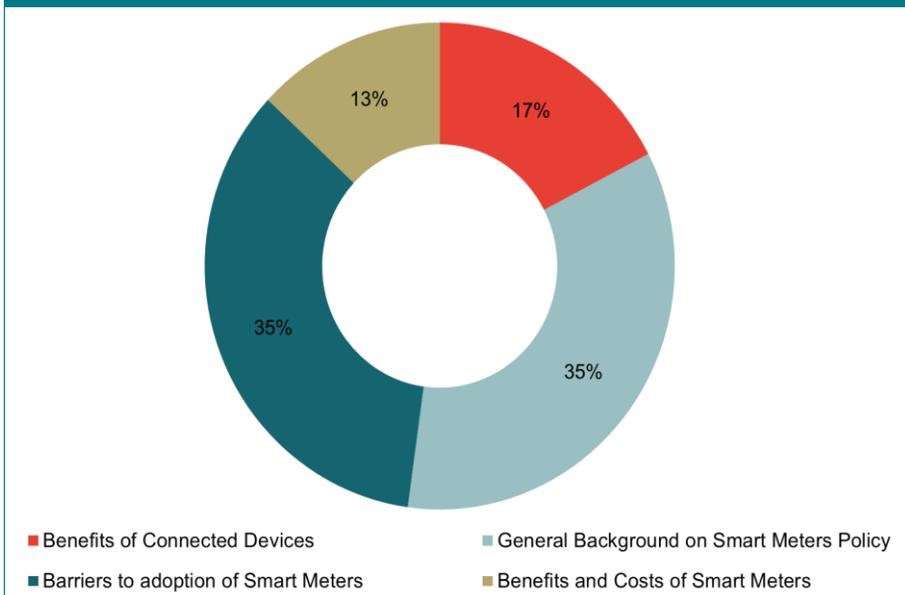
Note: we define the CD space as the set of consumer-facing applications and services driven by data collected from devices that sense and interface with the physical world.

We have reviewed in detail several sources of evidence on CDs and SMs

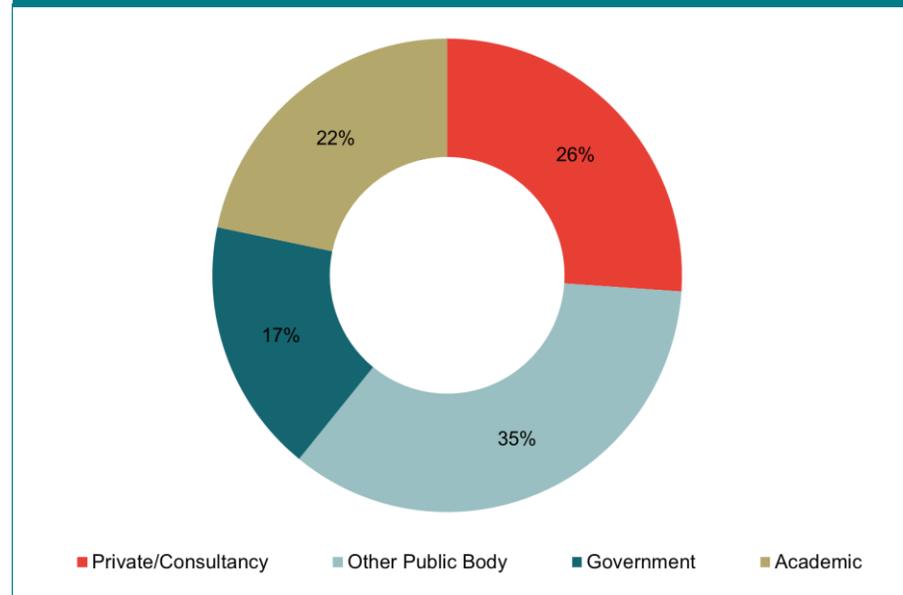
Overview of evidence reviewed in detail

- We have reviewed in detail a wide range of material from academic, private and public institutions (23 publications in total). Public bodies account for the majority of the total evidence base. This is not surprising, given the extent of public involvement in the implementation of smart metering.
- Most of the evidence base comes from an analysis of barriers and general background information, while a smaller proportion is related to the benefits.
- This is determined by the fact that the government has published two very detailed impact assessments of costs and benefits. Conversely, the evidence on barriers and on the general background on policy comes from a wider range of sources.

Breakdown of evidence by theme (% of publications)



Breakdown of evidence by type (% of publications)



We focus on CDs – applications of Internet of Things (IoT) technology that rely on consumer data

The difference between IoT applications and CD

- According to the OECD (2016), the IoT refers to an ‘ecosystem in which applications and services are driven by data collected from devices that sense and interface with the physical world’.
- The IoT will have applications in virtually every sector of the economy. Within this review, we focus on IoT applications which rely heavily on consumer data and we define them as consumer connected devices, in short connected devices (CDs).

Sector	IoT potential impact	Importance of CDs	Examples of CDs
Healthcare	Connected health, tele-monitoring	High	Wearable devices allow tele-monitoring of patient behaviours and symptoms
Transport	Self-driving cars, other automation for passenger transport	High	Uber-like platform services
Logistics	Post/delivery services; supply chain management	Low	Applications more relevant for businesses
Retail	Automated management of stock, personalised shopping experience	High	Apple Ibeacon allows retailers to target consumers with offers when they enter shop
Finance	Personal finance, increased sophistication of trading mechanisms	Medium	Fraud-detection systems relying on multiple devices
Manufacturing	Increased efficiency of production processes	Low	Applications more relevant for businesses
Agriculture	Monitoring of and automated reaction to environmental conditions to maximise yields	Low	Applications more relevant for businesses
Utilities	Increased efficiency of usage through smart meters, smart grids, smart buildings	High	Connected home services

The use of consumer data in CDs has potential benefits and costs for consumers

Available evidence
on benefits of IoT and
CDs

- The OECD (2016) has published a review of the challenges and benefits of IoT applications. We have focused on those related to CDs.
- A number of studies, including McKinsey (2015), Accenture and Frontier Economics (2015), have attempted to quantify the potential benefits of IoT in terms of productivity improvements. However, there has not been an attempt to systematically quantify the benefits and costs of CDs for consumers.

Consumer benefits from CDs

- **New products and tailored solutions:** CDs allow companies to offer products and services tailored to each user. For instance, they could enable the implementation of personalised medical treatments.
- **Efficiency:** data from multiple/device users participating in the market allow consumers to manage resources more efficiently (e.g. energy management with connected home solutions).

Barriers/enablers

- **Trust:** the growth of CDs and the realisation of the benefits will depend on the extent to which potential users trust the technology and the products and services that rely on it.
- **Interoperability:** a fragmented ecosystem with non-interoperable technologies could undermine the efficiencies achieved through economies of scale or could potentially allow some players to exercise market power.

Consumer costs from CDs

- **Digital security:** digital security incidents involving CDs can have physical consequences. For instance, a vehicle might stop responding to the driver's actions, as a result of external intervention.
- **Privacy risks:** CDs will increase the amount of data points that can be collected, aggregated and analysed not only by providers but potentially also by third parties.

SMs may offer insights into the use of consumer data from CDs

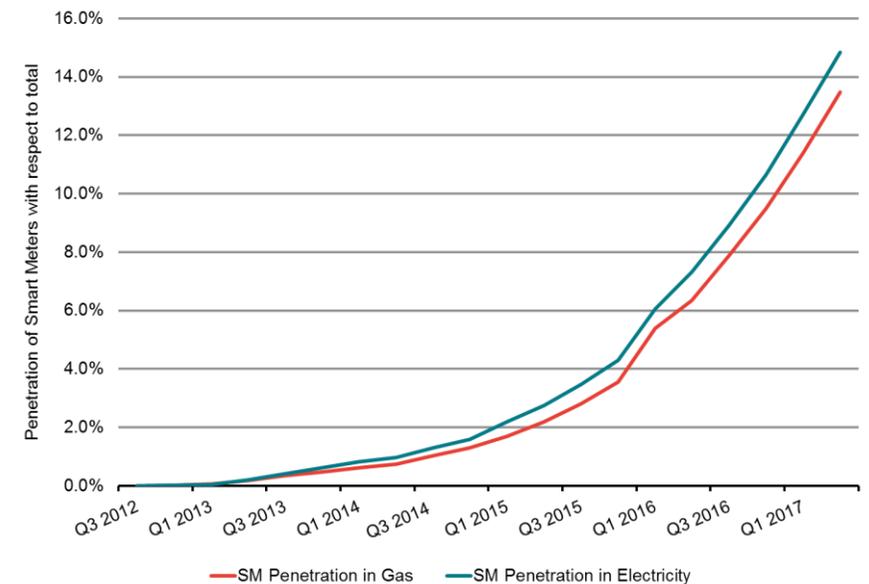
Reasons to use SMs as a case study

- **SMs themselves** allow exchange of information between consumers and suppliers. Electricity SMs are installed in over 14% of UK households, and there are plans to roll them out to all homes and small businesses in Great Britain by the end of 2020.
- **Availability of information:** the government has conducted a systematic cost-benefit analysis of the adoption of SMs.
- **Regulatory and physical infrastructure:** the government has intervened to design an ad hoc regulatory framework and physical infrastructure to monitor the access to consumer data. Companies will access data routed by a Central Hub (the Data Communication Company).

Background information on SMs

- SMs are devices which allow communication between houses and utility suppliers – sending information about energy use to suppliers, while also receiving information like current tariff rates.
- SMs are connected to in-home displays which allow consumers to monitor their energy usage and costs as they go.
- SMs are being rolled out in two phases by energy suppliers:
 - The foundation phase began in 2013 with the roll out of SMETS 1 (Smart Metering Equipment Technical Specification) meter
 - The rollout of SMETS 2 meters has been delayed several times since 2015 and remains subject to uncertainty.
- SMETS 1 meters communicate directly with energy suppliers, and they might stop working if the consumer switches supplier.
- SMETS2 should enable full interoperability, because they will send data to the Central Hub.

Penetration of SMs over time



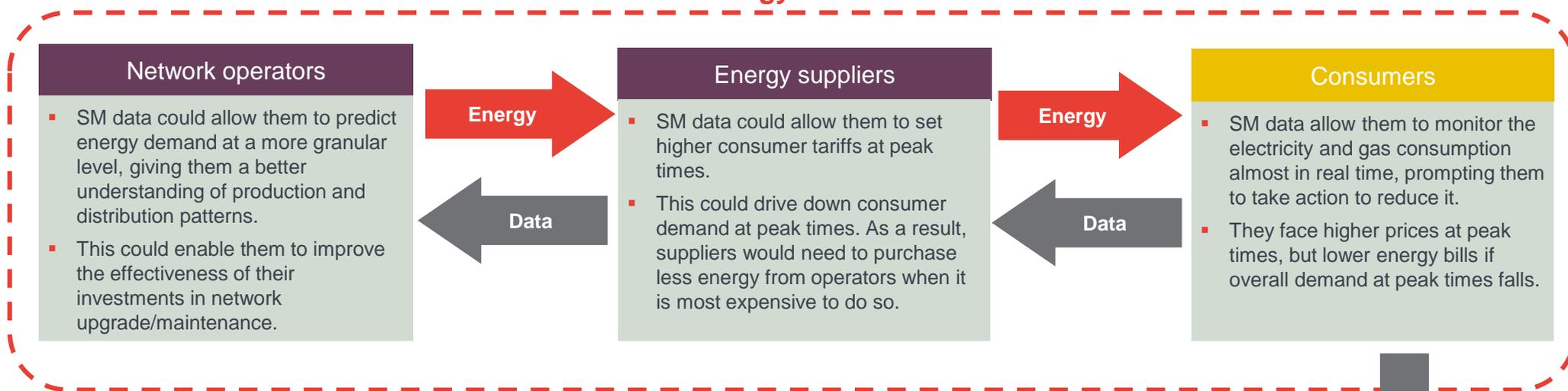
The data from SMs can be potentially valuable to consumers, energy suppliers and third parties

Consumer data can be potentially beneficial for consumers and companies

The data value chain of SMs involves four different types of players (that derive benefits from SM data):

- **Consumers:** buy energy from suppliers, send (receive) data on consumption (prices) from SMs
- **Energy suppliers:** buy energy from operators, receive (send) data on consumption (prices) to consumers
- **Network operators:** transport the energy to suppliers and can access anonymised/aggregated SM data
- **Third parties:** these are external players interested in SM data, directly from consumers or indirectly from energy suppliers.

Energy market



Network operators

- SM data could allow them to predict energy demand at a more granular level, giving them a better understanding of production and distribution patterns.
- This could enable them to improve the effectiveness of their investments in network upgrade/maintenance.

Energy suppliers

- SM data could allow them to set higher consumer tariffs at peak times.
- This could drive down consumer demand at peak times. As a result, suppliers would need to purchase less energy from operators when it is most expensive to do so.

Consumers

- SM data allow them to monitor the electricity and gas consumption almost in real time, prompting them to take action to reduce it.
- They face higher prices at peak times, but lower energy bills if overall demand at peak times falls.

Third parties

- SM data allow lifestyle information on the users (time spent at home, potentially the usage of different appliances) to be inferred.

Background: peak demand

Electricity (unlike gas) is not easy to store. This means that supply needs to be equal to demand pretty much all the time. Reducing demand at peak times (e.g. 6 pm) can significantly reduce the costs of running the network, potentially leading to lower prices for consumers.

The UK Government has estimated future benefits and costs from adoption of SMs

Available evidence on benefits, costs and barriers of SMs

- The Department for Business, Energy and Industrial Strategy (BEIS) (2016) has published a systematic assessment of benefits and costs of SMs, estimating that SMs are likely to generate net benefits to the UK for a present value of £5.7 bn.
- DECC (2014) has also conducted a comprehensive survey of key barriers to SM adoption.
- Other studies (from academics, private companies and public sector bodies) have offered evidence on benefits, barriers and costs.

Consumer benefits from SMs

- **Lower energy bills:** BEIS predicts savings of £11 per household in 2020 and £47 per household in 2030¹
- **Reduction in carbon emissions:** through lower energy consumption
- **Ease of switching:** due to the lack of meter readings (non-quantifiable)
- **More accurate and timely billing services:** due to the lack of meter readings (non-quantifiable).

Barriers/enablers to adoption

- **Circumstantial barriers:** some consumers (e.g. renters) are less likely to support installation
- **Hassle:** consumers might perceive the installation as an inconvenience
- **Privacy and trust:** consumers do not always trust energy suppliers with their data
- **Behavioural & informational barriers:** consumers might not be informed about benefits or might suffer from behavioural biases when considering benefits and costs.

Consumer costs from SMs

- **Installation costs:**
 - **Financial:** initially borne by suppliers, eventually passed on to consumers
 - **Time:** consumers need to be at home for the installation for about 3 hours
- **Security:** hackers might be able to exploit lifestyle information to their advantage (non-quantifiable).

The government believes that SMs will deliver savings to consumers in their energy bills. However, these results depend on adoption and usage patterns.

¹ On average, across pre-payment and credit meters.

Benefits from SMs: review of the existing evidence

Energy savings

- The evidence gathered by the House of Commons Science and Technology Committee (HCSTC 2016) suggests that adoption of SMs could lead to a 2-3% reduction in energy consumption in the UK. In its assessment, the government has assumed an average reduction of 2% in gas and 2.8% in electricity.
- These figures could potentially increase if connected home devices can automate energy-saving behaviour (e.g. lights switch off automatically or appliances function at the most convenient time).

Lower prices

- Operators in both gas and electricity should achieve operational costs savings, due to a reduction in customer service needs. These could be passed on to consumers.
- In electricity, the introduction of differential pricing throughout the day (through time-of-use tariffs) could lead to lower prices for some consumers. If peak demand falls, there might be some additional cost savings resulting from lower network security costs.

Reduction in carbon emissions

- Lower consumption of gas and electricity should lead to reduced carbon emissions and an improvement in air quality levels.
- In electricity, the reduction of peak demand could reduce the reliance on fossil fuels and an increase in the use of renewable energy sources. This is because peak demand is often met through fossil fuels (as they can offer prompter generation of the extra capacity required).

Ease of switching and more accurate/timely billing

- The elimination of meter readings will lead to more accurate and timely billing services. It should also facilitate the switching process between energy suppliers.
- In practice, first generation (SMET1) meters are not guaranteed to work effectively when the consumer switches supplier. This should not happen with the second generation meters (SMET2), which will be rolled out from late 2017.¹

¹ A consultation recently launched by BEIS on policy options to allow SMETS1 meters to be installed after July 2018 suggests there may be further delays in the roll-out: <https://www.gov.uk/government/consultations/the-operational-transition-of-smart-meters-including-draft-legal-text>

Costs from SMs: review of the existing evidence

Installation costs (both financial and time costs)

- A report by the by the House of Commons Science and Technology Committee (HCSTC 2016) suggests that the cost of providing SMs is being borne by consumers through their energy bills (an average of £215 per home).
- The installation of a SM is expected to take around three hours. It is generally more time consuming than for traditional meters because of:
 - the additional time spent establishing connection with the communication and data service providers
 - the need to provide advice to the consumer on energy efficiency and how to use the in-home display.
- There is quite a lot of variation in current and expected future costs for installation because of:
 - the uncertainty around future customer acceptance of SM installation
 - the number of technical difficulties that suppliers expect (for instance, it is not clear whether SMETS1 meters will be able to communicate with the Central Hub infrastructure).

Loss of security and privacy

- While SMs last 15-20 years, the encryption systems installed on them may become outdated and vulnerable to breaches more quickly.
- That SMs can potentially be switched off remotely may mean that SMs are more vulnerable to security breaches. In September 2014, security experts in Spain found that flawed code in memory chips of SMs allowed them to shut down power remotely to individual households and switch meter readings to other customers.
- There is the potential for third parties (or consumers themselves) to hack into smart meters to increase (or reduce) the energy usage measurements and bills. The same could also possibly be done with the wireless transmission of meter readings.
- A 2010 Federal Bureau of Investigation (FBI) bulletin reports that a utility in Puerto Rico estimated it lost \$400 million in annual revenue after their smart meter systems were hacked to under-record electric usage (Gunduz et al. 2015).

Barriers to adoption of SMs: review of the existing evidence

Circumstantial barriers		<ul style="list-style-type: none">Some groups are less likely to be interested in the installation of SMs. Smart Energy GB (2015) has identified some groups which require ‘specific engagement’:<ul style="list-style-type: none">older individuals (aged 75 and over)individuals with no access to internet or with low digital skillsprivate tenants (less willing to take some time off work to install a SM, due to the lower benefits).
Hassle		<ul style="list-style-type: none">The Department for Energy and Climate Change (DECC 2014) identified inconvenience (or ‘hassle’) as the second most important barrier to adoption (after ‘general lack of interest’).Research from Smart Energy GB (2016) has specified that consumers might perceive several aspects of the installation as a ‘hassle’, including engaging with energy suppliers, booking appointments and the perception that there is a hassle involved in ‘good’ energy behaviour (such as switching).
Privacy and trust		<ul style="list-style-type: none">Surveys from Smart Energy GB suggest that less than half of consumers trust their energy supplier with their data. This might affect their propensity to install SMs.Some quantitative surveys and qualitative studies suggest that privacy concerns could also prevent people from adopting SMs. However, the results depend on the framing of the question (when privacy is openly mentioned over half of people say it was a concern, but when the question is open-ended a significantly smaller proportion do).
Informational and behavioural barriers		<ul style="list-style-type: none">In the 2014 government survey (DECC 2014), ‘general lack of interest’ and ‘lack of knowledge’ were the first and third most important barriers to adoption. Awareness of SMs seems to have improved over time.In the most recent survey by Smart Energy GB (2017b) 55% of people reported having ‘detailed knowledge’ of SMs. In previous surveys (Smart Energy GB 2016, 2017a), the proportion was lower (33% in February 2017 and 30% in August 2016).¹Even if they have ‘detailed information’, consumers might be stopped by behavioural biases, such as inertia, loss aversion and discounting.

1. Note however that Smart Energy GB (2017b) results may not be fully comparable with previous results due to changes in the survey methodology.

Barriers to adoption: focus on consumer behaviour

Behavioural issues in SMs

- Smart Energy GB (2016) has identified several behavioural issues which might apply to the SM installation decision, broadly consistent with those highlighted by the literature on privacy decisions we have reviewed as part of this project.
- In a recent academic publication, Fowlie et al. (2017) have shown that 'inertia' is a driver in consumer selection of electricity tariffs in the United States. When selecting between standard and dynamic tariffs, consumers have a bias towards the default suggested option. However, ex post, they significantly benefit from the adoption of dynamic tariffs.

Subconscious biases identified by Smart Energy GB

Inertia

People avoid decision making and tend to stick to the default option chosen

Loss aversion

People perceive the pain of loss as disproportionately greater than the pleasure of gain

Sunk cost effect

People tend to persist on a course of action once they have invested some effort into it

Discounting

People tend to discount the value of future benefits in comparison to immediate gains

Recency bias

People tend to act on information that is available, and that they can recall more readily

Satisficing

People tend to spend enough effort to achieve a satisfactory, not an optimal, result

Adherence to norms

People tend to follow the behaviour of others and conform to expectations deemed 'normal'

Trust

People assess the credibility of a source when conducting individual cost-benefit analyses

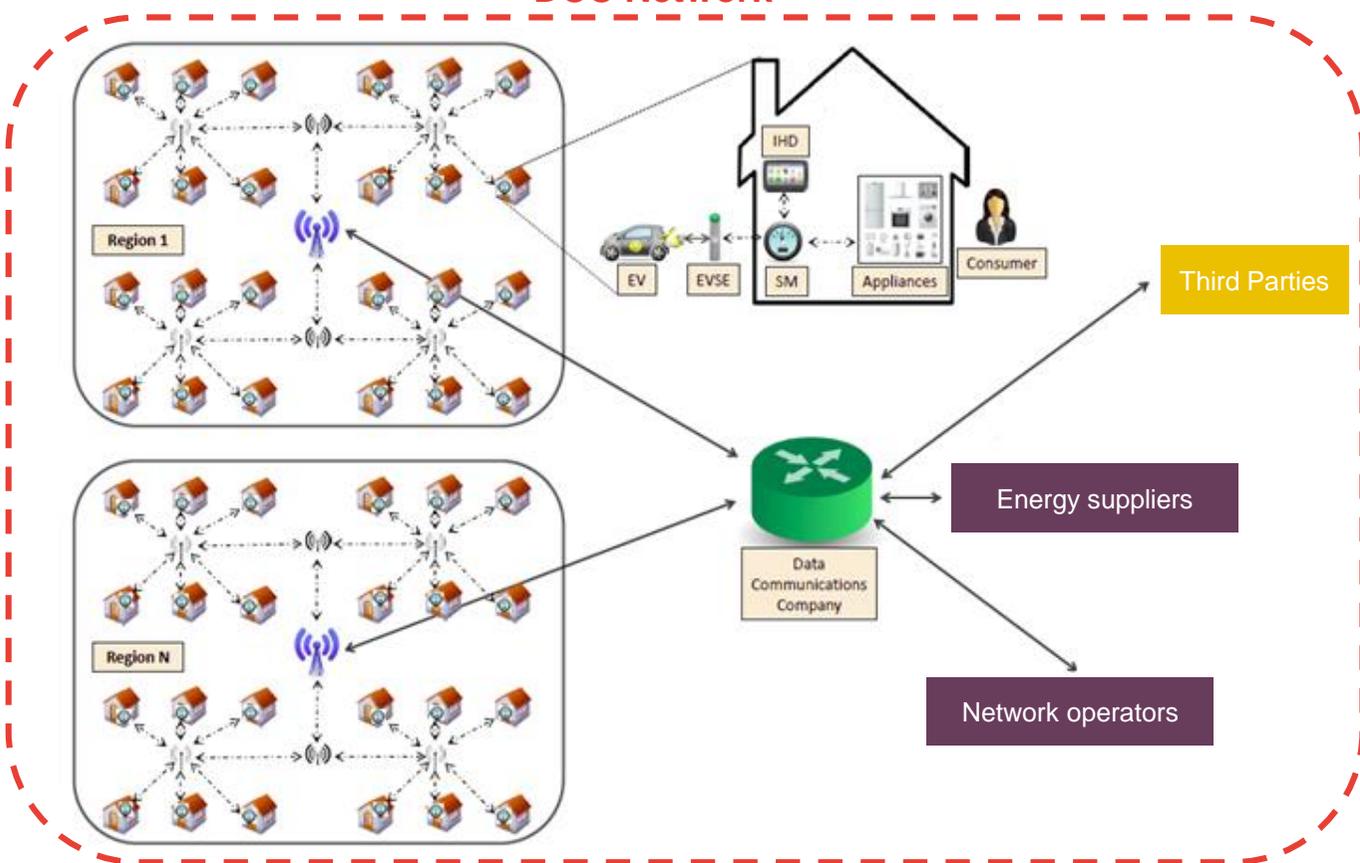
Conscious thought

The government has established a Central Hub to route the data from SM to energy suppliers, network operators and third parties

The establishment of the Data Communications Company (DCC)

- The government has established a Data Communications Company (DCC) to manage the routing of the data from consumers to the private companies. This has potential advantages in terms of network cost savings, interoperability and security.
- Consumers legally own the data and can decide how much of their individual information to share with the players (with the exclusion of minimum data required for regulated purposes).

DCC Network¹



Potential advantages of DCC

- **Network cost savings:** building a communication network for routing data is costly. The creation of the DCC has allowed economies of scale to be realised, enabling operators to achieve relevant cost savings.
- **Interoperability:** the DCC infrastructure should enable consumers to switch more easily across energy players. SMET1 meters (which were communicating directly with energy suppliers) have often lost their functionalities after switching.
- **Security:** the DCC is a regulated entity and is subject to a 12-year tendering renewal. This could potentially offer stronger incentives to ensure a safe routing of the data.

1. Figure adapted from Gunduz et al. (2015). EV stands for Electric Vehicle, EVSE for Electric Vehicle Supply Equipment and IHD for In-Home Display

The government has given consumers significant control over the use of their data from other parties in relation to SMs

General framework

- In a consultation in 2012 on 'Data Access and Privacy' within the Smart Metering Implementation Programme (DECC 2012), the DECC elaborated the existing framework to protect consumer data.
- This was incorporated within the 'Privacy Requirements' of the supply licence obligation and the Smart Energy Code (SEC).
- All parties intending to access data need to accede to the SEC and become a DCC user.

Conditions for energy suppliers

- The framework enables suppliers to access monthly consumption data for billing and other regulated purposes (Elam 2016). For more granular data, the framework requires suppliers to:
 - Obtain opt-in consent from consumers to access data at greater detail than daily reads ('Detailed Data') or to use any detail of consumption data for marketing
 - Obtain opt-out consent from consumers for access to daily or less detailed data.

Conditions for network operators

- Network operators should instead be able to access half-hourly energy consumption data from all domestic customers without consent, provided that:
 - The data were only used for regulated purposes (e.g. developing and maintaining an efficient, co-ordinated and economical network etc.)
 - They have submitted plans to Ofgem detailing which data they would access, for which purposes, and how the data would be treated such that it can no longer be associated with a single consumer.

Conditions for third parties

- Third parties can instead access data in two main ways:
 - Via the DCC network (either directly or through an existing user)
 - Via consumer access devices (smartphones, laptops, etc.) bypassing the DCC network.
- In both cases, they will still be required to accede to the SEC and register as a DCC user. The marginal cost of providing and installing large numbers of consumer access devices will be relatively high, so it seems likely that most organisations will access data via the DCC.

Implications for CDs: behavioural biases and lack of information could influence the adoption of CDs

Knowledge of CDs should not be taken for granted



- Latest findings from Energy GB show that a large majority of consumers now have at least some knowledge of what SMs do. However, there is still a third of consumers who do not – and this proportion is higher among younger people and private renters (Smart Energy GB 2017b).
- This highlights that limited knowledge of costs and benefits arising from CDs could be a significant barrier to their successful adoption.

Behavioural biases are important



- Consumers may not give sufficient consideration to future outcomes, and may prefer avoiding losses than realising gains.
- This may explain in part issues around the adoption of SMs – which imply immediate costs (at least in terms of time) and future savings (that are also uncertain from the point of view of the consumer).
- Similar biases may be relevant for CDs – limiting their adoption (if the time profile of benefits is similar to SMs) or fostering it (if they provide immediate gratification).

When they are adopted, automation could help achieve benefits



- In the case of SM, the energy savings can potentially increase if some choices can be made more automatable (e.g. lights switch off automatically within a connected home system).
- This shows that, to realise the benefits of CDs, it might be important to reduce the input required by the consumer.
- However, this might pose some additional privacy concerns, because it might increase the quantity of consumer data that is released.

Trade-offs around privacy



- SM regulation provides consumers – in principle – with means to limit the use of their data.
- This can protect consumers' privacy, but it may also limit the extent to which benefits of SMs can be fully realised. So far, it is unclear how many consumers will not opt into (or opt out from) the use of their energy consumption data.
- However, consumer trust in providers may vary by market. It is early to say how trust in CD markets compares to the energy case, but this may be one of the key drivers of how these markets evolve.

Implications for CDs: the Central Hub might offer a secure and cost-effective way of routing CDs data

Evidence on the Central Hub solution

- The Central Hub solution has been adopted to manage SM data by three countries in Europe (Denmark, Estonia, Poland) beside the UK (Zgajewski 2015). There is limited evidence of its use for other CDs systems or IoT applications alike.
- Similarly, there have not been systematic attempts to clarify its potential benefits and costs for other CDs systems.

Potential benefits of the Central Hub for CDs

- **Effective or perceived security:** if appropriate regulatory incentives are established, the Central Hub might have a greater incentive than individual players in routing the data securely. The existence of a government-like body could also reassure consumers that their data are being handled appropriately.
- **Interoperability:** the Central Hub should enable consumers to switch more easily across different players in the CDs space.



Potential costs of the Central Hub for CDs

- **Set-up could be costly:** industry players (or the government) incur extra costs to set up the regulated Central Hub. If companies simply establish common standards, this is not required.
- **Set-up could be difficult:** the Central Hub needs to interact with several market players. This might make the delivery of the network infrastructure more complicated.

The Central Hub could enable the realisation of a cheaper and more secure network for other CDs, but the set-up is not a straightforward process.

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Focus on privacy behaviour: key findings

A rich literature from psychology and economics documents the ways in which people stray systematically from 'rational behaviour' ('behavioural biases'). We do not provide a comprehensive list here, summarising instead findings on three key themes:

- 1 Making choices around privacy involves significant uncertainty. It is often unclear how data are going to be used, some costs of disclosure are intangible, and people can be uncertain over their own preferences.
- 2 Privacy choices are influenced by the choices others make, and by who the consumer is interacting with. People adapt over time to higher levels of intrusion into their privacy.
- 3 Privacy choices are influenced by subtle factors in ways that could be exploited by others:
 - Default settings matter, consistent with what has been shown in other contexts
 - Design choices influence privacy behaviour
 - The mere presence of a privacy policy can soothe privacy concerns, regardless of the content of the policy

Key sources: Acquisti et al. (2017, 2015, 2010, 2007)

Focus on privacy behaviour: key implications for Which?

Although consumers are affected by behavioural biases in their privacy decisions, providing information on personal data could nevertheless be useful

- 1 The literature suggests that consumers form ideas on what is 'normal' based on their experience and on the actions of people around them. It may be useful for some consumers to be exposed to a wider picture: for example, for people who are mainly exposed to high (low) levels of disclosure to know or be reminded that many others share less (more).
- 2 It also appears that people care about the consequences of their sharing. However, it may not be clear that there are consequences, and uncertainty implies the consequences are hard to assess. Providing information that reminds of the consequences and helps remove uncertainty (for example, making benefits and costs tangible, and quantifying them where possible) could help consumers make better decisions.
- 3 Nevertheless, even better informed consumers will always rely on shortcuts ('heuristics') and make decisions that can be influenced by design choices. Monitoring what design choices are made by companies and how they affect privacy decisions could be useful to help consumers navigate a complex world of privacy decisions.

Focus on privacy behaviour: opportunities for further research

1

It may be useful to test what type of information is most valued by consumers to support privacy decisions, and to test what is the best way to deliver it, potentially using on-line experiments.

2

It may be possible to scope quantitative work to value specific benefits and costs to consumers from the use of personal data.

3

Collecting evidence on design choices of most frequently used websites, apps and on-line services and on their (actual or potential) effects on privacy could inform consumer awareness initiatives and policy design.

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